

Module Manual

Master of Science (M.Sc.)

Product Development, Materials and Production

Cohort: Winter Term 2021

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Table of Contents

Table of Conte	ents	2
Program desci		4
Core Qualifica		5
	Business & Management	5
	Non-technical Courses for Master	6
	Nonlinear Structural Analysis	8
	Thermal Energy Systems	10 12
	: Vibration Theory : Finite Elements Methods	13
	: Control Systems Theory and Design	15
	: Continuum Mechanics	17
	Materials Modeling	20
	Applied Statistics	22
Module M1204:	Modelling and Optimization in Dynamics	24
	High-Order FEM	26
	Technical Acoustics I (Acoustic Waves, Noise Protection, Psycho Acoustics)	28
	Boundary Element Methods	29
	Practical Course Product Development, Materials and Production Nonlinear Dynamics	31
	Design optimization and probabilistic approaches in structural analysis	34
	: Technical Acoustics II (Room Acoustics, Computational Methods)	36
	Technical Complementary Course Core Studies for PEPMS (according to Subject Specific Regulation	
		938
Specialization	Product Development	40
	Aircraft Energy Systems	40
	Methods of Integrated Product Development	42
Module M1025:		44
	Cabin Systems Engineering	47
	: Aircraft Design I (Civil Aircraft Design) : Electrical Energy from Solar Radiation and Wind Power	50 52
	Robotics and Navigation in Medicine	55
	Flight Control Systems	57
	Medical Imaging Systems	59
	Selected Topics of Product Development, Materials Science and Production (Alternative A: 12 LP)	60
	Systems Engineering	74
	Turbomachinery	76
	Selected Topics of Product Development, Materials Science and Production (Alternative B: 6 LP)	78
	Mechanical Properties	92
	Optimal and Robust Control Processing of fibre-polymer-composites	94
Module M1344.	: Aircraft Design II (Special Air Vehicle Design)	98
		100
		102
Module M0563:		104
Module M0771:	Flight Physics	106
		108
Module M0830:		110
	Contains billing and Dist. Management	112
		114 116
Module M1183:		118
Module M1342:		120
		122
Module M1185:		124
Specialization		L25
		125
Module M0867:		127
		129
	A' G D ' 1/0' '1A' G D ')	131
		134 136
		139
		141
Modulo M0911	Modical Imaging Systems	1/12
Module M1141:	Selected Topics of Product Development, Materials Science and Production (Alternative A: 12 LP)	144
		158
		160
	Mochanical Droportics	162
		176 178
		180

Module M1343: Structure and properties of fibre-polymer-composites	182
Module M1344: Processing of fibre-polymer-composites	184
Module M1174: Automation Technology and Systems	186
Module M0563: Robotics	188
Module M0771: Flight Physics	190
Module M0815: Product Planning	192
Module M0830: Environmental Protection and Management	194
Module M0962: Sustainability and Risk Management	196
Module M1024: Methods of Integrated Product Development	198
Module M1025: Fluidics	200
Module M1155: Aircraft Cabin Systems	203
Module M1342: Polymers	205
Module M1170: Phenomena and Methods in Materials Science	207
Module M1185: Technical Complementary Course for PEPMS (according to Subject Specific Regulations)	209
Specialization Materials	210
Module M0763: Aircraft Energy Systems	210
Module M1141: Selected Topics of Product Development, Materials Science and Production (Alternative A: 1	2 LP) 212
Module M1209: Selected Topics of Product Development, Materials Science and Production (Alternative B: 6	LP) 226
Module M1193: Cabin Systems Engineering	240
Module M0511: Electrical Energy from Solar Radiation and Wind Power	243
Module M0630: Robotics and Navigation in Medicine	246
Module M0764: Flight Control Systems	248
Module M0811: Medical Imaging Systems	250
Module M1156: Systems Engineering	251
Module M1161: Turbomachinery	253
Module M1226: Mechanical Properties	255
Module M0840: Optimal and Robust Control	257
Module M1343: Structure and properties of fibre-polymer-composites	259
Module M1344: Processing of fibre-polymer-composites	261
Module M1174: Automation Technology and Systems	263
Module M0563: Robotics	265
Module M0771: Flight Physics	267
Module M0815: Product Planning	269
Module M0830: Environmental Protection and Management	271
Module M0867: Production Planning & Control and Digital Enterprise	273
Module M0962: Sustainability and Risk Management	275
Module M1024: Methods of Integrated Product Development	277
Module M1155: Aircraft Cabin Systems	279
Module M1025: Fluidics	281
Module M1183: Laser Systems and Methods of Manufacturing Design and Analysis	284
Module M1342: Polymers	286
Module M1185: Technical Complementary Course for PEPMS (according to Subject Specific Regulations)	288
Module M1170: Phenomena and Methods in Materials Science	289
Thesis	291
Module M-002: Master Thesis	291
	

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 form 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: Busin	ess & Management
Module Responsible	Prof. Matthias Meyer
Admission Requirements	None
Recommended Previous	None
Knowledge	
Educational Objectives	After taking part successfully, students have reached the following learning results
Professional Competence	
Knowledge Skills	 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.
Personal Competence Social Competence	Students are able to communicate in small interdisciplinary groups and to jointly develop solutions for complex problems
Autonomy	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	

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 None	
Knowledge	
Educational Objectives	After taking part successfully, students have reached the following learning results

Professional Competence

Knowledae

The Nontechnical Academic Programms (NTA)

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.

The Learning Architecture

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.

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".

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.

Teaching and Learning Arrangements

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.

Fields of Teaching

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.

The fields of teaching are augmented by soft skills offers and a foreign language offer. Here, the focus is on encouraging goaloriented communication skills, e.g. the skills required by outgoing engineers in international and intercultural situations.

The Competence Level

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.

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.

Specialized Competence (Knowledge)

Students can

- 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.

Skills Professional Competence (Skills)

In selected sub-areas students can

- $\bullet\;$ apply basic and specific methods of the said scientific disciplines,
- aquestion 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 sucsessful 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

Social Competence | Personal Competences (Social Skills)

	 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.
Autonomy	Personal Competences (Self-reliance) Students are able in selected areas • 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 writen form or verbaly • to organize themselves as an entrepreneurial subject country (as far as this study-focus would be chosen)
	Depends on choice of courses
Credit points	, o

ourses

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

Module M0603: Nonlin	near Structural Analysis			
Courses				
Title		Тур	Hrs/wk	СР
Nonlinear Structural Analysis (L027		Lecture	3	4
Nonlinear Structural Analysis (L027	9)	Recitation Section (small)	1	2
Module Responsible	Prof. Alexander Düster			
Admission Requirements	None			
Recommended Previous	Knowledge of partial differential equations is recomme	nded.		
Knowledge				
Educational Objectives	After taking part successfully, students have reached t	he following learning results		
Professional Competence				
Knowledge	Students are able to			
	+ give an overview of the different nonlinear phenome	na in structural mechanics.		
	+ explain the mechanical background of nonlinear phe	nomena in structural mechanics.		
	+ to specify problems of nonlinear structural analysis,	to identify them in a given situation a	nd to explain the	eir mathematical and
	mechanical background.			
Skills	Students are able to			
	+ model nonlinear structural problems.			
	+ select for a given nonlinear structural problem a suit	able computational procedure.		
	+ apply finite element procedures for nonlinear structu			
	+ critically verify and judge results of nonlinear finite e	lements.		
	+ to transfer their knowledge of nonlinear solution pro-	cedures to new problems.		
Personal Competence				
Social Competence	Students are able to			
	+ solve problems in heterogeneous groups and to docu	ument the corresponding results.		
	+ share new knowledge with group members.			
Autonomy	Students are able to			
3	+ acquire independently knowledge to solve complex	problems.		
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56	õ		
Credit points	6			
Course achievement	None			
Examination	Written exam			
Examination duration and	120 min			
scale				
Assignment for the	Civil Engineering: Specialisation Structural Engineering	: Elective Compulsory		
Following Curricula	International Management and Engineering: Specialisa	tion II. Civil Engineering: Elective Comp	ulsory	
	Materials Science: Specialisation Modeling: Elective Co	mpulsory		
	Mechatronics: Specialisation System Design: Elective C	compulsory		
	Product Development, Materials and Production: Core	Qualification: Elective Compulsory		
	Naval Architecture and Ocean Engineering: Core Qualif	ication: Elective Compulsory		
	Ship and Offshore Technology: Core Qualification: Elect	tive Compulsory		
	Theoretical Mechanical Engineering: Specialisation Sim	ulation Technology: Elective Compulso	ry	

Course L0277: Nonlinear Structural Analysis		
Тур	Lecture	
Hrs/wk	3	
СР	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	
	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 Structrual 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	
Тур	Recitation Section (small)
Hrs/wk	1
СР	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: Therr	nal Energy Systems			
	37 7			
Courses				
Title		Тур	Hrs/wk	СР
Thermal Engergy Systems (L0023)		Lecture	3	5
Thermal Engergy Systems (L0024)		Recitation Section (large)	1	1
Module Responsible	,			
Admission Requirements		,		
	Technical Thermodynamics I, II, Fluid Dynamics, Heat Trans	fer		
Knowledge				
Educational Objectives		llowing learning results		
Professional Competence		d the difference between efficien		66 - i Th h
Knowieage	Students know the different energy conversion stages an		-	
	increased knowledge in heat and mass transfer, especially German energy saving code and other technical relevant r			-
	industrial area and how to control such heating system	•		
	temperatures in a furnace. They have the basic knowledge			
	conduct the flue gases into the atmosphere. They are able			
	are and the same gases are all all assignments are asset	o model and mody laring systems	02,000 01.01.	tea languages.
Skills	Students are able to calculate the heating demand for diffe	rent heating systems and to choos	se the suitable co	omponents. They are
	able to calculate a pipeline network and have the ability to			
	Modelica programs and can transfer research knowledge	into practice. They are able to p	erform scientific	work in the field of
	thermal engineering.			
Personal Competence				
Social Competence	The students are able to discuss in small groups and develop	pp an approach.		
Autonomy	Students are able to define independently tasks, to get new	v knowledge from existing knowled	dge 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	60 min			
scale				
Assignment for the	Bioprocess Engineering: Specialisation A - General Bioproce	ss Engineering: Elective Compulso	ery	
Following Curricula	Energy Systems: Specialisation Energy Systems: Compulso	ту		
	Energy Systems: Specialisation Marine Engineering: Electiv			
	International Management and Engineering: Specialisation		neering: Elective	Compulsory
	Product Development, Materials and Production: Core Qual	fication: Elective Compulsory		
	Renewable Energies: Core Qualification: Compulsory			
	Theoretical Mechanical Engineering: Specialisation Energy			
	Process Engineering: Specialisation Process Engineering: El	ective Compulsory		

Course L0023: Thermal Enge	Avail Cyclema
	Lecture
Hrs/wk	
CP	
	Independent Study Time 108, Study Time in Lecture 42
	Prof. Arne Speerforck, Prof. Gerhard Schmitz
Language	DE
Cycle	WiSe
Content	1. Introduction
	 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 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 Thermal traetment 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 Laws and standards 5.1 Buildings 5.2 Industrial plants
Literature	 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, ER.: Taschenbuch für Heizung- und Klimatechnik 2013/2014, 76. Auflage, Deutscher Industrieverlag, 2013

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

Module M0751: Vibra	tion Theory			
Courses				
Title		Тур	Hrs/wk	СР
Vibration Theory (L0701)		Integrated Lecture	4	6
Module Responsible	Prof. Norbert Hoffmann			
Admission Requirements	None			
Recommended Previous Knowledge	Calculus Linear Algebra Engineering Mechanics			
Educational Objectives	After taking part successfully, students have reached the	following learning results		
Professional Competence				
Knowledge	Students are able to denote terms and concepts of Vibra	tion Theory and develop them fur	ther.	
Skills	Students are able to denote methods of Vibration Theory	and develop them further.		
Personal Competence				
Social Competence	Students can reach working results also in groups.			
Autonomy	Students are able to approach individually research tasks	in Vibration Theory.		
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56			
Credit points	6			
Course achievement	None			
Examination	Written exam			
Examination duration and	2 Hours			
scale				
_	Energy Systems: Core Qualification: Elective Compulsory			
Following Curricula	International Management and Engineering: Specialisation		•	
	Mechanical Engineering and Management: Specialisation	Mechatronics: Elective Compulso	ory	
	Mechatronics: Core Qualification: Compulsory	nd Baganarativa Madicina, Flacti	uo Compulsoru	
	Biomedical Engineering: Specialisation Artificial Organs a Biomedical Engineering: Specialisation Implants and End	-	, ,	
	Biomedical Engineering: Specialisation Medical Technology			
	Biomedical Engineering: Specialisation Management and	• •		
	Product Development, Materials and Production: Core Qu			
	Naval Architecture and Ocean Engineering: Core Qualific			
	Theoretical Mechanical Engineering: Core Qualification: E	lective Compulsory		

Course L0701: Vibration Theory		
Тур	Integrated Lecture	
Hrs/wk	4	
СР	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	e Elements Methods			
Courses				
Title		Тур	Hrs/wk	СР
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	Mechanics I (Statics, Mechanics of Materials) and Mechanics	II (Hydrostatics, Kinematics, Dyn	amics)	
Knowledge	Mathematics I, II, III (in particular differential equations)			
Educational Objectives	After taking part successfully, students have reached the foll	lowing learning results		
Professional Competence				
Knowledge	The students possess an in-depth knowledge regarding the overview of the theoretical and methodical basis of the method in the control of the		ent method and	are able to give a
G1 W				
Skills	s 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.			
Personal Competence				
Social Competence	Students can work in small groups on specific problems to a	rrive at joint solutions.		
Autonomy	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.			
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56			
Credit points				
Course achievement		n		
course demevement	No 20 % Midterm			
Examination	Written exam			
Examination duration and	120 min			
scale				
Assignment for the	Civil Engineering: Core Qualification: Compulsory			
Following Curricula	Energy Systems: Core Qualification: Elective Compulsory			
	Aircraft Systems Engineering: Specialisation Aircraft Systems	s: Elective Compulsory		
	Aircraft Systems Engineering: Specialisation Air Transportation	on Systems: Elective Compulsory	,	
	Aircraft Systems Engineering: Core Qualification: Elective Co	mpulsory		
	International Management and Engineering: Specialisation II	. Mechatronics: Elective Compuls	ory	
	International Management and Engineering: Specialisation II	. Product Development and Produ	uction: Elective C	ompulsory
	Mechatronics: Core Qualification: Compulsory			
	Biomedical Engineering: Specialisation Implants and Endopro	ostheses: Compulsory		
	Biomedical Engineering: Specialisation Management and Bus		ompulsory	
	Biomedical Engineering: Specialisation Medical Technology a			
	Biomedical Engineering: Specialisation Artificial Organs and	Regenerative Medicine: Elective	Compulsory	
	Product Development, Materials and Production: Core Qualifi			
	Technomathematics: Specialisation III. Engineering Science:	Elective Compulsory		
	Theoretical Mechanical Engineering: Core Qualification: Com	nulcon/		

Course L0291: Finite Element Methods			
Тур	Lecture		
Hrs/wk	2		
СР	3		
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28		
Lecturer	Prof. Otto von Estorff		
Language	EN		
Cycle	WiSe		
Content	- 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, KJ. (2000): Finite-Elemente-Methoden. Springer Verlag, Berlin		

Course L0804: Finite Element Methods		
Тур	Recitation Section (large)	
Hrs/wk	2	
СР	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: Contr	ol Systems Theory and Design			
Courses				
Title		Tun	Hrs/wk	СР
Control Systems Theory and Design	n (L0656)	Typ Lecture	Hrs/wk 2	4
Control Systems Theory and Design		Recitation Section (small)	2	2
Module Responsible	Prof. Herbert Werner			
Admission Requirements	None			
Recommended Previous	Introduction to Control Systems			
Knowledge				
Educational Objectives	After taking part successfully, students have reached	the following learning results		
Professional Competence				
Knowledge	Students can explain how linear dynamic sys	tems are represented as state space n	nodels; they can	interpret the system
	response to initial states or external excitation			
	 They can explain the system properties contr 	ollability and observability, and their re	ationship to state	e feedback and state
	estimation, respectively			
	They can explain the significance of a minimal			
	They can explain observer-based state feedba They can extend all of the above to multi-innu-		cking and disturt	pance rejection
	 They can extend all of the above to multi-inpu They can explain the z-transform and its relati 			
	They can explain state space models and tran		items	
	They can explain the experimental identificati			ification problem can
	be solved by solving a normal equation			
	They can explain how a state space model car	be constructed from a discrete-time im	pulse response	
Skills				
	Students can transform transfer function mode There are a grant all a billion and a base and billion. The control of th		ia .	
	 They can assess controllability and observabil They can design LQG controllers for multivaria 			
	They can design EQG controllers for multivaria They can carry out a controller design both in		nain and decide	which is appropriate
	for a given sampling rate		,	
	They can identify transfer function models and	state space models of dynamic system	s from experimen	tal data
	They can carry out all these tasks using standard software tools (Matlab Control Toolbox, System Identification Toolbox,			
	Simulink)			
Personal Competence				
Social Competence	Students can work in small groups on specific problems to arrive at joint solutions.			
Autonomy	Students can obtain information from provided sources (lecture notes, software documentation, experiment guides) and use it			
,	when solving given problems.		,,	ga,
	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	120 min			
scale				
•	Electrical Engineering: Core Qualification: Compulsor	•		
Following Curricula	Energy Systems: Core Qualification: Elective Compul Aircraft Systems Engineering: Core Qualification: Ele-	•		
	Computational Science and Engineering: Specialisation	' '	nulsory	
	International Management and Engineering: Specialisation	,		
	International Management and Engineering: Specialis			
	Mechanical Engineering and Management: Specialisa	·	•	
	Mechatronics: Core Qualification: Compulsory			
	Biomedical Engineering: Specialisation Artificial Orga	ns and Regenerative Medicine: Elective	Compulsory	
	Biomedical Engineering: Specialisation Implants and			
	Biomedical Engineering: Specialisation Medical Techn			
	Biomedical Engineering: Specialisation Management		mpulsory	
	Product Development, Materials and Production: Core Theoretical Mechanical Engineering: Core Qualification			
	meoretical mechanical Engineering. Core Qualification	л. сопіршаоту		

Course L0656: Control System	ms Theory and Design		
Тур	Lecture		
Hrs/wk	2		
СР	4		
Workload in Hours	Independent Study Time 92, Study Time in Lecture 28		
Lecturer	Prof. Herbert Werner		
Language	EN		
Cycle	WiSe		
Content	State space methods (single-input single-output)		
	Chaba are an and also and horse for for able on a shake for all and		
	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		
	Multi-input multi-output systems		
	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		
	Digital Control		
	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		
	System identification and model order reduction		
	Least squares estimation, ARX models, persistent excitation		
	Identification of state space models, subspace identification		
	Balanced realization and model order reduction		
	Case study		
	Modelling and multivariable control of a process evaporator using Matlab and Simulink		
	Software tools		
	Matlab/Simulink		
Literature			
	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		
Тур	Recitation Section (small)	
Hrs/wk	2	
СР	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: Conti	nuum Mechanics			
Courses				
Title		Тур	Hrs/wk	СР
Continuum Mechanics (L1533)		Lecture	2	3
Continuum Mechanics Exercise (L15	534)	Recitation Section (small)	2	3
Module Responsible	Prof. Christian Cyron			
Admission Requirements	None			
Recommended Previous	Basics of linear continuum mechanics as taught, e.g., in	the module Mechanics II (forces and	d moments, stres	ss, linear strain, free-
Knowledge	body principle, linear-elastic constitutive laws, strain ene	ergy).		
Educational Objectives	After taking part successfully, students have reached the	e following learning results		
Professional Competence				
Knowledge				
	The students can explain the fundamental concepts to calculate the mechanical behavior of materials.			
Skills	The students can set up balance laws and apply basics of deformation theory to specific aspects, both in applied contexts as in research contexts.			
Personal Competence				
Social Competence	The students are able to develop solutions, to present them to specialists in written form and to develop ideas further.			
Autonomy	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.			
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56			
Credit points	6			
Course achievement	None			
Examination	Written exam			
Examination duration and	60 min			
scale				
Assignment for the	Materials Science: Specialisation Modeling: Elective Com	pulsory		
Following Curricula	Mechanical Engineering and Management: Specialisation			
	Mechatronics: Technical Complementary Course: Elective			
	Biomedical Engineering: Specialisation Artificial Organs a		Compulsory	
	Biomedical Engineering: Specialisation Implants and End			
	Biomedical Engineering: Specialisation Medical Technolo			
	Biomedical Engineering: Specialisation Management and		mpulsory	
	Product Development, Materials and Production: Core Qu			
	Theoretical Mechanical Engineering: Core Qualification: E	Elective Compulsory		

Course L1533: Continuum Me	echanics
Тур	Lecture
СР	3
	Independent Study Time 62, Study Time in Lecture 28
	Prof. Christian Cyron
Language	
Cycle	
	WIGE
Content	Fundamentals of tensor calculus Transformation invariance Tensor algebra Tensor analysis Kinematics Motion of continuum Deformation of infinitesimal line, area and volume elements Material and spatial description Polar decomposition Spectral decomposition Spectral decomposition Strain measures Time derivatives Partial / material time derivatives Strain and deformation rates Transport theorems Balance equations (global and local form) Balance of mass The stress state Surface traction vectors Cauchy's fundamental theorem Stress tensors (Cauchy, 1. and 2. Piola-Kirchhoff, Kirchhoff stress tensor) Balance of angular momentum Balance of energy Balance of entropy Clausius-Duhem inequality Constitutive laws Constitutive laws Fluids Elastic solids Hyperelasticity Material symmetry
	Elasto-plastic solids Analysis
	Initial-boundary value problems and their numerical solution
Literature	R. Greve: Kontinuumsmechanik: Ein Grundkurs für Ingenieure und Physiker
	I-S. Liu: Continuum Mechanics, Springer
	weitere siehe in der Literaturliste des Scripts

Course L1534: Continuum Mechanics Exercise			
Тур	Recitation Section (small)		
Hrs/wk	2		
СР	3		
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28		
Lecturer	Prof. Christian Cyron		
Language	DE		
Cycle	WiSe		
Content	 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		

Module M1151: Mater	rials Modeling			
Courses				
Title		Тур	Hrs/wk	СР
Material Modeling (L1535)		Lecture	2	3
Material Modeling (L1536)		Recitation Section (small)	2	3
Module Responsible	Prof. Christian Cyron			
Admission Requirements	None			
Recommended Previous	Basics of linear and nonlinear continuum mechanics as	taught, e.g., in the modules Mechanic	s II and Continuu	m Mechanics (forces
Knowledge	and moments, stress, linear and nonlinear strain, free-b	ody principle, linear and nonlinear con	stitutive laws, st	rain energy)
Educational Objectives	After taking part successfully, students have reached th	e following learning results		
Professional Competence				
Knowledge	The students can explain the fundamentals of multidime	ensional consitutive material laws		
Skills	The students can implement their own material laws in	finite element codes. In particular, the	e students can a	pply their knowledge
	to various problems of material science and evaluate th	e corresponding material models.		
Personal Competence				
Social Competence	The students are able to develop solutions, to present the	nem to specialists and to develop idea	s further.	
Autonomy	The students are able to assess their own strengths and problems in the area of materials modeling and acquire	•	y and on their ov	wn identify and solve
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56			
Credit points	6			
Course achievement	None			
Examination	Written exam			
Examination duration and	60 min			
scale				
Assignment for the	Materials Science: Specialisation Modeling: Elective Con	npulsory		
Following Curricula	Mechanical Engineering and Management: Specialisatio	n Materials: Elective Compulsory		
	Biomedical Engineering: Specialisation Artificial Organs	and Regenerative Medicine: Elective C	Compulsory	
	Biomedical Engineering: Specialisation Implants and Engineering			
	Biomedical Engineering: Specialisation Medical Technology		-	
	Biomedical Engineering: Specialisation Management and		mpulsory	
	Product Development, Materials and Production: Core Q			
	Theoretical Mechanical Engineering: Specialisation Mate	• •		
	Theoretical Mechanical Engineering: Specialisation Simu	liation Technology: Elective Compulso	ry	

Course L1535: Material Mode	eling
Тур	Lecture
Hrs/wk	2
СР	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Prof. Christian Cyron
Language	DE
Cycle	WiSe
Content	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 - 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) 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.
Literature	

Course L1536: Material Modeling	
Тур	Recitation Section (small)
Hrs/wk	2
СР	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: Applie	ed Statistics				
Courses					
Title			Тур	Hrs/wk	СР
Applied Statistics (L1584)			Lecture	2	3
Applied Statistics (L1586)			Project-/problem-based Lea	arning 2	2
Applied Statistics (L1585)			Recitation Section (small)	1	1
Module Responsible	Prof. Michael Morlock				
Admission Requirements	None				
Recommended Previous	Basic knowledge of st	atistical methods			
Knowledge					
Educational Objectives	After taking part succ	essfully, students have re	ached the following learning results		
Professional Competence					
Knowledge	Students can explain	the statistical methods an	d the conditions of their use.		
Skills	Students are able to use the statistics program to solve statistics problems and to interpret and depict the results				
Personal Competence					
Social Competence	Team Work, joined pr	esentation of results			
Autonomy	To understand and in	terpret the question and s	olve		
Workload in Hours	Independent Study Ti	me 110, Study Time in Le	cture 70		
Credit points	6				
Course achievement	Compulsory Bonus	Form	Description		
	Yes None	Written elaboration			
Examination	Written exam				
Examination duration and	90 minutes, 28 quest	ons			
scale					
Assignment for the	Mechanical Engineeri	ng and Management: Spe	ialisation Management: Elective Compulso	ry	
Following Curricula	Mechatronics: Special	isation System Design: El	ective Compulsory		
	Mechatronics: Specialisation Intelligent Systems and Robotics: Elective Compulsory				
	Biomedical Engineeri	ng: Core Qualification: Cor	npulsory		
	Product Development	, Materials and Production	: Core Qualification: Elective Compulsory		
	Theoretical Mechanic	al Engineering: Specialisat	ion Bio- and Medical Technology: Elective C	Compulsory	

Course L1584: Applied Statis	itics
	Lecture
Hrs/wk	
СР	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Prof. Michael Morlock
Language	DE/EN
Cycle	WiSe
Content	The goal is to introduce students to the basic statistical methods and their application to simple problems. The topics include:
	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 categorial data
	Chossing the appropriate statistical method
	Determining critical sample sizes
Literature	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

Course L1586: Applied Statis	Course L1586: Applied Statistics		
Тур	Project-/problem-based Learning		
Hrs/wk	2		
СР	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 Statis	stics
Тур	Recitation Section (small)
Hrs/wk	1
СР	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: Mode	lling and Optimization in Dynamics			
Courses				
Title Flexible Multibody Systems (L1632))	Typ Lecture	Hrs/wk	CP 3
Optimization of dynamical systems (L1633)		Lecture	2	3
Module Responsible	Prof. Robert Seifried			
Admission Requirements	None			
Recommended Previous Knowledge	Mathematics I, II, III Mechanics I, II, III, IV Simulation of dynamical Systems			
Educational Objectives	After taking part successfully, students have reached th	e following learning results		
Professional Competence Knowledge				
Skills	Students are able + to think holistically + to independently, securly and critically analyze and systems + to describe dynamics problems mathematically + to optimize dynamics problems	optimize basic problems of	the dynamics of rigid an	d flexible multibo
Personal Competence Social Competence	Students are able to + solve problems in heterogeneous groups and to docur	ment the corresponding resu	lts.	
Autonomy	Students are able to + assess their knowledge by means of exercises. + acquaint themselves with the necessary knowledge to	o solve research oriented tas	ks.	
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56			
Credit points				
Course achievement				
Examination				
Examination duration and				
scale				
Assignment for the Following Curricula	Energy Systems: Core Qualification: Elective Compulson Aircraft Systems Engineering: Core Qualification: Electiv Aircraft Systems Engineering: Specialisation Aircraft Sys Mechatronics: Specialisation System Design: Elective Co Mechatronics: Specialisation Intelligent Systems and Rol Product Development, Materials and Production: Core Q	e Compulsory tems: Elective Compulsory impulsory potics: Elective Compulsory	sory	
	Product Development, Materials and Production: Core Q Theoretical Mechanical Engineering: Core Qualification:	•	sory	

Course L1632: Flexible Multibody Systems		
Тур	Lecture	
Hrs/wk	2	
СР	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	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	Schwertassek, R. und Wallrapp, O.: Dynamik flexibler Mehrkörpersysteme. Braunschweig, Vieweg, 1999. Seifried, R.: Dynamics of Underactuated Multibody Systems, Springer, 2014. Shabana, A.A.: Dynamics of Multibody Systems. Cambridge Univ. Press, Cambridge, 2004, 3. Auflage.	

Course L1633: Optimization of dynamical systems		
Тур	Lecture	
Hrs/wk	2	
СР	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	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	Bestle, D.: Analyse und Optimierung von Mehrkörpersystemen. Springer, Berlin, 1994. Nocedal, J. , Wright , S.J. : Numerical Optimization. New York: Springer, 2006.	

Module M0604: High-	Order FEM			
Courses				
Title		Тур	Hrs/wk	СР
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 of partial differential equations is recomm	ended.		
Knowledge				
	After taking part successfully, students have reached	the following learning results		
Professional Competence				
Knowledge	Students are able to			
	+ give an overview of the different (h, p, hp) finite ele	ment procedures.		
	+ explain high-order finite element procedures.+ specify problems of finite element procedures, to	identify them in a given cituation a	nd to ovnlain thei	r mathematical and
	mechanical background.	dentity them in a given situation a	nd to explain the	i illatilelliatical allu
	co.idinedi baengi sanai			
Skills	Students are able to			
	+ apply high-order finite elements to problems of stru			
	+ select for a given problem of structural mechanics	•		
	+ critically judge results of high-order finite elements+ transfer their knowledge of high-order finite element			
	Transfer their knowledge of high-order limite elemen	its to new problems.		
Personal Competence				
Social Competence	Students are able to			
	+ solve problems in heterogeneous groups and to do	cument the corresponding results.		
Autonomy	Students are able to			
	+ 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 5	56		
Credit points	6			
Course achievement		scription		
		rschendes Lernen		
Examination	Written exam			
Examination duration and	120 min			
scale	Energy Cystems, Care Qualification, Floating Commune			
Following Curricula	Energy Systems: Core Qualification: Elective Compuls International Management and Engineering: Specialis	,	luction: Floctivo Co	mpulcory
Following Curricula	Materials Science: Specialisation Modeling: Elective Co	·	accion. Liective CC	inipuisui y
	Mechanical Engineering and Management: Specialisat		on: Elective Comp	ulsory
	Mechatronics: Technical Complementary Course: Elec			•
	Product Development, Materials and Production: Core			
	Naval Architecture and Ocean Engineering: Core Qual	ification: Elective Compulsory		
	Technomathematics: Specialisation III. Engineering Sc	ience: Elective Compulsory		
	Theoretical Mechanical Engineering: Core Qualification	n: Elective Compulsory		

Course L0280: High-Order FEM		
Тур	Lecture	
Hrs/wk	3	
СР	4	
Workload in Hours	Independent Study Time 78, Study Time in Lecture 42	
Lecturer	Prof. Alexander Düster	
Language	EN	
Cycle	SoSe	
Content	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	[1] Alexander Düster, High-Order FEM, Lecture Notes, Technische Universität Hamburg-Harburg, 164 pages, 2014	
	[2] Barna Szabo, Ivo Babuska, Introduction to Finite Element Analysis – Formulation, Verification and Validation, John Wiley & Sons,	
	2011	

Course L0281: High-Order FE	ourse L0281: High-Order FEM		
Тур	Recitation Section (large)		
Hrs/wk	1		
СР	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: Techr	nical Acoustics I (Acoustic Waves, Nois	se Protection, Psycho Aco	ustics)	
Courses				
Title		Тур	Hrs/wk	СР
Technical Acoustics I (Acoustic Way	ves, Noise Protection, Psycho Acoustics) (L0516)	Lecture	2	3
Technical Acoustics I (Acoustic Way	res, Noise Protection, Psycho Acoustics) (L0518)	Recitation Section (large)	2	3
Module Responsible	Prof. Otto von Estorff			
Admission Requirements	None			
Recommended Previous	Mechanics I (Statics, Mechanics of Materials) and Mecha	nics II (Hydrostatics, Kinematics, Dyna	amics)	
Knowledge	Mathematics I, II, III (in particular differential equations)			
Educational Objectives	After taking part successfully, students have reached th	e following learning results		
Professional Competence				
Knowledge	The students possess an in-depth knowledge in acous	tics regarding acoustic waves, noise p	protection, and p	sycho acoustics and
	are able to give an overview of the corresponding theor	etical and methodical basis.		
Sville	The students are canable to handle engineering mablems in equation by these based application of the demand			of the demanding
Skiiis	Skills The students are capable to handle engineering problems in acoustics by theory-based application of the methodologies and measurement procedures treated within the module.			or the demanding
	meanount great and measurement procedures areased in	icimi che 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 challeng	ging acoustical problems in the areas	treated within	the module. Possible
	conflicting issues and limitations can be identified and t			
	,			
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56			
Credit points	6			
Course achievement	None			
Examination	Written exam			
Examination duration and	90 min			
scale				
Assignment for the	Energy Systems: Core Qualification: Elective Compulsor	у		
Following Curricula	Aircraft Systems Engineering: Core Qualification: Elective	e Compulsory		
	International Management and Engineering: Specialisat	ion II. Aviation Systems: Elective Comp	oulsory	
	Mechatronics: Specialisation System Design: Elective Co	ompulsory		
	Product Development, Materials and Production: Core Q	ualification: Elective Compulsory		
	Technomathematics: Specialisation III. Engineering Scie			
	Theoretical Mechanical Engineering: Specialisation Prod	uct Development and Production: Elec	tive Compulsory	

Course L0516: Technical Aco	Course L0516: Technical Acoustics I (Acoustic Waves, Noise Protection, Psycho Acoustics)		
Тур	Lecture		
Hrs/wk	2		
СР	3		
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28		
Lecturer	Prof. Otto von Estorff		
Language	EN		
Cycle	SoSe		
Content	- Introduction and Motivation		
	- Acoustic quantities		
	- Acoustic waves		
	- Sound sources, sound radiation		
	- Sound engergy 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 Aco	ourse L0518: Technical Acoustics I (Acoustic Waves, Noise Protection, Psycho Acoustics)		
Тур	Recitation Section (large)		
Hrs/wk	2		
СР	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: Boun	dary Element Methods			
Courses				
Title		Тур	Hrs/wk	СР
Boundary Element Methods (L0523		Lecture	2 2	3
Boundary Element Methods (L0524		Recitation Section (large)	2	3
Module Responsible	1			
Admission Requirements				
Recommended Previous		hanics II (Hydrostatics, Kinematics, Dyr	namics)	
Knowledge				
Educational Objectives	After taking part successfully, students have reached	the following learning results		
Professional Competence				
Knowledge	The students possess an in-depth knowledge regard overview of the theoretical and methodical basis of the		ment method and	l are able to give ar
Skills	The students are capable to handle engineering corresponding system matrices, and solving the resul	, ,	boundary elemer	nts, assembling the
Personal Competence Social Competence Autonomy	Students can work in small groups on specific problem. The students are able to independently solve challer. Problems can be identified and the results are critical.	nging computational problems and dev	relop own bounda	ry element routines
Workload in Hours	Independent Study Time 124, Study Time in Lecture 5	56		
Credit points				
Course achievement		scription		
COL. SO WEING FOR INCIDENT	No 20 % Midterm			
Examination	Written exam			
Examination duration and	90 min			
scale				
Assignment for the	Civil Engineering: Specialisation Structural Engineerin	g: Elective Compulsory		
Following Curricula				
	Civil Engineering: Specialisation Coastal Engineering:	Elective Compulsory		
	Energy Systems: Core Qualification: Elective Compuls	ory		
	Mechanical Engineering and Management: Specialisat	tion Product Development and Producti	on: Elective Comp	ulsory
	Mechatronics: Specialisation System Design: Elective	Compulsory		
	Product Development, Materials and Production: Core	Qualification: Elective Compulsory		
	Technomathematics: Specialisation III. Engineering Sc	cience: Elective Compulsory		
	Theoretical Mechanical Engineering: Specialisation Sir	mulation Technology: Elective Compuls	ory	

Course L0523: Boundary Eler	ment Methods
Тур	Lecture
Hrs/wk	2
СР	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Prof. Otto von Estorff
Language	EN
Cycle	SoSe
Content	- 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, KJ. (2000): Finite-Elemente-Methoden. Springer Verlag, Berlin

Course L0524: Boundary Element Methods	
Тур	Recitation Section (large)
Hrs/wk	2
СР	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

lodule M1164: Pract	ical Course Product Development, I	viaterials and Production		
ourses				
tle		Тур	Hrs/wk	СР
	ent, Materials and Production (L1566)	Practical Course	6	6
Module Responsible	Prof. Wolfgang Hintze			
Admission Requirements	None			
Recommended Previous Knowledge	Product Development:			
Kilowiedge	Lectures: Mechanics I-III			
	Lectures: Integrated Product Development I i	ncl. CAD practical training		
	Materials:			
	Lectures: Structural Metallic Materials, Metall	ic Materials for Aircraft Applications I	ntroduction to Matori	als Tosting
	Lectures: Structure and Properties of Polym			
	Composites		,	3
	Pure desertions			
	Production:			
	Lecture: Production Engineering			
	Lectures: Forming and Cutting Technology, M	lethods of production process design		
	Lectures: Machine Tools and Robotic			
Educational Objectives	After taking part successfully, students have reache	ed the following learning results		
Professional Competence	Arter taking part successiany, stadents have reache	at the following learning results		
	Students can			
-				
	 represent more complex context of different describe functionality of modern measureme 		phologics	
	describe functionality of modern measureme	The mistramentations and machine teer	mologies.	
Skills	Students are capable of			
	applying theoretical knowledge for practical a	applications		
	applying theoretical knowledge for practical as applying provided experimental methods for		of study.	
	analyzing and evaluating experimental result		,	
	 applying modern measurement instrumentat 	ions.		
Personal Competence				
Social Competence	Students can			
	 carry out and document experimental work in 	n groups.		
	 present and discuss experimental results in r 	nixed teams of different fields of stud	y.	
Autonomi	Students are able to			
Autonomy				
	 carry out parts of experimental work independent 	idently 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				
Course achievement				
Examination	Written elaboration			
Examination duration and				
scale	Biomedical Engineering: Core Qualification: Compul	SOLA		

Course L1566: Practical Cour	se Product Development, Materials and Production
Тур	Practical Course
Hrs/wk	6
СР	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
	Lödding, Prof. Jörg Weißmüller, Prof. Josef Schlattmann, Prof. Michael Morlock, Prof. Otto von Estorff, Prof. Thorsten Schüppstuhl
Language	DE
Cycle	SoSe SoSe
Content	Product Development:
	 Modal analysis - experimental and computational Appropriate design in engineering Characterization of rubbery-elastic materials Stick-Slip-Analysis at friction and wear test station Materials: 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
	Production: 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: Nonli	near Dynamics			
Courses				
Title		Тур	Hrs/wk	СР
Nonlinear Dynamics (L0702)		Integrated Lecture	4	6
Module Responsible	Prof. Norbert Hoffmann			
Admission Requirements	None			
Recommended Previous	Calculus			
Knowledge	Linear Algebra			
	Engineering Mechanics			
	gg			
Educational Objectives	After taking part successfully, students have reached the f	ollowing learning results		
Professional Competence				
Knowledge	Students are able to reflect existing terms and concepts	in Nonlinear Dynamics and t	o develop and resea	arch new terms and
	concepts.			
Skills	Students are able to apply existing methods and procesure	es of Nonlinear Dynamics and to	develop novel meth	ods and procedures.
Personal Competence				
,	Students can reach working results also in groups.			
,	Students are able to approach given research tasks individ	ually and to identify and follow	up novel research ta	sks by themselves.
	Independent Study Time 124, Study Time in Lecture 56			
Credit points				
Course achievement	None			
	Written exam			
Examination duration and	2 Hours			
scale				
-	Aircraft Systems Engineering: Core Qualification: Elective C			
Following Curricula	International Management and Engineering: Specialisation	•		
	Mechanical Engineering and Management: Specialisation N	·	ory	
	Mechatronics: Specialisation System Design: Elective Comp	•		
	Mechatronics: Specialisation Intelligent Systems and Robot Biomedical Engineering: Specialisation Artificial Organs and		ve Compulsory	
	Biomedical Engineering: Specialisation Implants and Endop	-	, ,	
	Biomedical Engineering: Specialisation Medical Technology			
	Biomedical Engineering: Specialisation Management and B	•		
	Product Development, Materials and Production: Core Qual		,	
	Theoretical Mechanical Engineering: Core Qualification: Ele			

Course L0702: Nonlinear Dyn	ourse L0702: Nonlinear Dynamics	
Тур	Integrated Lecture	
Hrs/wk	4	
СР	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.	

ourses				
itle	tic Approaches in Structural Applysis (11972)	Typ	Hrs/wk 2	CP 3
	tic Approaches in Structural Analysis (L1873) tic Approaches in Structural Analysis (L1874)	Lecture Recitation Section (large)	2	3
Module Responsible		Recitation Section (large)	2	3
Admission Requirements	None			
Recommended Previous	None			
Knowledge	Technical mechanics			
Kilowiedge	Higher math			
Educational Objectives	After taking part successfully, students have reached t	the following learning results		
Professional Competence	Arter taking part successivily, students have reached to	the following learning results		
Knowledge				
raiomeage	Design optimization			
	 Gradient based methods 			
	 Genetic algorithms 			
	 Optimization with constraints 			
	 Topology optimization 			
	Reliability analysis			
	Stochastic basics			
	Monte Carlo methods			
	Semi-analytic approaches			
	robust design optimization			
	Robustness measures Coupling of design application and reliable	hiliby analysis		
	 Coupling of design optimization and relia 	bility analysis		
Skills	Application of optimization observations and problem	abiliatio masthagae in the design of atmost		
	Application of optimization algorithms and prob Programming with Matlab	abilistic methods in the design of struct	ures	
	Implementation of algorithms			
	Debugging			
	Debugging			
Personal Competence				
Social Competence	Team work			
	Oral explanation of the the work			
	• Oral explanation of the the work			
Autonomy	Application of weakheds leaves of in the framework	le of a bome work		
	 Application of methods learned in the framewor Familiarizing with source code provided 	k of a florife work		
	Description of approaches and results			
	Description of approaches and results			
Workload in Hours	Independent Study Time 124, Study Time in Lecture 5	6		
Credit points	6			
Course achievement	None			
Examination	Written elaboration			
Examination duration and	10 pages			
scale				
Assignment for the	Aircraft Systems Engineering: Core Qualification: Elect	ive Compulsory		
Following Curricula	Product Development, Materials and Production: Core			
	, , , , , , , , , , , , , , , , , , , ,			

Course L1873: Design Optimization and Probabilistic Approaches in Structural Analysis		
Lecture		
2		
3		
Independent Study Time 62, Study Time in Lecture 28		
Prof. Benedikt Kriegesmann		
DE		
SoSe		
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.		
The following contents will be considered:		
The following contents will be considered.		
Design optimization		
Gradient based methods		
Genetic algorithms		
Optimization with constraints		
Topology optimization		
Reliability analysis		
Stochastic basics Marta Carlo matheda		
 Monte Carlo methods Semi-analytic approaches 		
robust design optimization		
Robustness measures		
Coupling of design optimization and reliability analysis		
[1] Arora, Jasbir. Introduction to Optimum Design. 3rd ed. Boston, MA: Academic Press, 2011.		
[2] Haldar, A., and S. Mahadevan. Probability, Reliability, and Statistical Methods in Engineering Design. John Wiley & Sons New		
York/Chichester, UK, 2000.		

Course L1874: Design Optimization and Probabilistic Approaches in Structural Analysis	
Тур	Recitation Section (large)
Hrs/wk	2
СР	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: Techr	nical Acoustics II (Room Acoustics	, Computational Methods)		
Courses				
Title		Тур	Hrs/wk	СР
Technical Acoustics II (Room Acous	tics, Computational Methods) (L0519)	Lecture	2	3
Technical Acoustics II (Room Acous	tics, Computational Methods) (L0521)	Recitation Section (large)	2	3
Module Responsible	Prof. Benedikt Kriegesmann			
Admission Requirements	None			
Recommended Previous	Technical Acoustics I (Acoustic Waves, Noise Pro	tection, Psycho Acoustics)		
Knowledge	Mechanics I (Statics, Mechanics of Materials) and	Mechanics II (Hydrostatics, Kinematics, Dyna	amics)	
	Mathematics I, II, III (in particular differential equ	nations)		
Educational Objectives	After taking part successfully, students have rea	ched the following learning results		
Professional Competence				
Knowledge	The students possess an in-depth knowledge in	acoustics regarding room acoustics and cor	nputational meth	nods and are able to
	give an overview of the corresponding theoretical and methodical basis.			
Chille	The students are conclus to bondle engine	aring problems in according by the on be	and application	of the demonding
SKIIIS	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.			
	computational methods and 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 shiplants are able to independently solve shellowing according weekless in the areas tracket within the area to be provided.			
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.			
	Connicting issues and innitations can be identified	d and the results are childally scrutilized.		
Workload in Hours	Independent Study Time 124, Study Time in Lec	ture 56		
Credit points	6			
Course achievement	None			
Examination	Oral exam			
Examination duration and	20-30 Minuten			
scale				
Assignment for the	Aircraft Systems Engineering: Core Qualification	Elective Compulsory		
Following Curricula	Mechatronics: Specialisation System Design: Ele	ctive Compulsory		
	Product Development, Materials and Production:	Core Qualification: Elective Compulsory		
	Theoretical Mechanical Engineering: Specialisation Product Development and Production: Elective Compulsory			
	Theoretical Mechanical Engineering: Specialisati	on Simulation Technology: Elective Compulso	ry	

Course L0519: Technical Acoustics II (Room Acoustics, Computational Methods)		
	Lecture	
Hrs/wk		
СР	3	
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28	
Lecturer	DrIng. Sören Keuchel	
Language	EN	
Cycle	WiSe	
Content	- 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, KJ. (2000): Finite-Elemente-Methoden. Springer Verlag, Berlin	
	patrie, Nj. (2000). Fillite-Elemente-Methoden. Springer Verlag, befilm	

Course L0521: Technical Acoustics II (Room Acoustics, Computational Methods)	
Тур	Recitation Section (large)
Hrs/wk	2
СР	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	DrIng. Sören Keuchel
Language	EN
Cycle	WiSe
Content	See interlocking course
Literature	See interlocking course

Following Curricula

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

Module M1184: Resea	arch Project Product Development, Materials and Production	
Courses		
Title	Typ Hrs/wk CP	
Module Responsible	Dozenten des Studiengangs	
Admission Requirements	None	
Recommended Previous	Subjects of the Master program and the chosen specialisation.	
Knowledge		
Educational Objectives	After taking part successfully, students have reached the following learning results	
Professional Competence		
Knowledge	 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. 	
Skills	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		
Social Competence	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	
Autonomy	their peers and supervisors. 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	according to FSPO	
scale		
Assignment for the Following Curricula	Product Development, Materials and Production: Core Qualification: Compulsory	

Specialization 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.

Module M0763: Aircra	aft Energy Systems			
Courses				
Title		Тур	Hrs/wk	СР
Aircraft Energy Systems (L0735)		Lecture	3	4
Aircraft Energy Systems (L0739)		Recitation Section (large)	2	2
Module Responsible	Prof. Frank Thielecke			
Admission Requirements	None			
Recommended Previous	Basic knowledge in:			
Knowledge	Mathematics			
	Mechanics			
	Thermodynamics			
	Electrical Engineering			
	Hydraulics			
	Control Systems			
	·			
Educational Objectives		ed the following learning results		
Professional Competence				
кпошейде	Students are able to:			
	Describe essential components and design per	oints of hydraulic, electrical and high-lift s	ystems	
	Give an overview of the functionality of air co	onditioning systems		
	Explain the need for high-lift systems such as	s ist functionality and effects		
	Assess the challenge during the design of support of the design of support of the design of the	pply systems of an aircraft		
Skills	Students are able to:			
	Design hydraulic and electric supply systems	s of aircrafts		
	Design high-lift systems of aircrafts			
	Analyze the thermodynamic behaviour of air	conditioning systems		
Personal Competence				
Social Competence	Students are able to:			
	Porform system design in groups and process	t and discuss results		
	Perform system design in groups and present	ב מווע מוטכמטט ופטעונט		
Δυτοροπν	Students are able to:			
Autonomy	State in a dire to.			
	Reflect the contents of lectures autonomousl	У		
Workload in Hours	Independent Study Time 110, Study Time in Lecture	e 70		
Credit points				
Course achievement	None			
Examination				
Examination duration and				
scale				
Assignment for the	Energy Systems: Specialisation Energy Systems: Ele	ective Compulsory		
Following Curricula				
	International Management and Engineering: Special	lisation II. Aviation Systems: Elective Com	pulsory	
	Product Development, Materials and Production: Sp	ecialisation Product Development: Electiv	e Compulsory	
	Product Development, Materials and Production: Sp	ecialisation Production: Elective Compulso	ory	
	Product Development, Materials and Production: Sp	ecialisation Materials: Elective Compulsor	y	
	Theoretical Mechanical Engineering: Specialisation	Aircraft Systems Engineering: Elective Cor	mpulsory	

Course L0735: Aircraft Energ	y Systems
Тур	Lecture
Hrs/wk	3
СР	4
Workload in Hours	Independent Study Time 78, Study Time in Lecture 42
Lecturer	Prof. Frank Thielecke
Language	DE
Cycle	WiSe
Content	 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	 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 Energ	ourse L0739: Aircraft Energy Systems	
Тур	Recitation Section (large)	
Hrs/wk	2	
СР	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: Metho	ods of Integrated Product Developme	nt		
Courses				
Title		Тур	Hrs/wk	СР
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	Basic knowledge of Integrated product development ar	nd applying CAE systems		
Knowledge				
Educational Objectives	After taking part successfully, students have reached the	he following learning results		
Professional Competence				
Knowledge	After passing the module students are able to:			
	 explain technical terms of design methodology, 			
	describe essential elements of construction man	agomont		
	describe essential elements of construction man describe current problems and the current state		ment	
	- acsense current problems and the current state	or research of integrated product develop	THETTE.	
Skills	After passing the module students are able to:			
	 select and apply proper construction methods to 	for non-standardized solutions of problem	e ac wall ac :	adant new houndary
	conditions,	for non-standardized solutions of problem	is as well as t	dapt new boundary
	 solve product development problems with the as 	ssistance of a workshop based approach		
	choose and execute appropriate moderation tecl			
	enouse and execute appropriate moderation teel			
Personal Competence				
Social Competence	After passing the module students are able to:			
	 prepare and lead team meetings and moderation 	n nrocesses		
	work in teams on complex tasks,	in processes,		
	represent problems and solutions and advance in	deas.		
	, , , , , , , , , , , , , , , , , , ,			
Autonomy	After passing the module students are able to:			
	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	30 Minuten			
scale				
Assignment for the		, ,		
Following Curricula	Aircraft Systems Engineering: Specialisation Air Transp			
	Aircraft Systems Engineering: Core Qualification: Electi			
	International Management and Engineering: Specialisat	·	on: Elective Co	ompulsory
	Mechatronics: Specialisation System Design: Elective C			
	Product Development, Materials and Production: Specia		У	
	Product Development, Materials and Production: Specia	• •		
	Product Development, Materials and Production: Special		- Camar :: !	
	Theoretical Mechanical Engineering: Specialisation Prod	auct Development and Production: Elective	e compulsory	

Course L1254: Integrated Pro	oduct Development II
	Lecture
Hrs/wk	
CP	
Workload in Hours	
Lecturer	
Language	
Cycle	
Content	
Content	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. Topics of the course include in particular: Methods of product development, Presentation techniques, Industrial Design, Design for variety Modularization methods, Design catalogs, Adapted QFD matrix, Systematic material selection, Assembly oriented design, Construction management 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. Exercise (PBL) In the exercise the content presented in the lecture "Integrated Product Development II" and methods of product development and design management will be enhanced.
	Students learn an independently moderated and workshop based approach through industry related practice examples to solv 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.
Literature	 Andreasen, 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,

Course L1255: Integrated Pro	ourse L1255: Integrated Product Development II		
Тур	Project-/problem-based Learning		
Hrs/wk	2		
СР	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		

Springer 2013.

Module M1025: Fluidi	cs			
Courses				
Title Fluidics (L1256) Fluidics (L1371)		Typ Lecture Project-/problem-based Learning	Hrs/wk 2 1	CP 3 2
Fluidics (L1257)		Recitation Section (large)	1	1
Module Responsible	Prof. Dieter Krause			
	None Good knowledge of mechanics (stereo statics, elastostat engineering design	ics, hydrostatics, kinematics and	kinetics), flui	d mechanics, and
Educational Objectives	After taking part successfully, students have reached the follo	owing learning results		
	After passing the module students are able to explain structures and functionalities of hydrostatic, pn explain the interaction of hydraulic components in hydi explain open and closed loop control of hydraulic syste describe functioning and applications of hydrodynamic and aggregates in plant technology After passing the module students are able to	raulic systems, ems,		s centrifugal pumps
	 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 Social Competence	After passing the module students are able to			
	 discuss and present functional context in groups, organise teamwork autonomously. 			
Autonomy	After passing the module students are able to obtain necessary knowledge for the simulation.			
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56			
Credit points				
Course achievement		n hydrostatischer Systeme		
Examination	Written exam			
Examination duration and scale Assignment for the	International Management and Engineering: Specialisation II.			
Following Curricula	International Management and Engineering: Specialisation II. Product Development, Materials and Production: Specialisatio Product Development, Materials and Production: Specialisatio Product Development, Materials and Production: Specialisatio Theoretical Mechanical Engineering: Specialisation Product Development	n Product Development: Compulsor n Production: Elective Compulsory n Materials: Elective Compulsory	ту	mpulsory

Production"	
Course L1256: Fluidics	
Тур	Lecture
Hrs/wk	2
СР	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
	Prof. Dieter Krause
Language	
Cycle	
Content	Lecture
	Hydrostatics
	physical fundamentals
	hydraulic fluids
	hydrostatic machines .
	• valves
	• components
	hydrostatic transmissions
	examples from industry
	Pneumatics
	generation of compressed air
	pneumatic motors
	Examples of use
	Hydrodynamics
	physical fundamentals
	hydraulic continous-flow machines
	hydrodynamic transmissions
	interoperation of motor and transmission
	Exercise
	Hydrostatics
	reading and design of hydraulic diagrams
	dimensioning of hydrostatic traction and working drives
	performance calculation
	perioritance carculation
	Hydrodynamics
	calculation / dimensioning of hydrodynamic torque converters
	calculation / dimensioning of rydrodynamic conque convercers calculation / dimensioning of centrifugal pumps
	creating and reading of characteristic curves of pumps and systems
	Cleaning and reading of annual consistence of participation of participati
	Field trip
	field trip to a regional company from the hydraulic industry.
	and dip to diregional company from the hydraulic models.
	Exercise
	Numerical simulation of hydrostatic systems
	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	Bücher
	Murrenhoff H : Grundlagen der Fluidtechnik Toil 1 : Hudraulik Shakor Vorlag Aachon 2011
	 Murrenhoff, H.: Grundlagen der Fluidtechnik - Teil 1: Hydraulik, Shaker Verlag, Aachen, 2011 Murrenhoff, H.: Grundlagen der Fluidtechnik - Teil 2: Pneumatik, Shaker Verlag, Aachen, 2006
	Mutreimon, H., Grundlagen der Fluddechnik - Teil 2. Friedmatik, Staker Verlag, Adchen, 2006 Matthies, H.J. Renius, K.Th.: Einführung in die Ölhydraulik, Teubner Verlag, 2006
	Beitz, W., Grote, KH.: Dubbel - Taschenbuch für den Maschinenbau, Springer-Verlag, Berlin, aktuelle Auflage
	,, oroto, ta tim babbo. Tabellandaci fai den Plabellinenbad, Springer-Verlag, berlin, aktaelle Adilage
	Skript zur Vorlesung

$\label{eq:module Manual M.Sc.} \begin{tabular}{ll} Module Manual M.Sc. \\ \begin{tabular}{ll} Product Development, Materials and Production \\ \end{tabular}$

Course L1371: Fluidics	ourse L1371: Fluidics	
Тур	Project-/problem-based Learning	
Hrs/wk	1	
СР	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	
Тур	Recitation Section (large)
Hrs/wk	1
СР	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		Тур	Hrs/wk	СР
Computer and communication tech	nology in cabin electronics and avionics (L1557)	Lecture	2	2
	nology 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	Basic knowledge in:			
Knowledge	Mathematics			
	Mechanics			
	Thermodynamics			
	Electrical Engineering			
	Control Systems			
	Previous knowledge in:			
	Systems Engineering			
	Systems Engineering			
Educational Objectives	After taking part successfully, students have reached the follow	ving learning results		
Professional Competence				
Knowledge	Students are able to:			
	• describe the structure and operation of computer architectur	es		
	• explain the structure and operation of digital communication	Networks		
	• explain architectures of cabin electronics, integrated modula	r avionics (IMA) and Aircraft Data	Communicatio	n Network (ADCN)
	• understand the approach of Model-Based Systems Engineer	ering (MBSE) in the design of ha	rdware and s	oftware-based cabin
	systems			
Chille	Chudonto ave abla ta			
SKIIIS	Students are able to:			
	understand, operate and maintain a Minicomputer	an naturally nauticinants		
	build up a network communication and communicate with other states and the states are states as the states are states are states as the states are states are states as the states are states as the states are states are states as the states are states are states as the states are states as the states are states are states as the states are states are states as the states are states as the states are states are states as the states are states as the states are st		- AFDV @ N-	and a
	connect a minicomputer with a cabin management system (A model system functions by management system).			
	model system functions by means of formal languages SysMI	L/OME and generate software code	e from the mo	ieis
	execute software code on a minicomputer			
Personal Competence				
Social Competence	Students are able to:			
	• elaborate partial results and merge with others to form a con	nplete solution		
A	Chudanta ava abla ta			
Autonomy	Students are able to:			
	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	120 minutes			
scale				
Assignment for the	Aircraft Systems Engineering: Specialisation Aircraft Systems:	Elective Compulsory		
_	Aircraft Systems Engineering: Core Qualification: Elective Com			
	International Management and Engineering: Specialisation II. A	•	sory	
	Product Development, Materials and Production: Specialisation	•	-	
	Product Development, Materials and Production: Specialisation	·		
	Product Development, Materials and Production: Specialisation			
	Theoretical Mechanical Engineering: Specialisation Aircraft Sys	' '	ılsorv	
		z.ig.i.cc.i.ig. Elective compe		

Course L1557: Computer and	d communication technology in cabin electronics and avionics
Тур	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	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. 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: 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	 Skript zur Vorlesung Schnabel, P.: Computertechnik-Fibel: Grundlagen Computertechnik, Mikroprozessortechnik, Halbleiterspeicher, Schnittstellen und Peripherie. Books on Demand; 1. Auflage, 2003 Schnabel, P.: Netzwerktechnik-Fibel: Grundlagen, Übertragungstechnik und Protokolle, Anwendungen und Dienste, Sicherheit. Books on Demand; 1. Auflage, 2004 Wüst, K.: Mikroprozessortechnik: Grundlagen, Architekturen und Programmierung von Mikroprozessoren, Mikrocontrollern und Signalprozessoren. Vieweg Verlag; 2. aktualisierte und erweiterte Auflage, 2006

Тур	Recitation Section (small)
Hrs/wk	1
СР	1
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14
	Prof. Ralf God
Language	DE
Cycle	WiSe
Content	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.
	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:
	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 Figure 1 interfaces (parish USB Ethernat)
	External interfaces (serial, USB, Ethernet)
	Layer model in network technology Network topologies
	Network topologies Network components
	Bus access procedures
	Integrated Modular Avionics (IMA) and Aircraft Data Communication Networks (ADCN)
	Cabin electronics and cabin networks
Literature	- Skript zur Vorlesung
	- Schnabel, P.: Computertechnik-Fibel: Grundlagen Computertechnik, Mikroprozessortechnik, Halbleiterspeicher, Schnittstellen und
	Peripherie. Books on Demand; 1. Auflage, 2003
	- Schnabel, P.: Netzwerktechnik-Fibel: Grundlagen, Übertragungstechnik und Protokolle, Anwendungen und Dienste, Sicherheit
	Books on Demand; 1. Auflage, 2004
	- Wüst, K.: Mikroprozessortechnik: Grundlagen, Architekturen und Programmierung von Mikroprozessoren, Mikrocontrollern und
	Signalprozessoren. Vieweg Verlag; 2. aktualisierte und erweiterte Auflage, 2006

Тур	Project-/problem-based Learning
Hrs/wk	3
СР	3
Workload in Hours	Independent Study Time 48, Study Time in Lecture 42
Lecturer	Prof. Ralf God
Language	DE
Cycle	SoSe
Content	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®):
	• 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	- 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 M0812: Aircra	aft Design I (Ci	vil Aircraft De	esign)			
Courses						
Title Aircraft Design I (Design of Transpo				Typ Lecture Recitation Section (large)	Hrs/wk 3 2	CP 3
Module Responsible				Recitation Section (large)	2	3
Admission Requirements	None					
Recommended Previous Knowledge	Bachelor Mecl Bachelor Traft Vordiplom Me Module Air Tra	ic Systems ch. Eng.				
Educational Objectives	After taking part suc	cessfully, students h	nave reached the followi	ng learning results		
Personal Competence	Principle unde Understanding Impact of the Introduction o Understanding and a	g of the interactions relevant design para f the principle desig pplication of design erdisciplinary and in plinary teams	and calculation method	various disciplines aft design		
Workload in Hours	Independent Study T	ime 110, Study Tim	e in Lecture 70			
Credit points						
Course achievement	No 10 %	Form Attestation	Description Durchführung	g einer Konzeptauslegung für	ein Verkehrsflug	zeug
Examination	Written exam					-
Examination duration and scale	180 min					
Assignment for the		-	ification: Compulsory			
Following Curricula	Product Developmer Product Developmer Product Developmer	t, Materials and Pro t, Materials and Pro t, Materials and Pro	duction: Specialisation P duction: Specialisation P duction: Specialisation P	iation Systems: Elective Com rroduct Development: Electiv rroduct Development: Electiv rroduction: Elective Compulso ms Engineering: Elective Coi	e Compulsory e Compulsory ory	

Course L0820: Aircraft Desig	n I (Design of Transport Aircraft)
Тур	Lecture
Hrs/wk	3
СР	3
Workload in Hours	Independent Study Time 48, Study Time in Lecture 42
Lecturer	Prof. Volker Gollnick, Jens Thöben
Language	DE
Cycle	WiSe
Content	Introduction into the aircraft design process
	Introduction/process of aircraft design/various aircraft configurations
	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	J. Roskam: "Airplane Design"
	D.D. Davinson II Aircraft Davins A Concentral Annyasehill
	D.P. Raymer: "Aircraft Design - A Conceptual Approach"
	J.P. Fielding: "Introduction to Aircraft Design"
	Jenkinson, Simpkon, Rhods: "Civil Jet Aircraft Design"

Course L0834: Aircraft Desig	Course L0834: Aircraft Design I (Design of Transport Aircraft)	
Тур	Recitation Section (large)	
Hrs/wk	2	
СР	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 M0511: Electi	rical Energy from Solar Radiation and	d Wind Power		
Courses				
Title Sustainability Management (L0007 Hydro Power Use (L0013) Wind Turbine Plants (L0011) Wind Energy Use - Focus Offshore (Typ Lecture Lecture Lecture Lecture Lecture	Hrs/wk 2 1 2 1	CP 1 1 3
		Lecture	1	1
Module Responsible Admission Requirements	None			
Recommended Previous	Module: Technical Thermodynamics I,			
Knowledge	Module: Technical Thermodynamics II,			
	Module: Fundamentals of Fluid Mechanics			
Educational Objectives	After taking part successfully, students have reached	the following learning results		
Professional Competence Knowledge	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.			
	Through active discussions of various topics within application of the theoretical background and are thus			derstanding and the
Skills	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.			
Personal Competence Social Competence	Students can discuss scientific tasks subjet-specificly	and multidisciplinary within a se	minar.	
Autonomy	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.			
Workload in Hours	Independent Study Time 96, Study Time in Lecture 84	1		
Credit points	6			
Course achievement	None			
Examination	Written exam			
Examination duration and scale	2.5 hours written exam + written elaboration (incl. pr	esentation) in sustainability mana	agement	
•	Civil Engineering: Specialisation Structural Engineerin Civil Engineering: Specialisation Geotechnical Engineering: Civil Engineering: Specialisation Coastal Engineering: International Management and Engineering: Specialis International Management and Engineering: Specialis Product Development, Materials and Production: Spec Product Development, Materials and Production: Spec Product Development, Materials and Production: Spec Renewable Energies: Core Qualification: Compulsory Theoretical Mechanical Engineering: Specialisation En Process Engineering: Specialisation Environmental Engineering: Specialisation Water and Environmental Engineering: Specialisation	ering: Elective Compulsory Elective Compulsory ation II. Energy and Environment ation II. Renewable Energy: Elect cialisation Product Development: cialisation Production: Elective Cor cialisation Materials: Elective Com ergy Systems: Elective Compulsory Environment: Compulsory	ive Compulsory Elective Compulsory Impulsory Impulsory Impulsory Impulsory	Compulsory

Course L0007: Sustainability	Management
Тур	Lecture
Hrs/wk	2
СР	1
Workload in Hours	Independent Study Time 2, Study Time in Lecture 28
Lecturer	Dr. Anne Rödl
Language	DE
Cycle	SoSe
Content	The lecture "Sustainability Management" gives an insight into the different aspects and dimensions of sustainability. First, essential terms and definitions, significant developments of the last years, and legal framework conditions are explained. The various aspects of sustainability are then presented and discussed in detail. The lecture mainly focuses on concepts for the implementation of the topic sustainability in companies: • What is "sustainability"?
	 Why is this concept an important topic for companies? What opportunities and business risks are addressed or are associated with it? How can the often mentioned three pillars of sustainability - economy, ecology, and social- be meaningfully integrated into corporate management despite their sometimes contradictory tendencies, and how a corresponding compromise can be found? What concepts or frameworks exist for the implementation of sustainability management in companies? Which sustainability labels exist for products or companies? What do they have in common, and where do they differ? Furthermore, the lecture is intended to provide insights into the concrete implementation of sustainability aspects into business practice. External lecturers from companies will be invited to report on how sustainability is integrated into their daily processes. In the course of an independently carried out group work, the students will analyze and discuss the implementation of sustainability aspects based on short case studies. By studying and comparing best practice examples, the students will learn about corporate decisions' effects and implications. It should become clear which risks or opportunities are associated if sustainability aspects are taken into account in management decisions.
Literature	Die folgenden Bücher bieten einen Überblick: Engelfried, J. (2011) Nachhaltiges Umweltmanagement. München: Oldenbourg Verlag. 2. Auflage Corsten H., Roth S. (Hrsg.) (2011) Nachhaltigkeit - Unternehmerisches Handeln in globaler Verantwortung. Wiesbaden: Gabler Verlag.

Course L0013: Hydro Power I	Use
Тур	Lecture
Hrs/wk	1
СР	1
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14
Lecturer	Prof. Stefan Achleitner
Language	DE
Cycle	SoSe SoSe
Content	 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	 Schröder, W.; Euler, G.; Schneider, K.: Grundlagen des Wasserbaus; Werner, Düsseldorf, 1999, 4. Auflage Quaschning, 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
Тур	Lecture
Hrs/wk	2
СР	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Dr. Rudolf Zellermann
Language	DE
Cycle	SoSe
Content	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
Тур	Lecture
Hrs/wk	1
СР	1
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14
Lecturer	Prof. Martin Skiba
Language	DE
Cycle	SoSe
Content	 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	 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, Heidel-berg, 1997, 3. Auflage Hau, E.: Windkraftanalagen; 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: Robot	tics and Naviga	tion in Medicine				
Courses						
Title Robotics and Navigation in Medicine (L0335) Robotics and Navigation in Medicine (L0338) Robotics and Navigation in Medicine (L0336)		Typ Lecture Project Seminar Recitation Section (small)	Hrs/wk 2 2	CP 3 2		
Module Responsible	1	efer				_
Admission Requirements	None	Cici				
Recommended Previous Knowledge	• principles of m	ath (algebra, analysis/ca ogramming, e.g., in Java ab skills				
Educational Objectives	After taking part succ	essfully, students have	reached the following	ng learning results		
Professional Competence Knowledge Skills	detail. Systems can systems regarding de	be evaluated with respections and limitations.	ect to collision det	clinical contexts and illust ection and safety and re s and robotic systems for m	gulations. Student	s can assess typical
Personal Competence Social Competence Autonomy				feedback and can incoorpo		
Workload in Hours	Independent Study Ti	me 110, Study Time in	Lecture 70			
Credit points	6					
Course achievement	Yes 10 %	Form Written elaboration Presentation	Description			
Examination	Written exam					
Examination duration and	90 minutes					
scale						
Assignment for the Following Curricula	Electrical Engineering International Manage International Manage Mechatronics: Specia Biomedical Engineeri Biomedical Engineeri Biomedical Engineeri Biomedical Engineeri Product Development	ment and Engineering: 's lisation Intelligent Syste ng: Specialisation Artific ng: Specialisation Impla ng: Specialisation Medic ng: Specialisation Mana c, Materials and Producti c, Materials and Producti	Technology: Elective Specialisation II. Ele Specialisation III. Provins and Robotics: El ial Organs and Regents and Endoprosthe al Technology and Organs and Busines ion: Specialisation Procession: Specialisation Procession III.	re Compulsory ctrical Engineering: Elective cess Engineering and Biote ective Compulsory enerative Medicine: Elective eses: Elective Compulsory Control Theory: Elective Cor s Administration: Elective Cor oduct Development: Elective roduction: Elective Compul	echnology: Elective e Compulsory mpulsory Compulsory ive Compulsory sory	Compulsory
	·		•	laterials: Elective Compulso ical Technology: Elective Co	•	

avigation in Medicine
Lecture
3
ndependent Study Time 62, Study Time in Lecture 28
Prof. Alexander Schlaefer
EN
5oSe
kinematics
calibration
tracking systems
navigation and image guidance
motion compensation
The seminar extends and complements the contents of the lecture with respect to recent research results.
Spong et al.: Robot Modeling and Control, 2005
Froccaz: Medical Robotics, 2012
Further literature will be given in the lecture.
2 3 r o = 6 r

Course L0338: Robotics and	Course L0338: Robotics and Navigation in Medicine	
Тур	Project Seminar	
Hrs/wk	2	
СР	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	Course L0336: Robotics and Navigation in Medicine		
Тур	Recitation Section (small)		
Hrs/wk	1		
СР	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		

Courses				
Title		Тур	Hrs/wk	СР
Flight Control Systems (L0736)		Lecture	3	4
Flight Control Systems (L0740)		Recitation Section (large)	2	2
Module Responsible	Prof. Frank Thielecke			
Admission Requirements	None			
Recommended Previous	basic knowledge of:			
Knowledge	mathematics			
	mechanics			
	thermo dynamics			
	• electronics			
	fluid technology			
	control technology			
	3,			
Educational Objectives	After taking part successfully, students have reached	the following learning results		
Professional Competence				
Knowledge	Students are able to			
	describe the structure of primary flight contro	I systems as well as actuation- avionic-	high lift systems	in general along wi
	corresponding properties and applications.	systems as well as actuation-, avionic-,	iligii ilit systeilis	in general along wi
	 explain different configurations and designs a 	and their origins		
	• explain different configurations and designs of	ind their origins		
	•			
Skills	Students are able to			
	e cize primary flight central actuation systems			
	 size primary flight control actuation systems perform a controller design process for the flight 	aht control actuators		
	design high-lift kinematics	girt control actuators		
	design high-life kinematics			
D				
Personal Competence	6			
Social Competence	Students are able to:			
	Develop joint solutions in mixed teams			
Autonomy	Students are able to:			
	 derive requirements and perform appropriate 	yet simplified design processes for airc	raft systems from	complex issues ar
	circumstances in a self-reliant manner			
Workload in Hours	Independent Study Time 110, Study Time in Lecture	70		
Credit points				
Course achievement				
Examination				
Examination duration and	165 Minutes			
scale				
Assignment for the	Aircraft Systems Engineering: Core Qualification: Cor	mpulsory		
Following Curricula	International Management and Engineering: Speciali	•		
	Product Development, Materials and Production: Spe	·		
	Product Development, Materials and Production: Spe	cialisation Production: Elective Compulse	ory	
	Product Development, Materials and Production: Spe	cialisation Materials: Elective Compulsor	Ty .	
	Theoretical Mechanical Engineering: Specialisation A	ircraft Systems Engineering: Elective Co	mpulsory	

Course L0736: Flight Control	Systems
Тур	Lecture
Hrs/wk	3
СР	4
Workload in Hours	Independent Study Time 78, Study Time in Lecture 42
Lecturer	Prof. Frank Thielecke
Language	DE
Cycle	SoSe
Content	 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-skit 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	Moir, Seabridge: Aircraft Systems Torenbek: Synthesis of Subsonic Airplane Design Curry: Aircraft Landing Gear Design: Principles and Practices

Course L0740: Flight Control Systems		
Тур	Recitation Section (large)	
Hrs/wk	2	
СР	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: Medic	al 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	none		
Knowledge			
Educational Objectives	After taking part successfully, students have reached the following learning results		
Professional Competence			
Knowledge			
	Students can:		
	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;		
	Describe and explain the main clinical uses of the different systems.		
Skills	Students are able to:		
	 Explain the physical processes of images and assign to the systems the basic mathematical or physical equations required; 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; 		
	Select a suitable imaging system for an application.		
Personal Competence			
Social Competence			
Autonomy	Students can:		
	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	90 min		
scale			
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		
	Theoretical Mechanical Engineering: Specialisation Bio- and Medical Technology: Elective Compulsory		

Course L0819: Medical Imagi	ng Systems
Тур	Lecture
Hrs/wk	4
СР	6
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56
Lecturer	Dr. Michael Grass, Dr. Frank Michael Weber, Dr. Sven Prevrhal, Dr. Tim Nielsen
Language	DE
Cycle	SoSe
Content	
Literature	Primary book:
	1. P. Suetens, "Fundamentals of Medical Imaging", Cambridge Press
	Secondary books:
	- 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	Тур	Hrs/wk	СР	
Applied Automation (L1592)	Project-/problem-based Learning	3	3	
Ergonomics (L0653)	Lecture	2	3	
Advanced Training Course SE-ZERT		2	3	
Elements of Integrated Production			3	
Development Management for Med		2	3	
Fatigue & Damage Tolerance (L031	Lecture Lecture	2	3	
Industry 4.0 for engineers (L2012)	Lecture	2	3	
Innovation and Product Manageme	nt (L2168) Seminar	2	3	
Lightweight Design Practical Course	e (L1258) Project-/problem-based Learning	3	3	
Mechanisms, Systems and Process	es of Materials Testing (L0950) Lecture	2	2	
Microsystems Technology (L0724)	Lecture	2	4	
Sustainable Industrial Production (L	Lecture	2	3	
Productivity Management (L0928)	Project-/problem-based Learning	2	2	
Productivity Management (L0931)	Recitation Section (small)	1	1	
Feedback Control in Medical Techni	ology (L0664) Lecture	2	3	
Structural Mechanics of Fibre Reinf	forced 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	s (L0176) Lecture	2	2	
Reliability in Engineering Dynamics	s (L1303) Recitation Section (small)	1	2	
Reliability of Aircraft Systems (L074	49) Lecture	2	3	
Module Responsible	Prof. Dieter Krause			
Admission Requirements	None			
Recommended Previous	None			
Knowledge				
Educational Objectives	After taking part successfully, students have reached the following learning results			
Professional Competence	3 3			
Knowledge				
Knowleage	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			
Skills				
	Students can apply specialized solution strategies and new scientific methods in selected			
	Students are able to transfer learned skills to new and unknown problems and can devel	op own solutio	n approaches	
Personal Competence				
Social Competence				
· ·				
Autonomy	Students are able to develop their knowledge and skills by autonomous election of cours	es.		
	, , ,			
Workload in Hours	Depends on choice of courses			
Credit points	12			
		Compulsory		
Credit points	Product Development, Materials and Production: Specialisation Product Development: Elective			
Credit points Assignment for the	Product Development, Materials and Production: Specialisation Product Development: Elective			

Course L1592	2: Applied Automation
Тур	Project-/problem-based Learning
Hrs/wk	3
СР	3
Workload in	Independent Study Time 48, Study Time in Lecture 42
Hours	
Examination	Mündliche Prüfung
Form	
Examination	30 Minuten
duration	
and scale	
Lecturer	Prof. Thorsten Schüppstuhl
Language	DE
Cycle	WiSe
Literature	-Project Based Learning -Robot Operating System -Robot structure and description -Motion description -Calibration -Accuracy John J. Craig Introduction to Robotics - Mechanics and Control ISBN: 0131236296 Pearson Education, Inc., 2005 Stefan Hesse Grundlagen der Handhabungstechnik ISBN: 3446418725 München Hanser, 2010 K. Thulasiraman and M. N. S. Swamy Graphs: Theory and Algorithms ISBN: 9781118033104 %CITAVIPICKER£9781118033104£Titel anhand dieser ISBN in Citavi-Projekt übernehmen£% John Wüey & Sons, Inc., 1992

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

Course L2739: Advanced Training Course SE-ZERT	
Тур	Project-/problem-based Learning
Hrs/wk	2
СР	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Examination Form	Klausur
Examination duration and	120 min
scale	
Lecturer	Prof. Ralf God
Language	DE
Cycle	SoSe
Content	
Literature	INCOSE Systems Engineering Handbuch - Ein Leitfaden für Systemlebenszyklus-Prozesse und -Aktivitäten, GfSE (Hrsg. der
	deutschen Übersetzung), ISBN 978-3-9818805-0-2.
	ISO/IEC 15288 System- und Software-Engineering - System-Lebenszyklus-Prozesse (Systems and Software Engineering - System
	Life Cycle Processes).

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

Course L1512: Development	Management for Mechatronics
Тур	Lecture
Hrs/wk	2
СР	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Examination Form	Mündliche Prüfung
Examination duration and	30 Minuten
scale	
Lecturer	NN, Dr. Johannes Nicolas Gebhardt
Language	DE
Cycle	SoSe
Content	Processes and methods of product development - from idea to market launch 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 Design of processes for product development IT systems for product development Establishment of management standards Typical types of organization
Literature	 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	
Тур	Lecture
Hrs/wk	2
СР	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Examination Form	Mündliche Prüfung
Examination duration and	45 min
scale	
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. Kluver Academic Puplisher, Dordrecht, 2001 E. Haibach. Betriebsfestigkeit
	Verfahren und Daten zur Bauteilberechnung. VDI-Verlag, Düsseldorf, 1989

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

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

Course L1258: Lightweight Design Practical Course		
Тур	Project-/problem-based Learning	
Hrs/wk	3	
СР	3	
Workload in Hours	Independent Study Time 48, Study Time in Lecture 42	
Examination Form	Mündliche Prüfung	
Examination duration and	30 min	
scale		
Lecturer	Prof. Dieter Krause	
Language	DE/EN	
Cycle	SoSe	
Content	Development of a sandwich structure made of fibre reinforced plastics	
	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	California II. Kanahadana wik Faran Kurahahafi Vada adau Koninana Dadia 2005	
	 Schürmann, H., "Konstruieren mit Faser-Kunststoff-Verbunden", Springer, Berlin, 2005. Puck, A., "Festigkeitsanalsyse von Faser-Matrix-Laminaten", Hanser, München, Wien, 1996. 	
	 Puck, A., "Festigkeitsandisyse von Faser-Matrix-Laminaten", Hanser, Munichen, 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
Тур	Lecture
Hrs/wk	2
СР	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Examination Form	Klausur
Examination duration and	90 Minuten
scale	
Lecturer	Dr. Jan Oke Peters
Language	DE
Cycle	SoSe
Content	Application, analysis and discussion of basic and advanced testing methods to ensure correct selection of applicable testing procedure for investigation of part/materials deficiencies 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	 E. Macherauch: Praktikum in Werkstoffkunde, Vieweg G. E. Dieter: Mechanical Metallurgy, McGraw-Hill R. Bürgel: Lehr- und Übungsbuch Festigkeitslehre, Vieweg R. Bürgel: Werkstoffe sícher beurteilen und richtig einsetzen, Vieweg

Course L0724: Microsystems	Technology
Тур	Lecture
Hrs/wk	2
СР	4
Workload in Hours	Independent Study Time 92, Study Time in Lecture 28
Examination Form	Mündliche Prüfung
Examination duration and	30 min
scale	
Lecturer	Prof. Hoc Khiem Trieu
Language	EN
Cycle	
Content	 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, SUB, 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; 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
	 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	M. Madou: Fundamentals of Microfabrication, CRC Press, 2002 N. Schwesinger: Lehrbuch Mikrosystemtechnik, Oldenbourg Verlag, 2009 T. M. Adams, R. A. Layton:Introductory MEMS, Springer, 2010
	G. Gerlach; W. Dötzel: Introduction to microsystem technology, Wiley, 2008

ourse L2863: Sustainable In	ndustrial Production
Тур	Lecture
Hrs/wk	2
СР	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Examination Form	Klausur
Examination duration and	60 min
scale	
Lecturer	Dr. Simon Markus Kothe
Language	DE
Cycle	SoSe
Content	Industrial production deals with the manufacture of physical products to satisfy human needs using various manufacturing processes that change the form and physical properties of raw materials. Manufacturing is a central driver of economic development and has a major impact on the well-being of humanity. However, the scale of current manufacturing activities results in enormous global energy and material demands that are harmful to both the environment and people. Historically, industria activities were mostly oriented towards economic constraints, while social and environmental consequences were only hardly considered. As a result, today's global consumption rates of many resources and associated emissions often exceed the natura regeneration rate of our planet. In this respect, current industrial production can mostly be described as unsustainable. This is emphasized each year by the Earth Overshoot Day, which marks the day when humanity's ecological footprint exceeds the Earth's annual regenerative capacity. This lecture aims to provide the motivation, analytical methods as well as approaches for sustainable industrial production and to clarify the influence of the production phase in relation to the raw material, use and recycling phases in the entire life cycle of products. For this, the following topics will be highlighted:
	 Motivation for sustainable production, the 17 Sustainable Development Goals (SDGs) of the UN and their relevance fo tomorrow's manufacturing; raw material vs. production phase vs. use phase vs. recycling/end-of-life phase: importance of the production phase for the environmental impact of manufactured products;
	- Typical energy- and resource-intensive processes in industrial production and innovative approaches to increase energy and resource efficiency;
	- Methodology for optimizing the energy and resource efficiency of industrial manufacturing chains with the three steps o modeling (1), evaluating (2) and improving (3);
	- Resource efficiency of industrial manufacturing value chains and its assessment using life cycle analysis (LCA);
	- Exercise: LCA analysis of a manufacturing process (thermoplastic joining of an aircraft fuselage segment) as part of a product life cycle assessment.
Literature	Litoratur
Literature	Literatur.
	- Stefan Alexander (2020): Resource efficiency in manufacturing value chains. Cham: Springer International Publishing.
	- Hauschild, Michael Z.; Rosenbaum, Ralph K.; Olsen, Stig Irving (Hg.) (2018): Life Cycle Assessment. Theory and Practice. Cham Springer International Publishing.
	- Kishita, Yusuke; Matsumoto, Mitsutaka; Inoue, Masato; Fukushige, Shinichi (2021): EcoDesign and sustainability. Singapore: Springer.
	- Schebek, Liselotte; Herrmann, Christoph; Cerdas, Felipe (2019): Progress in Life Cycle Assessment. Cham: Springer Internationa Publishing.
	- Thiede, Sebastian; Hermann, Christoph (2019): Eco-factories of the future. Cham: Springer Nature Switzerland AG.
	- Vorlesungsskript.

Course L0928: Productivity Management		
Тур	Project-/problem-based Learning	
Hrs/wk	2	
СР	2	
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28	
Examination Form	Klausur	
Examination duration and	90 Minuten	
scale		
	Prof. Hermann Lödding	
Language		
Cycle	SoSe	
Content	 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	Bokranz, R.; Landau, K.:Produktivitätsmanagement von Arbeitssystemen. Schäffer-Poeschel, Stuttgart, 2006. Takeda, H.: Das synchrone Produktionssystem: Just-in-Time für das ganze Unternehmen. 5. Aufl., mi-Wirtschaftsbuch, FinanzBuch Verlag, München, 2006. Nakajima, S.: Management der Produktionseinrichtungen (Total Productive Maintenance). Campus Verlag, New York, 1995. Shingo, S.: A Revolution in Manufacturing: The SMED System. Productivity, Inc., 1985	

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

Course L0664: Feedback Control in Medical Technology			
Тур	ecture		
Hrs/wk	2		
CP	3		
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28		
Examination Form	Mündliche Prüfung		
Examination duration and	20 min		
scale			
Lecturer	Johannes Kreuzer, Christian Neuhaus		
Language	DE		
Cycle	SoSe		
Content	Always viewed from the engineer's point of view, the lecture is structured as follows: 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 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.		
Literature	 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 L1514: Structural Mechanics of Fibre Reinforced Composites		
Тур	Lecture	
Hrs/wk	2	
СР	3	
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28	
Examination Form	Mündliche Prüfung	
Examination duration and	30 min	
scale		
Lecturer	Prof. Benedikt Kriegesmann	
Language		
Cycle	WiSe	
Content	Classical laminate theory	
	Rules of mixture	
	Failure mechanisms and criteria of composites	
	Boundary value problems of isotropic and anisotropic shells	
	Stability of composite structures	
	Optimization of laminated composites	
	Modelling composites in FEM	
	Numerical multiscale analysis of textile composites	
	Progressive failure analysis	
Literature	 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			
Тур	Lecture		
Hrs/wk	2		
СР	2		
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28		
Examination Form	Mündliche Prüfung		
Examination duration and	30 min		
scale			
Lecturer	Dr. Stefan Wischhusen		
Language	DE		
Cycle	WiSe		
Content	Lecture about equation-based, physical modelling using the modelling language Modelica and the free simulation tool OpenModelica. 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	 [1] Modelica Association: "Modelica Language Specification - Version 3.4", Linköping, Sweden, 2 0 1 7 [2] M. Tiller: "Modelica by Example", http://book.xogeny.com, 2014. [3] M. Otter, H. Elmqvist, et al.: "Objektorientierte Modellierung Physikalischer Systeme", at- Automatisierungstechnik (german), Teil 1 - 17, Oldenbourg Verlag, 1999 - 2000. [4] P. Fritzson: "Principles of Object-Oriented Modeling and Simulation with Modelica 3.3", Wiley-IEEE Press, New York, 2015. [5] P. Fritzson: "Introduction to Modeling and Simulation of Technical and Physical Systems with Modelica", Wiley, New York, 2011. 		

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

Course L1513: Technical Des	ian		
	Lecture		
Hrs/wk	2		
СР	3		
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28		
Examination Form	Schriftliche Ausarbeitung		
Examination duration and	10-15 Entwurfszeichnungen, Skizzen und ca. 5-10 A4-Dokumentationsseiten (Themen- und Entwurfsbegründung)		
scale			
Lecturer	Prof. Werner Granzeier		
Language	DE		
Cycle	SoSe		
Content	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	Literatur über technisches Produktdesign Technisches Rendering und Präsentation		

Zeichnen und perspektivisches Entwerfen Literaturhinweise What is Product Design? Laura Slack RotoVision Schweiz 2006 Product Design Now Design and Scetches CollinsDesign and maomao publications Spanien 2006 Ronald B. Kemnitzer, Rendering With Markers - Definitive Techniques for Designers, Illustrators and Architects, Watson, Guptil Puplications, a division of Billboard Publications Inc., New York 1983 Creative Techniques DRAWING Barons Educational Series ISBN-13: 978-0-7641-6182-7 Joseph Ungar, Rendering In Mixed Media - Techniques for Concept Presentation for Designers and Illustrators Watson-Guptil Publication a division of Billboard Publications Inc., New York 1985 AIRWORLD Design und Architektur für die Flugreise Vitra Design Stiftung Weil am Rhein 2004 Airline Design Perter Deslius Jacek Slaski te Neues 2005 Technik und Sicherheit von Passagierflugzeugen Frank Littek Motorbuch Verlag 2003 Jetliner Cabins Jennifer Coutts Clay Cs books England 2006 **BOEING Widebodies** Michael Haenggi motorbooks international USA 2003 form - Zeitschrift für Gestaltung, Verlag form GmbH, Hofgut Ober-Berrbach, 6104 Seeheim-Jugenheim (erscheint vierteljährlich, Verlag form GmbH) design report german magasin, (erscheint monatlich) md - möbel interior design, Konradin-Verlag Robert Kohlhammer GmbH, 7022 Leinfelden-Echterdingen (erscheint monatlich) CAR STYLING, Car Styling Publishing Co. 4-8-16-11F, Kitashinjuku, Shinjuku-ku, Tokio 160, Japan (erscheint vierteljährlich in japanischer und englischer Sprache, in Hamburg erhältlich bei: Overseas Courier Service Deutschland Auto & Design, Corso Frabcia 161, 10139 Torino, Italia

PIC	duction"	
		(erscheint vierteljährlich in italienischer und englischer Sprache alle zwei
		Monate , erhältlich am HBF Hamburg
		AERO International,
		Magazin für Zivilluftfahrt
		(erscheint monatlich)
		Aircraft interior international
		Engl. magasin for Aircraft cabin interior
		(erscheint 2 monatlich)
		aerotec
		Technik- und Branchenmagazin für die Luft- und Raumfahrtindustrie

Course L0379: Ceramics Technology			
Тур	Lecture		
Hrs/wk	2		
СР	3		
Workload in Hours	Independent Study Time 62, Stu	udy Time in Lecture 28	
Examination Form	Klausur		
Examination duration and	90 Minuten		
scale			
Lecturer	Dr. Rolf Janßen		
Language	DE/EN		
Cycle	WiSe		
Content	WiSe		
Literature	W.D. Kingery, "Introduction to Ceramics", John Wiley & Sons, New York, 1975 ASM Engineering Materials Handbook Vol.4 "Ceramics and Glasses", 1991 D.W. Richerson, "Modern Ceramic Engineering", Marcel Decker, New York, 1992		
	Skript zur Vorlesung	iic Engineering , Marcel Decker, New Tork, 1992	

Course L0949: Materials Testing		
Тур	Lecture	
Hrs/wk	Hrs/wk 2	
СР	CP 2	
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28	
Examination Form	Klausur	
Examination duration and	90 Minuten	
scale		
Lecturer	Dr. Jan Oke Peters	
Language	DE	
Cycle	WiSe	
Content	Application and analysis of basic mechanical as well as non-destructive testing of materials Determination elastic constants Tensile test Fatigue test (testing with constant stress, strain, or plastiv 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	E. Macherauch: Praktikum in Werkstoffkunde, Vieweg G. E. Dieter: Mechanical Metallurgy, McGraw-Hill	

Course L0176: Reliability in Engineering Dynamics		
Тур	Lecture	
Hrs/wk		
СР	2	
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28	
Examination Form	Klausur	
Examination duration and	90 min.	
scale		
Lecturer	NN	
Language	EN	
Cycle	SoSe	
	Method for calculation and testing of reliability of dynamic machine systems Modeling System identification Simulation Processing of measurement data Damage accumulation Test planning and execution	
Literature	Bertsche, B.: Reliability in Automotive and Mechanical Engineering. Springer, 2008. ISBN: 978-3-540-33969-4 Inman, Daniel J.: Engineering Vibration. Prentice Hall, 3rd Ed., 2007. ISBN-13: 978-0132281737 Dresig, H., Holzweißig, F.: Maschinendynamik, Springer Verlag, 9. Auflage, 2009. ISBN 3540876936. VDA (Hg.): Zuverlässigkeitssicherung bei Automobilherstellern und Lieferanten. Band 3 Teil 2, 3. überarbeitete Auflage, 2004. ISSN 0943-9412	

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

Course L0749: Reliability of	Course L0749: Reliability of Aircraft Systems		
Тур	Lecture		
Hrs/wk	2		
СР	3		
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28		
Examination Form	Klausur		
Examination duration and	90 Minuten		
scale			
Lecturer	Prof. Frank Thielecke, Dr. Andreas Vahl, Dr. Uwe Wieczorek		
Language	DE		
Cycle	WiSe		
Content	 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	• CS 25.1309 • SAE ARP 4754 • SAE ARP 4761		

Module M1156: Syste	ms Engineering			
Courses				
Title		Typ	Hrs/wk	СР
Systems Engineering (L1547)		Typ Lecture	3	4
Systems Engineering (L1548)		Recitation Section (large)	1	2
Module Responsible	Prof. Ralf God			
Admission Requirements	None			
Recommended Previous	Basic knowledge in:			
Knowledge				
	Mechanics			
	Thermodynamics			
	Electrical Engineering			
	Control Systems			
	-			
	Previous knowledge in:			
	Aircraft Cabin Systems			
Educational Objectives	After taking part successfully, students have reached	the following learning results		
Professional Competence				
•	Students are able to:			
J	 understand systems engineering process models, n 	nethods and tools for the development o	f complex Systen	ns
	describe innovation processes and the need for tec	·	, ,	
	explain the aircraft development process and the p			
	explain the system development process, including			
	identify environmental conditions and test procedu			
	 value the methodology of requirements-based engi 		nents engineerin	g (MBRE)
Skills	Students are able to:			
	plan the process for the development of complex S			
	organize the development phases and developmen			
	assign required business activities and technical Ta	sks		
	apply systems engineering methods and tools			
Personal Competence				
Social Competence	Students are able to:			
,	understand their responsibilities within a developm	ent team and integrate themselves with	their role in the	overall process
	, , , , , , , , , , , , , , , , , , ,			
Autonomy	Students are able to:			
	interact and communicate in a development team v	which has distributed tasks		
Workload in Hours	Independent Study Time 124, Study Time in Lecture	56		
Credit points				
Course achievement	None			
Examination	Written exam			
Examination duration and	120 Minutes			
scale				
Assignment for the	Aircraft Systems Engineering: Core Qualification: Con	npulsory		
Following Curricula	International Management and Engineering: Specialis	sation II. Aviation Systems: Elective Com	pulsory	
-	International Management and Engineering: Specialis	•		ompulsory
	Mechatronics: Specialisation System Design: Elective			
	Mechatronics: Specialisation Intelligent Systems and	Robotics: Elective Compulsory		
	Product Development, Materials and Production: Spec		Isory	
	Product Development, Materials and Production: Spec			
	Product Development, Materials and Production: Spec	· ·	-	
	Theoretical Mechanical Engineering: Specialisation Ai	rcraft Systems Engineering: Elective Cor	npulsory	

Course L1547: Systems Engineering		
Тур	Lecture	
Hrs/wk	3	
СР	4	
Workload in Hours	Independent Study Time 78, Study Time in Lecture 42	
Lecturer	Prof. Ralf God	
Language	DE	
Cycle	SoSe	
Content	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.	
	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: 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	- 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	
Тур	Recitation Section (large)
Hrs/wk	1
СР	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: Turbo	omachinery			
Courses				
Title		Тур	Hrs/wk	СР
Turbomachines (L1562)		Lecture	3	4
Turbomachines (L1563)		Recitation Section (large)	1	2
Module Responsible	Prof. Markus Schatz			
Admission Requirements	None			
Recommended Previous	Technical Thermodynamics I, II, Fluid Dynamics, Heat Transf	er		
Knowledge				
Educational Objectives	After taking part successfully, students have reached the fol	lowing learning results		
Professional Competence				
Knowledge	The students can			
	distinguish the physical phenomena of conversion of e	enerav.		
	understand the different mathematic modelling of tur			
	calculate and evaluate turbomachinery.			
Skills	The students are able to			
	- understand the physics of Turbomachinery,			
	- solve excersises self-consistent.			
Personal Competence				
Social Competence	The students are able to			
	discuss in small groups and develop an approach.			
Autonomy	The students are able to			
	 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	90 min			
scale				
Assignment for the	Energy Systems: Specialisation Energy Systems: Elective Co	mpulsory		
Following Curricula	Energy Systems: Specialisation Marine Engineering: Elective	Compulsory		
	Product Development, Materials and Production: Specialisati	on Product Development: Elective	e Compulsory	
	Product Development, Materials and Production: Specialisati	·	•	
	Product Development, Materials and Production: Specialisati	on Materials: Elective Compulsory	/	

Course L1562: Turbomachine	95
Тур	Lecture
Hrs/wk	3
СР	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:
Literature	 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	 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

Course L1563: Turbomachines	
Тур	Recitation Section (large)
Hrs/wk	1
СР	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	Тур		Hrs/wk	СР
Applied Automation (L1592)		problem-based Learning	3	3
Ergonomics (L0653)			2	3
Advanced Training Course SE-ZERT	(L2739) Project-/p	problem-based Learning	2	3
Elements of Integrated Production	Systems (L0927) Project-/p	problem-based Learning	2	3
Development Management for Med	hatronics (L1512) Lecture		2	3
Fatigue & Damage Tolerance (L031	.0) Lecture		2	3
Industry 4.0 for engineers (L2012)	Lecture		2	3
Innovation and Product Manageme	nt (L2168) Seminar		2	3
Lightweight Design Practical Cours	e (L1258) Project-/p	problem-based Learning	3	3
Mechanisms, Systems and Process	es of Materials Testing (L0950) Lecture		2	2
Microsystems Technology (L0724)	Lecture		2	4
Sustainable Industrial Production (I	.2863) Lecture		2	3
Productivity Management (L0928)	Project-/p	problem-based Learning	2	2
Productivity Management (L0931)	Recitatio	n Section (small)	1	1
Feedback Control in Medical Techn	ology (L0664) Lecture		2	3
Structural Mechanics of Fibre Reinf	orced Composites (L1514) Lecture		2	3
System Simulation (L1820)	Lecture		2	2
System Simulation (L1821)	Recitatio	n 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) Recitatio	n Section (small)	1	2
Reliability of Aircraft Systems (L074	49) Lecture		2	3
Module Responsible	Prof. Dieter Krause			
Admission Requirements	None			
Recommended Previous	None			
Knowledge				
Educational Objectives	After taking part successfully, students have reached the following learning	ng results		
Professional Competence				
Knowledge				
Miowieuge	 Students are able to express their extended knowledge and discuss 	ss the connection of diff	erent special fiel	ds or application
	areas of product development, materials and production			
	Students are qualified to connect different special fields with each of the students are qualified to connect different special fields with each of the students are qualified to connect different special fields with each of the students are qualified to connect different special fields with each of the students.	other		
Skills	Charles to a complete and a charles a charles in a charle			
	Students can apply specialized solution strategies and new scientif			
	 Students are able to transfer learned skills to new and unknown pro 	oblems and can develop	own solution ap	proaches
Personal Competence				
Personal Competence				
Social Competence	-			
-	Students are able to develop their knowledge and skills by autonon	nous election of courses		
Social Competence	Students are able to develop their knowledge and skills by autonon	nous election of courses		
Social Competence	Students are able to develop their knowledge and skills by autonon Depends on choice of courses	nous election of courses		
Social Competence Autonomy	Depends on choice of courses	nous election of courses		
Social Competence Autonomy Workload in Hours	Depends on choice of courses			
Social Competence Autonomy Workload in Hours Credit points	Depends on choice of courses	evelopment: Elective Co		
Social Competence Autonomy Workload in Hours Credit points Assignment for the	Depends on choice of courses 6 Product Development, Materials and Production: Specialisation Product De	evelopment: Elective Co n: Elective Compulsory		

Course L1592	2: Applied Automation
Тур	Project-/problem-based Learning
Hrs/wk	3
СР	3
Workload in	Independent Study Time 48, Study Time in Lecture 42
Hours	
Examination	Mündliche Prüfung
Form	
Examination	30 Minuten
duration	
and scale	
Lecturer	Prof. Thorsten Schüppstuhl
Language	DE
Cycle	WiSe
	-Project Based Learning -Robot Operating System -Robot structure and description -Motion description -Calibration -Accuracy John J. Craig Introduction to Robotics - Mechanics and Control ISBN: 0131236296 Pearson Education, Inc., 2005 Stefan Hesse Grundlagen der Handhabungstechnik ISBN: 3446418725 München Hanser, 2010 K. Thulasiraman and M. N. S. Swamy Graphs: Theory and Algorithms ISBN: 9781118033104 %CITAVIPICKER£9781118033104£Titel anhand dieser ISBN in Citavi-Projekt übernehmen£% John Wüey & Sons, Inc., 1992

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

Course L2739: Advanced Trai	ining Course SE-ZERT
Тур	Project-/problem-based Learning
Hrs/wk	2
СР	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Examination Form	Klausur
Examination duration and	120 min
scale	
Lecturer	Prof. Ralf God
Language	DE
Cycle	SoSe SoSe
Content	
	INCOSE Systems Engineering Handbuch - Ein Leitfaden für Systemlebenszyklus-Prozesse und -Aktivitäten, GfSE (Hrsg. der deutschen Übersetzung), ISBN 978-3-9818805-0-2. ISO/IEC 15288 System- und Software-Engineering - System-Lebenszyklus-Prozesse (Systems and Software Engineering - System Life Cycle Processes).

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

Course L1512: Development	Management for Mechatronics
Тур	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	30 Minuten
scale	
Lecturer	NN, Dr. Johannes Nicolas Gebhardt
Language	DE
Cycle	SoSe
Content	Processes and methods of product development - from idea to market launch 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 Design of processes for product development IT systems for product development Establishment of management standards Typical types of organization
Literature	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	
Тур	Lecture
Hrs/wk	2
СР	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Examination Form	Mündliche Prüfung
Examination duration and	45 min
scale	
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. Kluver Academic Puplisher, Dordrecht, 2001 E. Haibach. Betriebsfestigkeit
	Verfahren und Daten zur Bauteilberechnung. VDI-Verlag, Düsseldorf, 1989

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

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

Course L1258: Lightweight Design Practical Course		
Тур Р	Project-/problem-based Learning	
Hrs/wk 3	3	
CP 3	3	
Workload in Hours	Independent Study Time 48, Study Time in Lecture 42	
Examination Form	Mündliche Prüfung	
Examination duration and 3	30 min	
scale		
Lecturer F	Prof. Dieter Krause	
Language [DE/EN	
Cycle S	SoSe	
Content	Development of a sandwich structure made of fibre reinforced plastics	
	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	Schürmann, H., "Konstruieren mit Faser-Kunststoff-Verbunden", Springer, Berlin, 2005.	
	Puck, A., "Festigkeitsanalsyse 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
Тур	Lecture
Hrs/wk	2
СР	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Examination Form	Klausur
Examination duration and	90 Minuten
scale	
Lecturer	Dr. Jan Oke Peters
Language	DE
Cycle	SoSe
Content	Application, analysis and discussion of basic and advanced testing methods to ensure correct selection of applicable testing procedure for investigation of part/materials deficiencies • 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	 E. Macherauch: Praktikum in Werkstoffkunde, Vieweg G. E. Dieter: Mechanical Metallurgy, McGraw-Hill R. Bürgel: Lehr- und Übungsbuch Festigkeitslehre, Vieweg R. Bürgel: Werkstoffe sícher beurteilen und richtig einsetzen, Vieweg

Course L0724: Microsystems	Technology
Тур	Lecture
Hrs/wk	
СР	4
Workload in Hours	Independent Study Time 92, Study Time in Lecture 28
Examination Form	
Examination duration and	
scale	
Lecturer	Prof. Hoc Khiem Trieu
Language	
Cycle	
Content	
Content	 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, SUB, 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: pelistor and thermal conductivity sensor; metal oxide semiconductor gas sensor, clambda probe, MOS
	and silicon fusion bonding; micro electroplating, 3D-MID)
Literature	M. Madou: Fundamentals of Microfabrication, CRC Press, 2002 N. Schwesinger: Lehrbuch Mikrosystemtechnik, Oldenbourg Verlag, 2009
	T. M. Adams, R. A. Layton:Introductory MEMS, Springer, 2010
	G. Gerlach; W. Dötzel: Introduction to microsystem technology, Wiley, 2008

ourse L2863: Sustainable In	ndustrial Production
Тур	Lecture
Hrs/wk	2
СР	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Examination Form	Klausur
Examination duration and	60 min
scale	
Lecturer	Dr. Simon Markus Kothe
Language	DE
Cycle	SoSe
Content	Industrial production deals with the manufacture of physical products to satisfy human needs using various manufacturing processes that change the form and physical properties of raw materials. Manufacturing is a central driver of economic development and has a major impact on the well-being of humanity. However, the scale of current manufacturing activities results in enormous global energy and material demands that are harmful to both the environment and people. Historically, industria activities were mostly oriented towards economic constraints, while social and environmental consequences were only hardly considered. As a result, today's global consumption rates of many resources and associated emissions often exceed the natura regeneration rate of our planet. In this respect, current industrial production can mostly be described as unsustainable. This is emphasized each year by the Earth Overshoot Day, which marks the day when humanity's ecological footprint exceeds the Earth's annual regenerative capacity. This lecture aims to provide the motivation, analytical methods as well as approaches for sustainable industrial production and to clarify the influence of the production phase in relation to the raw material, use and recycling phases in the entire life cycle of products. For this, the following topics will be highlighted:
	 Motivation for sustainable production, the 17 Sustainable Development Goals (SDGs) of the UN and their relevance fo tomorrow's manufacturing; raw material vs. production phase vs. use phase vs. recycling/end-of-life phase: importance of the production phase for the environmental impact of manufactured products;
	- Typical energy- and resource-intensive processes in industrial production and innovative approaches to increase energy and resource efficiency;
	- Methodology for optimizing the energy and resource efficiency of industrial manufacturing chains with the three steps o modeling (1), evaluating (2) and improving (3);
	- Resource efficiency of industrial manufacturing value chains and its assessment using life cycle analysis (LCA);
	- Exercise: LCA analysis of a manufacturing process (thermoplastic joining of an aircraft fuselage segment) as part of a product life cycle assessment.
Literature	Litoratur
Literature	Literatur.
	- Stefan Alexander (2020): Resource efficiency in manufacturing value chains. Cham: Springer International Publishing.
	- Hauschild, Michael Z.; Rosenbaum, Ralph K.; Olsen, Stig Irving (Hg.) (2018): Life Cycle Assessment. Theory and Practice. Cham Springer International Publishing.
	- Kishita, Yusuke; Matsumoto, Mitsutaka; Inoue, Masato; Fukushige, Shinichi (2021): EcoDesign and sustainability. Singapore: Springer.
	- Schebek, Liselotte; Herrmann, Christoph; Cerdas, Felipe (2019): Progress in Life Cycle Assessment. Cham: Springer Internationa Publishing.
	- Thiede, Sebastian; Hermann, Christoph (2019): Eco-factories of the future. Cham: Springer Nature Switzerland AG.
	- Vorlesungsskript.

Course L0928: Productivity Management	
Тур	Project-/problem-based Learning
Hrs/wk	2
СР	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Examination Form	Klausur
Examination duration and	90 Minuten
scale	
	Prof. Hermann Lödding
Language	
Cycle	SoSe
Content	 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	Bokranz, R.; Landau, K.:Produktivitätsmanagement von Arbeitssystemen. Schäffer-Poeschel, Stuttgart, 2006. Takeda, H.: Das synchrone Produktionssystem: Just-in-Time für das ganze Unternehmen. 5. Aufl., mi-Wirtschaftsbuch, FinanzBuch Verlag, München, 2006. Nakajima, S.: Management der Produktionseinrichtungen (Total Productive Maintenance). Campus Verlag, New York, 1995. Shingo, S.: A Revolution in Manufacturing: The SMED System. Productivity, Inc., 1985

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

Course L0664: Feedback Control in Medical Technology		
Тур	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	20 min	
scale		
Lecturer	Johannes Kreuzer, Christian Neuhaus	
Language	DE	
Cycle	SoSe	
Content	Always viewed from the engineer's point of view, the lecture is structured as follows:	
Literature	 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 L1514: Structural Mechanics of Fibre Reinforced Composites		
Тур	Lecture	
Hrs/wk	2	
СР	3	
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28	
Examination Form	Mündliche Prüfung	
Examination duration and	30 min	
scale		
Lecturer	Prof. Benedikt Kriegesmann	
Language		
Cycle	WiSe	
Content	Classical laminate theory	
	Rules of mixture	
	Failure mechanisms and criteria of composites	
	Boundary value problems of isotropic and anisotropic shells	
	Stability of composite structures	
	Optimization of laminated composites	
	Modelling composites in FEM	
	Numerical multiscale analysis of textile composites	
	Progressive failure analysis	
Literature	 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	
Тур	Lecture
Hrs/wk	2
СР	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Examination Form	Mündliche Prüfung
Examination duration and	30 min
scale	
Lecturer	Dr. Stefan Wischhusen
Language	DE
Cycle	WiSe
Content	Lecture about equation-based, physical modelling using the modelling language Modelica and the free simulation tool OpenModelica. • 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	 [1] Modelica Association: "Modelica Language Specification - Version 3.4", Linköping, Sweden, 2 0 1 7 [2] M. Tiller: "Modelica by Example", http://book.xogeny.com, 2014. [3] M. Otter, H. Elmqvist, et al.: "Objektorientierte Modellierung Physikalischer Systeme", at- Automatisierungstechnik (german), Teil 1 - 17, Oldenbourg Verlag, 1999 - 2000. [4] P. Fritzson: "Principles of Object-Oriented Modeling and Simulation with Modelica 3.3", Wiley-IEEE Press, New York, 2015. [5] P. Fritzson: "Introduction to Modeling and Simulation of Technical and Physical Systems with Modelica", Wiley, New York, 2011.

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

Course L1513: Technical Design	
	Lecture
Hrs/wk	
СР	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Examination Form	Schriftliche Ausarbeitung
Examination duration and	10-15 Entwurfszeichnungen, Skizzen und ca. 5-10 A4-Dokumentationsseiten (Themen- und Entwurfsbegründung)
scale	
Lecturer	Prof. Werner Granzeier
Language	DE
Cycle	SoSe
Content	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	Literatur über technisches Produktdesign Technisches Rendering und Präsentation

Zeichnen und perspektivisches Entwerfen Literaturhinweise What is Product Design? Laura Slack RotoVision Schweiz 2006 Product Design Now Design and Scetches CollinsDesign and maomao publications Spanien 2006 Ronald B. Kemnitzer, Rendering With Markers - Definitive Techniques for Designers, Illustrators and Architects, Watson, Guptil Puplications, a division of Billboard Publications Inc., New York 1983 Creative Techniques DRAWING Barons Educational Series ISBN-13: 978-0-7641-6182-7 Joseph Ungar, Rendering In Mixed Media - Techniques for Concept Presentation for Designers and Illustrators Watson-Guptil Publication a division of Billboard Publications Inc., New York 1985 AIRWORLD Design und Architektur für die Flugreise Vitra Design Stiftung Weil am Rhein 2004 Airline Design Perter Deslius Jacek Slaski te Neues 2005 Technik und Sicherheit von Passagierflugzeugen Frank Littek Motorbuch Verlag 2003 Jetliner Cabins Jennifer Coutts Clay Cs books England 2006 **BOEING Widebodies** Michael Haenggi motorbooks international USA 2003 form - Zeitschrift für Gestaltung, Verlag form GmbH, Hofgut Ober-Berrbach, 6104 Seeheim-Jugenheim (erscheint vierteljährlich, Verlag form GmbH) design report german magasin, (erscheint monatlich) md - möbel interior design, Konradin-Verlag Robert Kohlhammer GmbH, 7022 Leinfelden-Echterdingen (erscheint monatlich) CAR STYLING, Car Styling Publishing Co. 4-8-16-11F, Kitashinjuku, Shinjuku-ku, Tokio 160, Japan (erscheint vierteljährlich in japanischer und englischer Sprache, in Hamburg erhältlich bei: Overseas Courier Service Deutschland Auto & Design, Corso Frabcia 161, 10139 Torino, Italia

Production"	
	(erscheint vierteljährlich in italienischer und englischer Sprache alle zwei
	Monate , erhältlich am HBF Hamburg
	AERO International,
	Magazin für Zivilluftfahrt
	(erscheint monatlich)
	Aircraft interior international
	Engl. magasin for Aircraft cabin interior
	(erscheint 2 monatlich)
	aerotec
	Technik- und Branchenmagazin für die Luft- und Raumfahrtindustrie

Course L0379: Ceramics Tecl	hnology	
Тур	Lecture	
Hrs/wk	2	
СР	3	
Workload in Hours	Independent Study Time 62, Stu	udy Time in Lecture 28
Examination Form	Klausur	
Examination duration and	90 Minuten	
scale		
	Dr. Rolf Janßen	
Language		
Cycle		sing with amphasis an advanced shrushwall agramics. The savgas fears wadeningthy an accordan
Content	Introduction to ceramic processing with emphasis on advanced structural ceramics. The course focus predominatly on powder-based processing, e.g. "powder-metauurgical techniques and sintering (soild 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.	
	Content:	1. Introduction
	Inhalt:	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
Literature	W.D. Kingery, "Introduction to C	Ceramics", John Wiley & Sons, New York, 1975
	ASM Engineering Materials Hand	dbook Vol.4 "Ceramics and Glasses", 1991
	D.W. Richerson, "Modern Ceram	nic Engineering", Marcel Decker, New York, 1992
	Skript zur Vorlesung	

Course L0949: Materials Testing	
Тур	Lecture
Hrs/wk	2
СР	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Examination Form	Klausur
Examination duration and	90 Minuten
scale	
Lecturer	Dr. Jan Oke Peters
Language	DE
Cycle	WiSe
Content	
	Application and analysis of basic mechanical as well as non-destructive testing of materials Determination elastic constants Tensile test Fatigue test (testing with constant stress, strain, or plastiv 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	E. Macherauch: Praktikum in Werkstoffkunde, Vieweg G. E. Dieter: Mechanical Metallurgy, McGraw-Hill

Course L0176: Reliability in I	Engineering Dynamics	
Тур	Lecture	
Hrs/wk	2	
СР	2	
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28	
Examination Form	Klausur	
Examination duration and	90 min.	
scale		
Lecturer	NN	
Language		
Cycle	SoSe SoSe	
Content	Method for calculation and testing of reliability of dynamic machine systems Modeling System identification Simulation Processing of measurement data Damage accumulation Test planning and execution	
Literature	Bertsche, B.: Reliability in Automotive and Mechanical Engineering. Springer, 2008. ISBN: 978-3-540-33969-4 Inman, Daniel J.: Engineering Vibration. Prentice Hall, 3rd Ed., 2007. ISBN-13: 978-0132281737 Dresig, H., Holzweißig, F.: Maschinendynamik, Springer Verlag, 9. Auflage, 2009. ISBN 3540876936. VDA (Hg.): Zuverlässigkeitssicherung bei Automobilherstellern und Lieferanten. Band 3 Teil 2, 3. überarbeitete Auflage, 2004. ISSN 0943-9412	

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

Course L0749: Reliability of Aircraft Systems	
Тур	Lecture
Hrs/wk	2
СР	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Examination Form	Klausur
Examination duration and	90 Minuten
scale	
Lecturer	Prof. Frank Thielecke, Dr. Andreas Vahl, Dr. Uwe Wieczorek
Language	DE
Cycle	WiSe
Content	 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	• CS 25.1309 • SAE ARP 4754 • SAE ARP 4761

Module M1226: Mech	anical Properties			
Courses				
Title		Тур	Hrs/wk	СР
Mechanical Behaviour of Brittle Mat		Lecture	2	3
Dislocation Theory of Plasticity (L16	562)	Lecture	2	3
Module Responsible	Dr. Erica Lilleodden			
Admission Requirements	None			
Recommended Previous	Basics in Materials Science I/II			
Knowledge				
Educational Objectives	After taking part successfully, students have reached the	ne following learning results		
Professional Competence				
Knowledge	Students can explain basic principles of crystallograp	phy, statics (free body diagram	ns, tractions) and therm	odynamics (energy
	minimization, energy barriers, entropy)			
Skille	Students are capable of using standardized calculation	mothods: tonsor calculations de	orivativos intograls ton	or transformations
Skills	Students are capable of using standardized calculation	methods, tensor calculations, di	erivatives, integrals, ten	sor transformations
Personal Competence				
Social Competence	Students can provide appropriate feedback and handle feedback on their own performance constructively.			
Autonomy	Students are able to			
	- assess their own strengths and weaknesses			
	- assess their own state of learning in specific terms an	d to define further work steps or	n this basis guided by te	achers.
	- work independently based on lectures and notes to so	olve problems, and to ask for hel	p or clarifications when	needed
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56			
Credit points	6			
Course achievement	None			
Examination	Written exam			
Examination duration and	90 min			
scale				
Assignment for the	Materials Science: Core Qualification: Compulsory			
Following Curricula	Mechanical Engineering and Management: Specialisation	on Materials: Elective Compulsor	у	
	Product Development, Materials and Production: Specia	alisation Product Development: E	Elective Compulsory	
	Product Development, Materials and Production: Specia	alisation Production: Elective Cor	mpulsory	
	Product Development, Materials and Production: Specia	alisation Materials: Compulsory		
	Theoretical Mechanical Engineering: Specialisation Mat	erials Science: Elective Compuls	ory	

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

Course L1662: Dislocation Th	neory of Plasticity
Тур	Lecture
Hrs/wk	2
СР	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Dr. Erica Lilleodden
Language	DE/EN
Cycle	SoSe SoSe
Content	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.
	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.
Literature	Vorlesungsskript Aktuelle Publikationen Bücher: Introduction to Dislocations, by D. Hull and D.J. Bacon Theory of Dislocations, by J.P. Hirth and J. Lothe Physical Metallurgy, by Peter Hassen

Module M0840: Optim	nal and Robust Control			
Courses				
Title		Typ	Hrs/wk	СР
Optimal and Robust Control (L0658)	Typ Lecture	2	3
Optimal and Robust Control (L0659		Recitation Section (small)	2	3
Module Responsible	Prof. Herbert Werner			
Admission Requirements	None			
Recommended Previous				
Knowledge	 Classical control (frequency response, root locus) 			
-	State space methods			
	 Linear algebra, singular value decomposition 			
Educational Objectives	After taking part successfully, students have reached the	e following learning results		
Professional Competence				
Knowledge				
_	 Students can explain the significance of the matri 			
	They can explain the duality between optimal star			
	They can explain how the H2 and H-infinity norms They can explain how an LOC design graph laws are			
	They can explain how an LQG design problem can They can explain how model upgettainty can be a			
	 They can explain how model uncertainty can be in They can explain how - based on the small gain 			
	an uncertain plant.	ineorem - a robust controller can gu	arantee stability	and performance for
	They understand how analysis and synthesis cond	litions on feedback loops can be repr	esented as linear	matrix inequalities.
	, , ,	·		
Skills	 Students are capable of designing and tuning LQQ 	i controllers for multivariable plant m	odels.	
	They are capable of representing a H2 or H-infinit			and of using standard
	software tools for solving it.	,		3
	 They are capable of translating time and frequent 	ncy domain specifications for control	loops into const	raints on closed-loop
	sensitivity functions, and of carrying out a mixed-	sensitivity design.		
	They are capable of constructing an LFT uncertainty	inty model for an uncertain system	, and of designin	ng a mixed-objective
	robust controller.			
	 They are capable of formulating analysis and syn 	thesis conditions as linear matrix ine	equalities (LMI), a	nd of using standard
	LMI-solvers for solving them.			
	They can carry out all of the above using standard	I software tools (Matlab robust contro	ol toolbox).	
Personal Competence				
	Students can work in small groups on specific problems	to arrive at joint solutions.		
Autonomy	Students are able to find required information in source:		software docume	ntation) and use it to
	solve given problems.			
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56			
Credit points				
Course achievement	None			
Examination	Oral exam			
Examination duration and	30 min			
scale				
Assignment for the	Electrical Engineering: Specialisation Control and Power		ulsory	
Following Curricula	Energy Systems: Core Qualification: Elective Compulsory			
	Aircraft Systems Engineering: Core Qualification: Elective			
	Mechatronics: Specialisation Intelligent Systems and Rol Mechatronics: Specialisation System Design: Elective Co	' '		
	Biomedical Engineering: Specialisation Artificial Organs	•	Compulsory	
	Biomedical Engineering: Specialisation Implants and Enc	-	Compuisor y	
	Biomedical Engineering: Specialisation Medical Technology		pulsory	
	Biomedical Engineering: Specialisation Management and	,		
	Product Development, Materials and Production: Special	Sation Froduct Development, Electiv		
	Product Development, Materials and Production: Special Product Development, Materials and Production: Special			
		sation Production: Elective Compulso	ory	

Course L0658: Optimal and Robust Control		
Тур	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	 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 H2 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 (H2, 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	 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. Postlewhaite "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 F	urse L0659: Optimal and Robust Control	
Тур	Recitation Section (small)	
Hrs/wk	2	
СР	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: Proce	essing of fibre-polymer-composites			
Courses				
Title		Тур	Hrs/wk	СР
Processing of fibre-polymer-compos	sites (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 in the basics of chemistry / physics / mat	erials science		
Knowledge				
Educational Objectives	After taking part successfully, students have reached	d the following learning results		
Professional Competence				
Knowledge	Students are able to give a summary of the technic relationships. They are capable of describing and language. They can explain the typical process of so	communicating relevant problems and ques	stions using a	·
Skills	Students can use the knowledge of fiber-reinforced testing and analysis.	composites (FRP) and its constituents (fiber ,	matrix) and	define the necessary
	They can explain the complex structure-property rel the interactions of chemical structure of the poly		fiber types,	including to explain
	neighboring contexts (e.g. sustainability, environme	ntal protection).		
Personal Competence				
Social Competence	Students are able to cooperate in small, mixed-subj context of civil engineering. They are able to effect audience. Students have the ability to develop alter discuss advantages as well as drawbacks.	vely present and explain their results alone	or in groups	in front of a qualified
Autonomy				
Workload in Hours	Independent Study Time 124, Study Time in Lecture	56		
Credit points	6			
Course achievement	None			
Examination	Written exam			
Examination duration and	90 min			
scale				
Assignment for the	Materials Science: Specialisation Engineering Materi	als: Elective Compulsory	_	
Following Curricula	Mechanical Engineering and Management: Specialis	ation Materials: Elective Compulsory		
	Product Development, Materials and Production: Spe	ecialisation Product Development: Elective Co	mpulsory	
	Product Development, Materials and Production: Spe	ecialisation Production: Elective Compulsory		
	Product Development, Materials and Production: Spe	ecialisation Materials: Elective Compulsory		

Course L1895: Processing of	Course L1895: Processing of fibre-polymer-composites		
Тур	Lecture		
Hrs/wk	2		
СР	3		
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28		
Lecturer	Prof. Bodo Fiedler		
Language	DE/EN		
Cycle	SoSe 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		

Course L1516: From Molecul	Course L1516: From Molecule to Composites Part		
Тур	Project-/problem-based Learning		
Hrs/wk	2		
СР	3		
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28		
Lecturer	Prof. Bodo Fiedler		
Language	DE/EN		
Cycle	SoSe		
Content	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). 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. 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"). After the test during the "customer / supplier conversation" there is a mutual feedback-talk ("lessons learned") in order to ensure the continuous improvement.		
Literature	Customer Request ("Handout")		

Module M1690: Aircra	aft Design II (Special Air Vehicle Design)		
Courses				
	gn of Rotorcraft, special operations aircraft, UAV) (L0844) gn of Rotorcraft, special operations aircraft, UAV) (L0847)	Typ Lecture Recitation Section (large)	Hrs/wk 3 2	CP 3 3
Module Responsible	Prof. Volker Gollnick			
Admission Requirements	None			
Recommended Previous	Aircraft Design I (Design of Transport Aircraft)			
Knowledge	Air Transportation Systems			
Educational Objectives	After taking part successfully, students have reached the	following learning results		
Professional Competence				
Knowledge	Understanding of various flight systems and its special unmanned air systems)	characteristics (supersonic aircraft,	rotorcraft, high p	performance aircraft,
	Understanding of pro's and con's and physical character	istics of different air systems		
	Understanding of special mission requirements and its im	pact on systems definition and conce	eptual design	
	Intensified knowledge of performance design on various a	air systems		
Skills	Understanding and application of design and calculation	methods		
	Understanding of interdisciplinary and integrative interde	pendencies		
	mission oriented technical definition of air systems			
	special conceptual calculation methods for special equipr	ment characteristics		
	assessment of different design solutions			
Personal Competence				
Social Competence	Working in teams for focused solutions			
	communication, assertiveness, technical persuasion			
Autonomy	Organisation of worksflows and strategies for solutions			
	structured task analysis and definition of solutions			
Workload in Hours	Independent Study Time 110, Study Time in Lecture 70			
Credit points	6			·
Course achievement	None			
	Written exam			
Examination duration and	180 min			
Scale Assignment for the	Aircraft Systems Engineering: Core Qualification: Elective	Compulsory		
Following Curricula			oulsorv	
	Product Development, Materials and Production: Specialis	,	,	
	Product Development, Materials and Production: Specialis	•	. ,	
	Theoretical Mechanical Engineering: Specialisation Aircra	ft Systems Engineering: Elective Con	npulsory	

Course L0844: Aircraft Desig	n II (Conceptual Design of Rotorcraft, special operations aircraft, UAV)
Тур	Lecture
Hrs/wk	3
СР	3
Workload in Hours	Independent Study Time 48, Study Time in Lecture 42
Lecturer	Prof. Volker Gollnick, Dr. Bernd Liebhardt, Jens Thöben
Language	DE/EN
Cycle	SoSe
Content	Design of supersonic civil aircraft Principles of high performance and special operations aircraft design Principles of Rotorcraft Design Principles of Unmanned Air Systems design, air taxis, electric aircraft
Literature	Gareth Padfield: Helicopter Flight Dynamics, butterworth ltd. Raymond Prouty: Helicopter Performance Stability and Control, Krieger Publ. Klaus Hünecke: Das Kampfflugzeug von Heute, Motorbuch Verlag Jay Gundelach: Designing Unmanned Aircraft Systems - Configurative Approach, AIAA

Course L0847: Aircraft Desig	urse L0847: Aircraft Design II (Conceptual Design of Rotorcraft, special operations aircraft, UAV)	
Тур	Recitation Section (large)	
Hrs/wk	2	
СР	3	
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28	
Lecturer	Prof. Volker Gollnick, Dr. Bernd Liebhardt, Jens Thöben	
Language	DE/EN	
Cycle	SoSe	
Content	See interlocking course	
Literature	See interlocking course	

Module M1343: Struct	cure and properties of fibre-polymer	-composites		
Courses				
Title		Тур	Hrs/wk	СР
Structure and properties of fibre-pol	lymer-composites (L1894)	Lecture	2	3
Structure and properties of fibre-pol		Project-/problem-based Learning	2	2
Structure and properties of fibre-pol		Recitation Section (large)	1	1
-	Prof. Bodo Fiedler			
	None			
Recommended Previous Knowledge	Basics: chemistry / physics / materials science			
_	After taking part successfully, students have reached	the following learning results		
Professional Competence	After taking part successfully, students have reached	the following learning results		
Knowledge	Students can use the knowledge of fiber-reinforced composites (FRP) and its constituents to play (fiber / matrix) and define the necessary testing and analysis.			
	They can explain the complex relationships structure	-property relationship and		
	the interactions of chemical structure of the polyn neighboring contexts (e.g. sustainability, environmen		fiber types,	including to explain
Skills	Students are capable of			
	 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 stiff	fness, corrosio	on resistance.
Personal Competence				
Social Competence	Students can			
	 arrive at funded work results in heterogenius groups and document them. provide appropriate feedback and handle feedback on their own performance constructively. 			
Autonomy	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 110 Study Time in Leature	70		
+	Independent Study Time 110, Study Time in Lecture 6	, ,		
Course achievement				
Examination				
Examination duration and				
scale				
Assignment for the	Energy Systems: Core Qualification: Elective Compuls	sory		
Following Curricula	Aircraft Systems Engineering: Core Qualification: Elec	tive Compulsory		
	International Management and Engineering: Specialis	ation II. Product Development and Producti	on: Elective C	ompulsory
	Materials Science: Specialisation Engineering Materia	, ,		
	Mechanical Engineering and Management: Core Quali			
	Product Development, Materials and Production: Spec	•	ompulsory	
	Product Development, Materials and Production: Spec			
	Product Development, Materials and Production: Spec Renewable Energies: Specialisation Bioenergy System			
	Renewable Energies: Specialisation Wind Energy System			
	Renewable Energies: Specialisation White Energy Systems: Elective Compulsory			
	Theoretical Mechanical Engineering: Specialisation Materials Science: Elective Compulsory			

Course L1894: Structure and properties of fibre-polymer-composites				
Тур	Lecture			
Hrs/wk	2			
СР	3			
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28			
Lecturer	Prof. Bodo Fiedler			
Language	EN			
Cycle	SoSe			
Content	- 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			
Litoraturo	Hall, Clyne: Introduction to Composite materials, Cambridge University Press			
Literature				
	Daniel, Ishai: Engineering Mechanics of Composites Materials, Oxford University Press			
	Mallick: Fibre-Reinforced Composites, Marcel Deckker, New York			

Course L2614: Structure and properties of fibre-polymer-composites		
Тур	Project-/problem-based Learning	
Hrs/wk	2	
СР	2	
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28	
Lecturer	Prof. Bodo Fiedler	
Language	DE/EN	
Cycle	SoSe	
Content		
Literature		

Course L2613: Structure and properties of fibre-polymer-composites		
Тур	Recitation Section (large)	
Hrs/wk	1	
СР	1	
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14	
Lecturer	Prof. Bodo Fiedler	
Language	EN	
Cycle	SoSe	
Content		
Literature		

FIOGUCCIOII				
Module M1174: Autor	nation Technology and Systems			
Courses				
Title Automation Technology and Systems (L2329) Automation Technology and Systems (L2331)		Typ Lecture Project-/problem-based Learning	Hrs/wk 4 1	CP 4 1
Automation Technology and System		Recitation Section (small)	1	1
	Prof. Thorsten Schüppstuhl			
Admission Requirements Recommended Previous Knowledge	None without major course assessment			
Educational Objectives	After taking part successfully, students have reached the fo	ollowing learning results		
Professional Competence Knowledge				
Skills	know methods for a systematical analysis of automation tasks and are able to use them have special competences in industrial robot based automation systems Students are able to			
	analyze complex Automation tasks develop application based concepts and solutions design subsystems and integrate into one system investigate and evaluate safety of machinery create simple programs for robots and programmab design of circuit for pneumatic applications	e logic controllers		
Personal Competence				
Social Competence	Students are able to			
	- find solutions for automation and handling tasks in groups			
	- develop solutions in a production environment with qualified personnel at technical level and represent decisions.			
Autonomy	analyze automation tasks independently generate programs for robots and programmable log develop solutions for practice oriented tasks of auto design safety concepts for automation applications assess consequences of their professional actions are	mation independently		
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				
Assignment for the	International Management and Engineering: Specialisation	II. Product Development and Production	on: Elective C	ompulsory
Following Curricula	Product Development, Materials and Production: Specialisa Product Development, Materials and Production: Specialisa Product Development, Materials and Production: Specialisa	tion Production: Compulsory	ompulsory	
1	Theoretical Mechanical Engineering: Specialisation Product	Development and Production: Elective	e Compulsory	

Course L2329: Automation Technology and Systems		
Тур	Lecture	
Hrs/wk	4	
СР	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		
Тур	Project-/problem-based Learning	
Hrs/wk	1	
СР	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 T	Course L2330: Automation Technology and Systems		
Тур	Recitation Section (small)		
Hrs/wk	1		
СР	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: Robot	tics					
Courses						
Title				Тур	Hrs/wk	СР
Robotics: Modelling and Control (L0	168)			Integrated Lecture	4	4
Robotics: Modelling and Control (L1	.305)			Project-/problem-based Learning	2	2
Module Responsible	Dr. Martin Gomse	Dr. Martin Gomse				
Admission Requirements	None					
Recommended Previous	Fundamentals of elect	rical engineering				
Knowledge	Broad knowledge of m	echanics				
	Broad knowledge of fr	centanies				
	Fundamentals of conti	rol theory				
Educational Objectives	After taking part succe	essfully, students have re	eached the following	ng learning results		
Professional Competence						
Knowledge	Students are able to d	escribe fundamental pro	perties of robots a	and solution approaches for multi	iple problems in	robotics.
Skills	Students are able to d	erive and solve equation	s of motion for va	rious manipulators.		
	Students can generate trajectories in various coordinate systems.					
	Students can design li	Students can design linear and partially nonlinear controllers for robotic manipulators.				
Personal Competence						
-	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	Indopondent Study Tir	ne 96, Study Time in Lec	turo 94			
Credit points	6	ne 90, Study Time in Lec	ture 64			
Course achievement	Compulsory Bonus	Form	Description			
Course achievement	Yes None	Subject theoretical		n PBL-Einheiten sowie Erreic	hen des Gesa	amtziels und der
		practical work	jeweiligen Se	ssion-Ziele		
Examination	Written exam					
Examination duration and	120 min					
scale						
Assignment for the	Aircraft Systems Engir	neering: Core Qualificatio	n: Elective Compu	ilsory		
Following Curricula	_			duct Development and Production	on: Elective Con	npulsory
	_			chatronics: Elective Compulsory		
	_	ng and Management: Cor	e Qualification: Co	ompulsory		
		Materials and Bradustia	a. Cassis!!+!- 5	reduct Davidant Flort C	· manulaa · · ·	
	· ·		•	roduct Development: Elective Co	mpulsory	
				roduction: Elective Compulsory laterials: Elective Compulsory		
	· ·		•	Computer Science: Elective Com	npulsory	
				lopment and Production: Elective		
		5gp				

Course L0168: Robotics: Mod	lelling and Control
Тур	Integrated Lecture
Hrs/wk	4
СР	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		
Тур	Project-/problem-based Learning	
Hrs/wk	2	
СР	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: Fligh	t Physics			
Courses				
Title Aerodynamics and Flight Mechanic Flight Mechanics II (L0730)	:s I (L0727)	Typ Lecture Lecture	Hrs/wk 3 2	CP 3 2
Flight Mechanics II (L0731)		Recitation Section (large)	1	1
Module Responsible	Prof. Frank Thielecke			
Admission Requirements				
Recommended Previous				
Knowledge				
	Mathematics			
	Mechanics			
	Thermodynamics			
	Aviation			
Educational Objectives	After taking part successfully, students have reached the f	ollowing learning results		
Professional Competence				
Knowledge	Students are able to			
	- Describe the fundamental equations of coreducation	oo fay aananyaasibla inaannyaasibla	and frietional fla	
	Describe the fundamental equations of aerodynamic Explain the principles of wings and profiles	LS for compressible, incompressible	and irictional no	W
	Explain the principles of wings and profiles Explain the aircraft equations of motion			
	Evaluate aircraft performance and stability			
	Describe the dynamics of the longitudinal and latera	al motion		
	Describe methods of flight simulation and airborne			
		5,		
61.71				
Skills	Students are able to			
	Perform flight mechanic simulations			
	Derive flight mechanic relations from virtual and real flight test data			
Personal Competence				
	Students are able to:			
	 Perform simulations in groups and discuss results Evaluate flight test data in groups, discuss and present the results 			
	- Evaluate mynt test data in groups, discuss and present the results			
Autonomy	Students are able to:			
	Process teaching content independently			
	Prepare, work out and process simulation models in	dependently		
	Apply teaching content on virtual and real flight test			
Workload in Hours	Independent Study Time 96, Study Time in Lecture 84			
Credit points				
Course achievement	None			
Examination	Written exam			
Examination duration and	120 Minutes (WS) + 90 Minutes (SS)			
scale				
Assignment for the	Aircraft Systems Engineering: Core Qualification: Compulso	ory		
Following Curricula	International Management and Engineering: Specialisation	II. Aviation Systems: Elective Com	pulsory	
	Product Development, Materials and Production: Specialisa	ation Product Development: Electiv	e Compulsory	
	Product Development, Materials and Production: Specialisa	ation Production: Elective Compulso	ory	
	Product Development, Materials and Production: Specialisa	tion Materials: Elective Compulsor	у	
	Theoretical Mechanical Engineering: Specialisation Aircraft	Systems Engineering: Elective Cor	mpulsory	

Course L0727: Aerodynamics and Flight Mechanics I		
Тур	Lecture	
Hrs/wk	3	
СР	3	
Workload in Hours	Independent Study Time 48, Study Time in Lecture 42	
Lecturer	Prof. Frank Thielecke, Dr. Ralf Heinrich	
Language	DE	
Cycle	WiSe	
Content	 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	 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		
Тур	Lecture	
Hrs/wk	2	
СР	2	
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28	
Lecturer	Prof. Frank Thielecke	
Language	DE	
Cycle	SoSe	
Content	stationary asymmetric flight dynamics of lateral movement methods of flight simulation eyperimental methods of flight mechanics model validation using system identification wind tunnel techniques	
Literature	 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	
Тур	Recitation Section (large)
Hrs/wk	1
СР	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: Produ	act Planning			
Courses				
Title		Тур	Hrs/wk	СР
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	Good basic-knowledge of Business Administration			
Knowledge				
	After taking part successfully, students have reached the	following learning results		
Professional Competence				
Knowledge	Students will gain insights into:			
	Product Planning			
	 Process 			
	 Methods 			
	Design thinking			
	 Process 			
	 Methods 			
	User integration			
Skills	Students will gain deep insights into:			
	Product Planning			
	 Process-related aspects 			
	 Organisational-related aspects 			
	 Human-Ressource related aspects 			
	 Working-tools, methods and instruments 			
	0			
Personal Competence				
Social Competence				
,	Interact within a team			
	Raise awareness for globabl issues			
Autonomy				
	Gain access to knowledge sources			
	Interpret complex cases Develop precentation skills			
	Develop presentation skills			
Workload in Hours	Independent Study Time 110, Study Time in Lecture 70			
Credit points	6			
Course achievement	Compulsory Bonus Form Descript	tion		
	Yes 20 % Subject theoretical and			
Francisco	practical work			
Examination				
Examination duration and scale	90 minutes			
Assignment for the	Global Innovation Management: Core Qualification: Compu	Ilsory		
Following Curricula	International Management and Engineering: Specialisation	•	npulsory	
. cc.mig carricula	Mechanical Engineering and Management: Specialisation I			
	Product Development, Materials and Production: Specialisa		ompulsory	
	Product Development, Materials and Production: Specialise	·	p y	
	Product Development, Materials and Production: Specialise			
	Theoretical Mechanical Engineering: Specialisation Produc		e Compulsory	
	* *			

Course L0851: Product Planning		
Тур	Lecture	
Hrs/wk	3	
СР	3	
Workload in Hours	Independent Study Time 48, Study Time in Lecture 42	
Lecturer	Prof. Cornelius Herstatt	
Language	EN	
Cycle	WiSe	
Content	Product Planning Process	
	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.: 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 Voluntary presentations in the third hour (articles / case studies) - Guest lectures by researchers - Lecture on Sustainability with frequent reference to current research - Permanent reference to current research Examination: 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.	
Literature	Ulrich, K./Eppinger, S.: Product Design and Development, 2nd. Edition, McGraw-Hill 2010	

Course L0853: Product Planning Seminar	
Тур	Project-/problem-based Learning
Hrs/wk	2
СР	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 choosen independently.
Literature	See lecture information "Product Planning".

Module M0830: Enviro	onmental Protection and Manag	gement		
Courses				
itle		Тур	Hrs/wk	СР
ntegrated Pollution Control (L0502)		Lecture	2	2
lealth, Safety and Environmental M		Lecture	2	3
lealth, Safety and Environmental M		Recitation Section (small)	1	1
Module Responsible	Prof. Ralf Otterpohl			
-	None			
Recommended Previous				
Knowledge	 Good knowledge in Technologies for En 	vironmental Protection (end-of-pipe, integrate	ed solutions)	
J	Good knowledge of the relevant Environ	nmental Legislation		
	Basic knowledge of instruments for Env	rironmental Assessment		
Educational Objectives	After taking part successfully, students have r	reached the following learning results		
Professional Competence	The carried part succession, seconds have t	cachea and lonoming learning results		
-	The students are able to describe the basic	s of regulations economic instruments volu	intary initiatives	fundamentals of HS
Knowiedge	legislation ISO 14001, EMAS and Responsible			
	substance cycles and approaches from end			
	knowledge of complex industry related probl			
	carry out innovative technical solutions, rem			
	approaches in the full range of problems in dif			
Skills	Students are able to assess current problems	s and situations in the field of environmental	nrotection They	can consider the he
Skiiis	available techniques and to plan and suggest			
	solve problems on a technical, administrative		seeme context. by	tino means they ee
	soive problems on a teemmean, aanimistrative	and registative reven		
Personal Competence				
-	The students can work together in internation	al groups.		
,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,		3		
Autonomy	Students are able to organize their work flow	to prepare themselves for presentations and	contributions to	the discussions. The
,	can acquire appropriate knowledge by making			
		, - ,		
Workload in Hours	Independent Study Time 110, Study Time in L	ecture 70		
Credit points	6			
Course achievement	None			
Examination	Written exam			
Examination duration and	90 min			
scale				
Assignment for the	Civil Engineering: Specialisation Water and Tra	affic: Elective Compulsory		
Following Curricula	Bioprocess Engineering: Specialisation C -	Bioeconomic Process Engineering, Focus M	Management and	Controlling: Elective
	Compulsory			
	Environmental Engineering: Core Qualification	: Compulsory		
	Joint European Master in Environmental Studie	es - Cities and Sustainability: Specialisation W	ater: Elective Com	pulsory
	Joint European Master in Environmental Studie	es - Cities and Sustainability: Specialisation En	ergy: Elective Con	npulsory
	Product Development, Materials and Production	on: Specialisation Product Development: Elect	ve Compulsory	
		6 1 11 11 15 15 15 15 16 15		
	Product Development, Materials and Production	on: Specialisation Production: Elective Comput	sory	
	Product Development, Materials and Production Product Development, Materials and Production	·	-	
	•	on: Specialisation Materials: Elective Compulso	ory	
	Product Development, Materials and Production	on: Specialisation Materials: Elective Compulso ental Process Engineering: Elective Compulsor	ory	

Course L0502: Integrated Po	llution Control
Тур	Lecture
Hrs/wk	2
СР	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Prof. Ralf Otterpohl
Language	EN
Cycle	WiSe
Content	The lecture focusses on:
	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	Förstner, Ulrich (1998): Integrated Pollution Control, Springer-Verlag Berlin Heidelberg, ISBN 978-3-642-80313-0 Shen, Thomas T. (1999): Industrial Pollution Prevention, Springer-Verlag Berlin Heidelberg, ISBN 978-3-540-65208-3

Course L0387: Health, Safety	and Environmental Management
Тур	Lecture
Hrs/wk	2
СР	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Hans-Joachim Nau
Language	EN
Cycle	WiSe
Content	 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	C. Stephan: Industrial Health, Safety and Environmental Management, MV-Verlag, Münster, 2007/2012 (can be found in the library under GTG 315) Exercises can be downloaded from StudIP

Course L0388: Health, Safety	ourse L0388: Health, Safety and Environmental Management	
Тур	Recitation Section (small)	
Hrs/wk	1	
СР	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։ Prodւ	iction Planning & Control and	d Digital Enterprise		
Courses				
Title		Тур	Hrs/wk	СР
The Digital Enterprise (L0932)		Lecture	2	2
Production Planning and Control (LI	0929)	Lecture	2	2
Production Planning and Control (LI		Recitation Section (small)	1	1
Exercise: The Digital Enterprise (L0	933)	Recitation Section (small)	1	1
Module Responsible	Prof. Hermann Lödding			
Admission Requirements	None			
Recommended Previous	Fundamentals of Production and Quality N	Management		
Knowledge				
Educational Objectives	After taking part successfully, students ha	ave reached the following learning results		
Professional Competence				
Knowledge	Students can explain the contents of the r	module in detail and take a critical position to them	١.	
Skills	Students are capable of choosing and app	olying models and methods from the module to inde	ustrial problems.	
Personal Competence				
Social Competence	Students can develop joint solutions in mi	xed 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	180 Minuten			
scale				
Assignment for the	International Management and Engineerin	ng: Specialisation II. Product Development and Prod	luction: Elective C	ompulsory
Following Curricula	Logistics, Infrastructure and Mobility: Spec	cialisation Production and Logistics: Elective Comp	ulsory	
	Biomedical Engineering: Specialisation Art	tificial Organs and Regenerative Medicine: Elective	Compulsory	
	Biomedical Engineering: Specialisation Im	plants and Endoprostheses: Elective Compulsory		
	Biomedical Engineering: Specialisation Me	edical Technology and Control Theory: Elective Com	npulsory	
	Biomedical Engineering: Specialisation Ma	anagement and Business Administration: Compulso	ry	
	Product Development, Materials and Prod	uction: Specialisation Product Development: Electiv	ve Compulsory	
	Product Development, Materials and Prod	uction: Specialisation Production: Compulsory		
	Product Development, Materials and Prod	uction: Specialisation Materials: Elective Compulso	ry	
	Theoretical Mechanical Engineering: Spec	ialisation Product Development and Production: Ele	ective Compulsory	

Course L0932: The Digital Enterprise		
Тур	Lecture	
Hrs/wk	2	
СР	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: 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, AW.: 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	
Тур	Lecture
Hrs/wk	2
СР	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Prof. Hermann Lödding
Language	DE
Cycle	WiSe
Content	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	 Vorlesungsskript Lödding, H: Verfahren der Fertigungssteuerung, Springer 2008 Nyhuis, P.; Wiendahl, HP.: Logistische Kennlinien, Springer 2002

Course L0930: Production Pl	Course L0930: Production Planning and Control	
Тур	Recitation Section (small)	
Hrs/wk	1	
СР	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	Course L0933: Exercise: The Digital Enterprise	
Тур	Recitation Section (small)	
Hrs/wk	1	
СР	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	Siehe korrespondierende Vorlesung	
	See interlocking course	

Module M0962: Susta	inability and Risk Managemer	nt		
Courses				
Title		Тур	Hrs/wk	СР
Safety, Reliability and Risk Assessn		Seminar	2	3
Environment and Sustainability (L0		Lecture	2	3
Module Responsible				
Admission Requirements	None			
Recommended Previous	none			
Knowledge				
Educational Objectives	After taking part successfully, students have	e reached the following learning results		
Professional Competence				
Knowledge		niques and to give an overview for the field	l of safety and risk as:	sessment as well as
	environmental and sustainable engineering	, in detail:		
	 basics in safety and reliability of tech 	nnical facilities		
	safety and reliability analysis method	ds		
	 risk assessment 			
	 Production and usage of bio-char 			
	 energy production and supply 			
	 sustainable product design 			
Skills	Students are able apply interdisciplinary s	system-oriented methods for risk assessme	ent and sustainability	reporting. They can
	evaluate the effort and costs for processes	and select economically feasible treatment of	oncepts.	
Personal Competence				
Social Competence				
,	Students can gain knowledge of the subject	ct area from given sources and transform i	t to new guestions. Fu	rthermore, they can
,		ch-oriented duties in for risk management a		-
	the potential social, economic and cultural i	impact.		
Workload in Hours	Independent Study Time 124, Study Time in	n Lecture 56		
Credit points	6			
Course achievement	None			
Examination	Written elaboration			
Examination duration and	Elaboration and presentation (45 minutes in	n groups)		
scale				
Assignment for the	Civil Engineering: Core Qualification: Compu	•		
Following Curricula		- Bioeconomic Process Engineering, Focu	is Management and	Controlling: Elective
	Compulsory	· Specialisation II. Civil Engineering: Elective	Compulsory	
		: Specialisation II. Civil Engineering: Elective tion: Specialisation Product Development: E		
	•	ction: Specialisation Production: Elective Com		
		ction: Specialisation Production: Elective Comp		
	Water and Environmental Engineering: Core			

Course L1145: Safety, Reliab	ility and Risk Assessment
•	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
	An introduction in safety and risk assessment is given and some typical problems of structural and environmental engineering are treated: • basics in safety and reliability of technical facilities • safety and reliability analysis methods • risk assessment • practical examples and excursions • discussions and presentations
Literature	- Vorlesungsunterlagen - Schneider, J., Schlatter, H.P.: Sicherheit und Zuverlässigkeit im Bauwesen. www.risksafety.ch/files/sicherheit_und_zuverlaessigkeit.pdf

Course L0319: Environment	and Sustainability
Тур	Lecture
Hrs/wk	2
СР	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Prof. Kerstin Kuchta
Language	EN
Cycle	WiSe
Content	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.
	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
	Recycling of Wind Turbines
	Alternative Mobility
	Disposal of Nuclear Wastes
	Waste2Energy
	Offshore Wind energy
Literature	Wird in der Veranstaltung bekannt gegeben.

Production"		
Module M1155: Aircra	aft 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		
Admission Requirements		
Recommended Previous Knowledge		
Kilowicage	• Mechanics	
	Thermodynamics	
	• Electrical Engineering	
	Control Systems	
Educational Objectives	After taking part successfully, students have reached the following learning results	
Professional Competence		
	Students are able to:	
J	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	
Skills	Students are able to:	
	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	
Personal Competence		
-	Students are able to:	
	• comprehend existing system solutions and explain them on the basis of existing requirements	
	discuss with experts in technical language	
	explain system functions	
	classify the criticality of functions	
	describe systems as is	
A coho m a man c	Chudanta ara ahla ta	
Autonomy	Students are able to: • independently reflect on lecture content and expert presentations	
	independently develop more in-depth content	
	recognize further areas of knowledge	
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56	
Credit points		
Course achievement		
Examination duration and		
scale		
Assignment for the	Electrical Engineering: Specialisation Control and Power Systems Engineering: Elective Compulsory	
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: Specialisation Aircraft Systems Engineering: Elective Compulsory	
	Systems Engineering, Specialisation / in clare Systems Engineering, Elective Companior)	

Course L1545: Aircraft Cabin	Systems
Тур	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	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.
	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: • 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	- Skript zur Vorlesung - Jenkinson, L.R., Simpkin, P., Rhodes, D.: Civil Jet Aircraft Design. London: Arnold, 1999 - Rossow, CC., 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	
Тур	Recitation Section (large)
Hrs/wk	1
СР	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 Anal	ysis	
Courses				
Title		Тур	Hrs/wk	СР
Laser Systems and Process Techno		Lecture	2	3
Methods for Analysing Production F	Processes (L0876)	Lecture	2	3
Module Responsible	Prof. Wolfgang Hintze			
Admission Requirements	None			
Recommended Previous				
Knowledge				
Educational Objectives	After taking part successfully, studer	nts have reached the following learning results		
Professional Competence				
Knowledge				
Skills				
Personal Competence				
Social Competence				
Autonomy				
Workload in Hours	Independent Study Time 124, Study	Time in Lecture 56		
Credit points	6			
Course achievement	None			
Examination	Written exam			
Examination duration and	180 min			
scale				
Assignment for the	Product Development, Materials and	Production: Specialisation Product Development	:: Elective Compulsory	
Following Curricula	Product Development, Materials and	Production: Specialisation Production: Compulso	ory	
	Product Development, Materials and	Production: Specialisation Materials: Elective Co	mpulsory	
	Theoretical Mechanical Engineering:	Specialisation Product Development and Product	tion: Elective Compulsory	•

Course L1612: Laser Systems	and Process Technologies
Тур	Lecture
Hrs/wk	
СР	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Prof. Claus Emmelmann
Language	EN
Cycle	WiSe
Content	 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	 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		
Тур	Lecture	
Hrs/wk	2	
СР	3	
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28	
Lecturer	Prof. Wolfgang Hintze	
Language	DE	
Cycle	WiSe	
Content	 Modelling and simulation of maching and forming processes Numerical simulation of forces, temperatures, deformation in machining Analysis of vibration problems in maching (chatter, modal analysis,) Knowledge based process planning Design of experiments Machinability of nonmetallic materials Analysis of interaction between maching process and machine tool systems with regard to process stability and quality Simulation of maching processes by virtual reality methods 	
Literature	Tönshoff, H.K.; Denkena, B.; Spanen Grundlagen, Springer (2004) Klocke, F.; König, W.; Fertigungsverfahren Umformen, Springer (2006) Weck, M.; Werkzeugmaschinen Fertigungssysteme 3, Springer (2001) Weck, M.; Werkzeugmaschinen Fertigungssysteme 5, Springer (2001)	

Module M1342: Polyn	ners			
Courses				
Title		Тур	Hrs/wk	СР
Structure and Properties of Polyme		Lecture	2	3
Processing and design with polyme	rs (L1892)	Lecture	2	3
Module Responsible	Dr. Hans Wittich			
Admission Requirements	None			
Recommended Previous	Basics: chemistry / physics / material scien	nce		
Knowledge				
Educational Objectives	After taking part successfully, students have	ve reached the following learning results		
Professional Competence				
Knowledge	Students can use the knowledge of plastics	s and define the necessary testing and analysi	S.	
	They can explain the complex relationships	s structure-property relationship and		
		e polymers, including to explain neighboring o	contexts (e.g. sustaina	bility, environmental
	protection).			
Skills	Students are capable of			
	- using standardized calculation methods evaluate the different materials.	s in a given context to mechanical propert	ies (modulus, streng	th) to calculate and
	- selecting appropriate solutions for mecha	anical recycling problems and sizing example	stiffness, corrosion re	sistance.
Personal Competence				
Social Competence	Students can			
	- arrive at funded work results in heteroger	nius groups and document them.		
	- provide appropriate feedback and handle	feedback on their own performance construct	cively.	
Autonomy	Students are able to			
riaconomy	ordadines and abile to			
	- assess their own strengths and weakness	ses.		
	- assess their own state of learning in spec	ific terms and to define further work steps on	this basis.	
	- assess possible consequences of their pro	ofessional activity.		
Workload in Hours	Independent Study Time 124, Study Time i	in Lecture 56		
Credit points	6			
Course achievement	None			
Examination	Written exam			
Examination duration and scale	180 min			
Assignment for the	Materials Science: Specialisation Engineeri	ng Materials: Flective Compulsory		
Following Curricula	,			
3	'	ificial Organs and Regenerative Medicine: Elec	tive Compulsory	
		nagement and Business Administration: Electiv		
	Biomedical Engineering: Specialisation Med	dical Technology and Control Theory: Elective	Compulsory	
	Product Development, Materials and Produ	iction: Specialisation Production: Elective Com	pulsory	
	Product Development, Materials and Produ	nction: Specialisation Materials: Elective Compu	ulsory	
	·	iction: Specialisation Product Development: Ele		
	Theoretical Mechanical Engineering: Specia	alisation Materials Science: Elective Compulso	ry	

Course L0389: Structure and	Properties of Polymers
Тур	Lecture
Hrs/wk	2
СР	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Dr. Hans Wittich
Language	DE
Cycle	WiSe
Content	- Structure and properties of polymers
	- Structure of macromolecules
	Constitution, Configuration, Conformation, Bonds, Synthesis, Molecular weihght distribution
	- Morphology
	amorph, crystalline, blends
	- Properties
	Elasticity, plasticity, viscoelacity
	- Thermal properties
	- Electrical properties
	- Theoretical modelling
	- Applications
Literature	Ehrenstein: Polymer-Werkstoffe, Carl Hanser Verlag

Course L1892: Processing an	d design with polymers
Тур	Lecture
Hrs/wk	2
СР	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	Manufacturing of Polymers: General Properties; Calendering; Extrusion; Injection Moulding; Thermoforming, Foaming; Joining
	Designing with Polymers: Materials Selection; Structural Design; Dimensioning
Literature	Osswald, Menges: Materials Science of Polymers for Engineers, Hanser Verlag
	Crawford: Plastics engineering, Pergamon Press
	Michaeli: Einführung in die Kunststoffverarbeitung, Hanser Verlag
	Konstruieren mit Kunststoffen, Gunter Erhard , Hanser Verlag

Module M1170: Pheno	omena and Methods in Material	Science			
Courses					
Title		Тур		Hrs/wk	СР
Experimental Methods for the Char	acterization of Materials (L1580)	Lecture		2	2
Phase equilibria and transformation	ns (L1579)	Lecture		2	2
Übung zu Phänomene und Methode	en der Materialwissenschaft (L2991)	Recitation	Section (large)	2	2
Module Responsible	Prof. Jörg Weißmüller				
Admission Requirements	None				
Recommended Previous	Basic knowledge in Materials Science, e.g. We	kstoffwissenschaft I/II			
Knowledge					
Educational Objectives	After taking part successfully, students have re	eached the following learnin	g results		
Professional Competence			-		
Knowledge	The students will be able to explain the prope	rties of advanced materials	along with their app	olications in tech	nology, in particular
3	metallic, ceramic, polymeric, semiconductor, r				33.
	,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,	, in the second	,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,		
Skills	The students will be able to select material	configurations according to	the technical need	Is and, if neces	sary, to design new
	materials considering architectural principles	from the micro- to the m	acroscale. The stud	ents will also g	ain an overview on
	modern materials science, which enables	them to select optimum	materials combina	ations dependir	ng on the technical
	applications.				
Personal Competence					
-	The students are able to present colutions to	nocialists and to dayalan ide	a a fourth au		
Social Competence	The students are able to present solutions to s	pecialists and to develop ide	eas further.		
Autonomy	The students are able to				
	 assess their own strengths and weaknes 	sses.			
	gather new necessary expertise by their				
	3 , , , ,				
Workload in Hours	Independent Study Time 96, Study Time in Led	ture 84			
Credit points	6				
Course achievement	None				
Examination	Written exam				
Examination duration and	90 min				
scale					
Assignment for the	International Management and Engineering: Sp	pecialisation II. Product Deve	lopment and Produc	ction: Elective Co	ompulsory
Following Curricula	Materials Science: Core Qualification: Compuls	ory			
•	Product Development, Materials and Productio	•	velopment: Elective	Compulsory	
	Product Development, Materials and Productio	·	•		
	Product Development, Materials and Productio			-	
	Theoretical Mechanical Engineering: Specialisa	•			
		. ,			

Course L1580: Experimental	Methods for the Characterization of Materials
Тур	Lecture
Hrs/wk	2
СР	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Prof. Shan Shi
Language	EN
Cycle	WiSe
Content	 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		
Тур	Lecture	
Hrs/wk	2	
СР	2	
Workload in Hours	Independent Study Time 32, 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	D.A. Porter, K.E. Easterling, "Phase transformations in metals and alloys", New York, CRC Press, Taylor & Francis, 2009, 3. Auflage Peter Haasen, "Physikalische Metallkunde", Springer 1994 Herbert B. Callen, "Thermodynamics and an introduction to thermostatistics", New York, NY: Wiley, 1985, 2. Auflage. Robert W. Cahn und Peter Haasen, "Physical Metallurgy", Elsevier 1996 H. Ibach, "Physics of Surfaces and Interfaces" 2006, Berlin: Springer.	

purse L2991: Übung zu Phänomene und Methoden der Materialwissenschaft	
	Recitation Section (large)
Hrs/wk	2
СР	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Prof. Shan Shi
Language	DE
Cycle	WiSe
Content	
Literature	

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	See selected module according to FSPO		
Knowledge			
Educational Objectives	After taking part successfully, students have reached the following learning results		
Professional Competence			
Knowledge	see selected module according to FSPO		
Skills	see selected module according to FSPO		
Personal Competence			
Social Competence	see selected module according to FSPO		
Autonomy	see selected module according to FSPO		
Workload in Hours	Depends on choice of courses		
Credit points	6		
Assignment for the	Product Development, Materials and Production: Specialisation Product Development: Elective Compulsory		
Following Curricula	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.

Madula MOZCZ, Airera	off European Constants			
Module M0763: Aircra	int Energy Systems			
Courses				
Title		Тур	Hrs/wk	СР
Aircraft Energy Systems (L0735)		Lecture	3	4
Aircraft Energy Systems (L0739)		Recitation Section (large)	2	2
Module Responsible	Prof. Frank Thielecke			
Admission Requirements	None			
Recommended Previous	Basic knowledge in:			
Knowledge				
	Mathematics Machanian			
	Mechanics The ground in a praise.			
	Thermodynamics Fleetvice Francisco			
	Electrical Engineering Hydraulics			
	Hydraulics Control Systems			
	Control Systems			
Educational Objectives	After taking part successfully, students have reached t	the following learning results		
Professional Competence				
Knowledge	Students are able to:			
	Describe essential components and design poin	to of hydraulic, electrical and high lift o	vetome	
	Give an overview of the functionality of air cond	· · · · · · · · · · · · · · · · · · ·	ystems	
	Explain the need for high-lift systems such as is			
	Assess the challenge during the design of suppl			
	Assess the challenge during the design of suppl	y systems of an ancial		
Skills	Students are able to:			
	 Design hydraulic and electric supply systems of 	aircrafts		
	 Design high-lift systems of aircrafts 			
	Analyze the thermodynamic behaviour of air core	nditioning systems		
Personal Competence				
Social Competence	Students are able to:			
	 Perform system design in groups and present at 	ad discuss results		
	Terrorm system design in groups and present an	id discuss results		
Autonomv	Students are able to:			
,				
	Reflect the contents of lectures autonomously			
Workload in Hours	Independent Study Time 110, Study Time in Lecture 7	0		
Credit points	6			
Course achievement	None			
Examination	Written exam			
Examination duration and	165 Minutes			
scale				
Assignment for the	Energy Systems: Specialisation Energy Systems: Election	ive Compulsory		
Following Curricula	Aircraft Systems Engineering: Core Qualification: Comp			
-	International Management and Engineering: Specialisa		pulsory	
	Product Development, Materials and Production: Speci			
	Product Development, Materials and Production: Speci			
	Product Development, Materials and Production: Speci	·	-	
	Theoretical Mechanical Engineering: Specialisation Airo			
	mediedical Mechanical Engineering, Specialisation Air	and Systems Engineering, Elective Cor	i ipuisui y	

Course L0735: Aircraft Energ	y Systems
Тур	Lecture
Hrs/wk	3
СР	4
Workload in Hours	Independent Study Time 78, Study Time in Lecture 42
Lecturer	Prof. Frank Thielecke
Language	DE
Cycle	WiSe
Content	 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	 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 Energ	ourse L0739: Aircraft Energy Systems	
Тур	Recitation Section (large)	
Hrs/wk	2	
СР	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: Produ	iction Planning & Control and I	Digital Enterprise		
Module Mood7: Produ	iction Flamming & Control and I	Digital Enterprise		
Courses				
Title		Тур	Hrs/wk	СР
The Digital Enterprise (L0932)		Lecture	2	2
Production Planning and Control (LC	0929)	Lecture	2	2
Production Planning and Control (Li	0930)	Recitation Section (small)	1	1
Exercise: The Digital Enterprise (L0	933)	Recitation Section (small)	1	1
Module Responsible	Prof. Hermann Lödding			
Admission Requirements	None			
Recommended Previous	Fundamentals of Production and Quality Man	agement		
Knowledge				
Educational Objectives	After taking part successfully, students have	reached the following learning results		
Professional Competence				
Knowledge	Students can explain the contents of the module in detail and take a critical position to them.			
Skills	Students are capable of choosing and applying models and methods from the module to industrial problems.			
Personal Competence				
Social Competence	Students can develop joint solutions in mixed	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	180 Minuten			
scale				
Assignment for the	International Management and Engineering:	Specialisation II. Product Development and Produ	uction: Elective C	ompulsory
Following Curricula	Logistics, Infrastructure and Mobility: Special	lisation Production and Logistics: Elective Compu	Isory	
	Biomedical Engineering: Specialisation Artific	cial Organs and Regenerative Medicine: Elective	Compulsory	
	Biomedical Engineering: Specialisation Impla	nts and Endoprostheses: Elective Compulsory		
	Biomedical Engineering: Specialisation Medic	cal Technology and Control Theory: Elective Com	pulsory	
	Biomedical Engineering: Specialisation Mana	gement and Business Administration: Compulsor	у	
	Product Development, Materials and Product	ion: Specialisation Product Development: Elective	e Compulsory	
	Product Development, Materials and Product	ion: Specialisation Production: Compulsory		
	Product Development, Materials and Product	ion: Specialisation Materials: Elective Compulsor	у	
	Theoretical Mechanical Engineering: Speciali	sation Product Development and Production: Elec	ctive Compulsory	

Course L0932: The Digital En	terprise
Тур	Lecture
Hrs/wk	2
СР	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: 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, AW.: 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	
Тур	Lecture
Hrs/wk	2
СР	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Prof. Hermann Lödding
Language	DE
Cycle	WiSe
Content	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	 Vorlesungsskript Lödding, H: Verfahren der Fertigungssteuerung, Springer 2008 Nyhuis, P.; Wiendahl, HP.: Logistische Kennlinien, Springer 2002

Course L0930: Production Pl	Course L0930: Production Planning and Control	
Тур	Recitation Section (small)	
Hrs/wk	1	
СР	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	Course L0933: Exercise: The Digital Enterprise		
Тур	Recitation Section (small)		
Hrs/wk	1		
СР	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	Siehe korrespondierende Vorlesung		
	See interlocking course		

Module M1183: Laser	Systems and Methods of	of Manufacturing Design and Analy	sis			
Courses						
Title		Тур	Hrs/wk	СР		
aser Systems and Process Techno	•	Lecture	2	3		
Methods for Analysing Production F	Processes (L0876)	Lecture	2	3		
Module Responsible	Prof. Wolfgang Hintze					
Admission Requirements	None					
Recommended Previous						
Knowledge						
Educational Objectives	After taking part successfully, stud	ents have reached the following learning results				
Professional Competence						
Knowledge						
Skills						
Personal Competence						
Social Competence						
Autonomy						
Workload in Hours	Independent Study Time 124, Stud	y Time in Lecture 56				
Credit points	6					
Course achievement	None					
Examination	Written exam					
Examination duration and	180 min					
scale						
Assignment for the	Product Development, Materials an	d Production: Specialisation Product Development:	Elective Compulsory			
Following Curricula	Product Development, Materials an	d Production: Specialisation Production: Compulsory	/			
	Product Development, Materials an	d Production: Specialisation Materials: Elective Com	ipulsory			
	Theoretical Mechanical Engineering	g: Specialisation Product Development and Production	on: Elective Compulsory	,		

Course L1612: Laser Systems	s and Process Technologies
Тур	Lecture
Hrs/wk	2
СР	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Prof. Claus Emmelmann
Language	EN
Cycle	WiSe
Content	 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	 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						
Тур	Lecture					
Hrs/wk						
СР						
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28					
Lecturer	Prof. Wolfgang Hintze					
Language	DE					
Cycle	WiSe					
Content	 Modelling and simulation of maching and forming processes Numerical simulation of forces, temperatures, deformation in machining Analysis of vibration problems in maching (chatter, modal analysis,) Knowledge based process planning Design of experiments Machinability of nonmetallic materials Analysis of interaction between maching process and machine tool systems with regard to process stability and quality Simulation of maching processes by virtual reality methods 					
Literature	Tönshoff, H.K.; Denkena, B.; Spanen Grundlagen, Springer (2004) Klocke, F.; König, W.; Fertigungsverfahren Umformen, Springer (2006) Weck, M.; Werkzeugmaschinen Fertigungssysteme 3, Springer (2001) Weck, M.; Werkzeugmaschinen Fertigungssysteme 5, Springer (2001)					

Module M1193: Cabin	Systems Engineering				
Courses					
Courses					
Title		Тур	Hrs/wk	СР	
· ·	nology in cabin electronics and avionics (L1557)	Lecture Recitation Section (small)	2	2 1	
Model-Based Systems Engineering	nology in cabin electronics and avionics (L1558) (MBSE) with SysML/UML (L1551)	Project-/problem-based Learning	3	3	
Module Responsible		Troject /problem based Learning	3		
-					
Admission Requirements					
Recommended Previous	Mathematics				
Knowledge	Mechanics				
	Thermodynamics				
	Electrical Engineering				
	Control Systems				
	control systems				
	Previous knowledge in:				
	Systems Engineering				
Educational Objectives	After taking part successfully students have reached the follo	wing loarning results			
Professional Competence	After taking part successfully, students have reached the follo	wing learning results			
·	Students are able to:				
Knowleage	 describe the structure and operation of computer architecture 	ros			
	explain the structure and operation of digital communication				
	explain architectures of cabin electronics, integrated modula		Communicatio	n Network (ADCN)	
	understand the approach of Model-Based Systems Engine				
	systems	eg (1.1552) the design of he	. arranc ana si	oremane basea casiii	
	-,				
Skills	Students are able to:				
	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				
Personal Competence					
-	Students are able to:				
,	elaborate partial results and merge with others to form a cor	nplete solution			
Autonomy	Students are able to:				
	organize and schedule their practical tasks				
Workload in Hours	Independent Study Time 96, Study Time in Lecture 84				
Credit points	, ,				
Course achievement	None				
Examination					
Examination duration and					
scale	120 111114(C)				
	Aircraft Systems Engineering: Specialisation Aircraft Systems:	Flective Compulsory			
Following Curricula	Aircraft Systems Engineering: Specialisation Aircraft Systems. Aircraft Systems Engineering: Core Qualification: Elective Com	, .			
i onowing curricula	International Management and Engineering: Specialisation II. A	•	sorv		
	Product Development, Materials and Production: Specialisation	•	-		
	Product Development, Materials and Production: Specialisation	·	раізоі у		
	Product Development, Materials and Production: Specialisation	, ,			
	Theoretical Mechanical Engineering: Specialisation Aircraft Sys		llsory		
			,		

Course L1557: Computer and	d communication technology in cabin electronics and avionics
Тур	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	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. 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: 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	- Skript zur Vorlesung - Schnabel, P.: Computertechnik-Fibel: Grundlagen Computertechnik, Mikroprozessortechnik, Halbleiterspeicher, Schnittstellen und Peripherie. Books on Demand; 1. Auflage, 2003 - Schnabel, P.: Netzwerktechnik-Fibel: Grundlagen, Übertragungstechnik und Protokolle, Anwendungen und Dienste, Sicherheit. Books on Demand; 1. Auflage, 2004 - Wüst, K.: Mikroprozessortechnik: Grundlagen, Architekturen und Programmierung von Mikroprozessoren, Mikrocontrollern und Signalprozessoren. Vieweg Verlag; 2. aktualisierte und erweiterte Auflage, 2006

Тур	Recitation Section (small)
Hrs/wk	1
СР	
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14
Lecturer	Prof. Ralf God
Language	DE
Cycle	WiSe
Content	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. 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 electronic and cabin networks: 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	 - Skript zur Vorlesung - Schnabel, P.: Computertechnik-Fibel: Grundlagen Computertechnik, Mikroprozessortechnik, Halbleiterspeicher, Schnittstellen ur Peripherie. Books on Demand; 1. Auflage, 2003 - Schnabel, P.: Netzwerktechnik-Fibel: Grundlagen, Übertragungstechnik und Protokolle, Anwendungen und Dienste, Sicherhe Books on Demand; 1. Auflage, 2004 - Wüst, K.: Mikroprozessortechnik: Grundlagen, Architekturen und Programmierung von Mikroprozessoren, Mikrocontrollern ur Signalprozessoren. Vieweg Verlag; 2. aktualisierte und erweiterte Auflage, 2006

Course L1551: Model-Based	Systems Engineering (MBSE) with SysML/UML			
Тур	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 SoSe			
Content	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®):			
	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	- 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 M0812: Aircra	aft Design I (Ci	vil Aircraft De	esign)			
Courses						
Title Aircraft Design I (Design of Transport				Typ Lecture	Hrs/wk 3 2	CP 3
Aircraft Design I (Design of Transpo	ı			Recitation Section (large)	2	3
Admission Requirements	None					
Recommended Previous Knowledge	Bachelor Mecl Bachelor Traft Vordiplom Me Module Air Tra	ic Systems ch. Eng.				
Educational Objectives	After taking part suc	cessfully, students h	have reached the followi	ng learning results		
Personal Competence	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 Understanding and application of design and calculation methods Understanding of interdisciplinary and integrative interdependencies Working in interdisciplinary teams Communication					
Workload in Hours	Independent Study T	ime 110, Study Tim	ne in Lecture 70			
Credit points						
Course achievement	No 10 %	Form Attestation	Description Durchführun	g einer Konzeptauslegung für	r ein Verkehrsflug	zeua
Examination		, account	Barcinaman	g cc. Ronzeptadolegang ful	. c verkem snug.	-009
Examination duration and scale	180 min					
Assignment for the		-	ification: Compulsory			
Following Curricula	Product Developmer Product Developmer Product Developmer	nt, Materials and Pro nt, Materials and Pro nt, Materials and Pro	duction: Specialisation F duction: Specialisation F duction: Specialisation F	iation Systems: Elective Com Product Development: Electiv Product Development: Electiv Production: Elective Compulso Prosizems Engineering: Elective Col	re Compulsory re Compulsory ory	

Course L0820: Aircraft Desig	Course L0820: Aircraft Design I (Design of Transport Aircraft)				
Тур	Lecture				
Hrs/wk					
СР					
Workload in Hours	Independent Study Time 48, Study Time in Lecture 42				
Lecturer	Prof. Volker Gollnick, Jens Thöben				
Language	DE				
Cycle	WiSe				
Content	Introduction into the aircraft design process				
	Introduction/process of aircraft design/various aircraft configurations				
	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	J. Roskam: "Airplane Design"				
	D.D. Davinson II Aircraft Davins A Concentral Annyasehil				
	D.P. Raymer: "Aircraft Design - A Conceptual Approach"				
	J.P. Fielding: "Introduction to Aircraft Design"				
	Jenkinson, Simpkon, Rhods: "Civil Jet Aircraft Design"				

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

Course L0834: Aircraft Design I (Design of Transport Aircraft)			
Тур	citation Section (large)		
Hrs/wk	2		
СР	3		
Workload in Hours	dependent 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 M0511: Electi	rical Energy from Solar Radiation and	l Wind Power		
Courses				
Title Sustainability Management (L0007 Hydro Power Use (L0013) Wind Turbine Plants (L0011) Wind Energy Use - Focus Offshore (Typ Lecture Lecture Lecture Lecture	Hrs/wk 2 1 2 1	CP 1 1 3
		Lecture	1	1
Module Responsible Admission Requirements	None			
Recommended Previous	Module: Technical Thermodynamics I,			
Knowledge	Module: Technical Thermodynamics II,			
	Module: Fundamentals of Fluid Mechanics			
Educational Objectives	After taking part successfully, students have reached	the following learning results		
Professional Competence Knowledge	By ending this module students can explain in detail knowledge of wind turbines with a particular focus of wind energy use ir 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.			
	Through active discussions of various topics within application of the theoretical background and are thus			derstanding and the
Skills	Students are able to apply the acquired theoretical foundations on exemplary water or wind power systems and evaluate an assess technically the resulting relationships in the context of dimensioning and operation of these energy systems. They can it 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.			
Personal Competence Social Competence	Students can discuss scientific tasks subjet-specificly	and multidisciplinary within a se	eminar.	
Autonomy	Students can independently exploit sources in the clecture and to acquire the particular knowledge about		ecture material to clear	the contents of the
Workload in Hours	Independent Study Time 96, Study Time in Lecture 84	ļ		
Credit points	6			
Course achievement	None			
Examination	Written exam			
Examination duration and scale	2.5 hours written exam + written elaboration (incl. presentation) in sustainability management			
•	Civil Engineering: Specialisation Structural Engineerin Civil Engineering: Specialisation Geotechnical Engineering: Civil Engineering: Specialisation Coastal Engineering: International Management and Engineering: Specialis. International Management and Engineering: Specialis. Product Development, Materials and Production: Spec Product Development, Materials and Production: Spec Product Development, Materials and Production: Spec Renewable Energies: Core Qualification: Compulsory Theoretical Mechanical Engineering: Specialisation En Process Engineering: Specialisation Environmental Process Engineering: Specialisation Mater and Environmental Engineering: Specialisation Water and Environmental Engineering: Specialisation	ering: Elective Compulsory Elective Compulsory Elective Compulsory ation II. Energy and Environment ation II. Renewable Energy: Elect ialisation Product Development: ialisation Production: Elective Com ialisation Materials: Elective Com ergy Systems: Elective Compulso coess Engineering: Elective Comp Environment: Compulsory	ive Compulsory Elective Compulsory Impulsory Impulsory Impulsory Impulsory	Compulsory

Course L0007: Sustainability	Management
Тур	Lecture
Hrs/wk	2
СР	1
Workload in Hours	Independent Study Time 2, Study Time in Lecture 28
Lecturer	Dr. Anne Rödl
Language	DE
Cycle	SoSe
Content	The lecture "Sustainability Management" gives an insight into the different aspects and dimensions of sustainability. First, essential terms and definitions, significant developments of the last years, and legal framework conditions are explained. The various aspects of sustainability are then presented and discussed in detail. The lecture mainly focuses on concepts for the implementation of the topic sustainability in companies:
	 What is "sustainability"? Why is this concept an important topic for companies? What opportunities and business risks are addressed or are associated with it? How can the often mentioned three pillars of sustainability - economy, ecology, and social- be meaningfully integrated into corporate management despite their sometimes contradictory tendencies, and how a corresponding compromise can be found? What concepts or frameworks exist for the implementation of sustainability management in companies? Which sustainability labels exist for products or companies? What do they have in common, and where do they differ? Furthermore, the lecture is intended to provide insights into the concrete implementation of sustainability aspects into business practice. External lecturers from companies will be invited to report on how sustainability is integrated into their daily processes. In the course of an independently carried out group work, the students will analyze and discuss the implementation of sustainability aspects based on short case studies. By studying and comparing best practice examples, the students will learn about corporate decisions' effects and implications. It should become clear which risks or opportunities are associated if sustainability aspects are taken into account in management decisions.
Literature	Die folgenden Bücher bieten einen Überblick: Engelfried, J. (2011) Nachhaltiges Umweltmanagement. München: Oldenbourg Verlag. 2. Auflage Corsten H., Roth S. (Hrsg.) (2011) Nachhaltigkeit - Unternehmerisches Handeln in globaler Verantwortung. Wiesbaden: Gabler Verlag.

Course L0013: Hydro Power I	Use Control of the Co
Тур	Lecture
Hrs/wk	1
СР	1
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14
Lecturer	Prof. Stefan Achleitner
Language	DE
Cycle	SoSe
Content	 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	 Schröder, W.; Euler, G.; Schneider, K.: Grundlagen des Wasserbaus; Werner, Düsseldorf, 1999, 4. Auflage Quaschning, 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		
Тур	Lecture	
Hrs/wk	2	
СР	3	
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28	
Lecturer	Dr. Rudolf Zellermann	
Language	DE	
Cycle	SoSe	
Content	 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
Тур	Lecture
Hrs/wk	1
СР	1
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14
Lecturer	Prof. Martin Skiba
Language	DE
Cycle	SoSe
Content	 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	 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, Heidel-berg, 1997, 3. Auflage Hau, E.: Windkraftanalagen; 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: Robo	tics and Naviga	tion in Medicine				
Courses						
Title Robotics and Navigation in Medicine (L0335) Robotics and Navigation in Medicine (L0338) Robotics and Navigation in Medicine (L0336)			Typ Lecture Project Seminar Recitation Section (small)	Hrs/wk 2 2	CP 3 2	
Module Responsible		efer		,		
Admission Requirements						
Recommended Previous Knowledge	 principles of m 	ath (algebra, analysis/ca ogramming, e.g., in Java ab skills				
Educational Objectives	After taking part succ	essfully, students have r	eached the following	g learning results		
	detail. Systems can systems regarding de	be evaluated with responsions.	ect to collision dete	elinical contexts and illust ection and safety and re and robotic systems for m	gulations. Students	s can assess typical
,				eedback and can incoorpo		
Workload in Hours	Independent Study Ti	me 110, Study Time in L	ecture 70			
Credit points	6					
Course achievement	Yes 10 % Yes 10 %	Form Presentation Written elaboration	Description			
Examination						
Examination duration and						
scale Assignment for the		pecialisation II: Intelligen	co Enginocripa: FI	tivo Compulsor:		
Following Curricula	International Manage International Manage Mechatronics: Special Biomedical Engineerin Biomedical Engineerin Biomedical Engineerin Biomedical Engineerin Product Development Product Development Product Development	ment and Engineering: S isation Intelligent System ng: Specialisation Artificia ng: Specialisation Implan ng: Specialisation Medica ng: Specialisation Manag , Materials and Productio , Materials and Productio , Materials and Productio	pecialisation II. Elec pecialisation II. Proc ms and Robotics: Ele al Organs and Regei its and Endoprosthe il Technology and Co ement and Business on: Specialisation Propor: Specialisation Propor: Specialisation Ma	trical Engineering: Elective	echnology: Elective e Compulsory mpulsory Compulsory ive Compulsory sory	Compulsory

Course L0335: Robotics and	Navigation in Medicine
Тур	Lecture
Hrs/wk	2
СР	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Prof. Alexander Schlaefer
Language	EN
Cycle	SoSe
Content	- kinematics
	- calibration
	- tracking systems
	- navigation and image guidance
	- motion compensation
	The seminar extends and complements the contents of the lecture with respect to recent research results.
Literature	Spong et al.: Robot Modeling and Control, 2005
	Troccaz: Medical Robotics, 2012
	Further literature will be given in the lecture.

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

Course L0338: Robotics and	Course L0338: Robotics and Navigation in Medicine	
Тур	Project Seminar	
Hrs/wk	2	
СР	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	Course L0336: Robotics and Navigation in Medicine	
Тур	Recitation Section (small)	
Hrs/wk	1	
СР	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	

Courses				
Title		Тур	Hrs/wk	CP
Flight Control Systems (L0736)		Lecture	3	4
Flight Control Systems (L0740)		Recitation Section (large)	2	2
Module Responsible	Prof. Frank Thielecke			
Admission Requirements				
Recommended Previous	basic knowledge of:			
Knowledge	mathematics			
	mechanics			
	thermo dynamics			
	electronics			
	fluid technology			
	control technology			
Educational Objectives	After taking part successfully, students have reached the fo	llowing learning results		
Professional Competence	race, carring part successionly, students have reached the fo			
	Students are able to			
, and medge	Stadents are asie tom			
	describe the structure of primary flight control system	ns as well as actuation-, avionic-,	high lift systems	in general along wi
	corresponding properties and applications.			
	explain different configurations and designs and the	ir origins		
	•			
Skills	Students are able to			
	size primary flight control actuation systems	tual a structura		
	 perform a controller design process for the flight con design high-lift kinematics 	troi actuators		
	design night kinematics			
Personal Competence	Chudanha ava abla ta.			
Social Competence	Students are able to:			
	 Develop joint solutions in mixed teams 			
Autonomy	Students are able to:			
Autonomy	Students are able to.			
	derive requirements and perform appropriate yet significant.	mplified design processes for aircr	aft systems from	complex issues an
	circumstances in a self-reliant manner			
Workload in Hours	Independent Study Time 110, Study Time in Lecture 70			
Credit points				
Course achievement	None			
Examination	Written exam			
Examination duration and	165 Minutes			
scale				
Assignment for the	Aircraft Systems Engineering: Core Qualification: Compulso	ry		
Following Curricula			pulsory	
	Product Development, Materials and Production: Specialisa	ion Product Development: Elective	e Compulsory	
	Product Development, Materials and Production: Specialisa	tion Production: Elective Compulso	ory	
	Product Development, Materials and Production: Specialisa	ion Materials: Elective Compulsor	4	
	Theoretical Mechanical Engineering: Specialisation Aircraft	Systems Engineering: Elective Cor	npulsory	

Course L0736: Flight Control	Systems
Тур	Lecture
Hrs/wk	3
СР	4
Workload in Hours	Independent Study Time 78, Study Time in Lecture 42
Lecturer	Prof. Frank Thielecke
Language	DE
Cycle	SoSe
Content	 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-skit 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	 Moir, Seabridge: Aircraft Systems Torenbek: Synthesis of Subsonic Airplane Design Curry: Aircraft Landing Gear Design: Principles and Practices

Course L0740: Flight Control	ourse L0740: Flight Control Systems		
Тур	Recitation Section (large)		
Hrs/wk	2		
СР	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: Medic	al 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	none
Knowledge	
Educational Objectives	After taking part successfully, students have reached the following learning results
Professional Competence	
Knowledge	
	Students can:
	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;
	Describe and explain the main clinical uses of the different systems.
Skills	Students are able to:
	 Explain the physical processes of images and assign to the systems the basic mathematical or physical equations required; 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;
Daniel Committee	Select a suitable imaging system for an application.
Personal Competence Social Competence	none
·	Students can:
riaconomy	Statella Call.
	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	90 min
scale	
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 Production: Elective Compulsory Product Development, Materials and Production: Specialisation Materials: Elective Compulsory
	Theoretical Mechanical Engineering: Specialisation Bio- and Medical Technology: Elective Compulsory

Course L0819: Medical Imaging Systems	
Тур	Lecture
Hrs/wk	4
СР	6
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56
Lecturer	Dr. Michael Grass, Dr. Frank Michael Weber, Dr. Sven Prevrhal, Dr. Tim Nielsen
Language	DE
Cycle	SoSe
Content	
Literature	Primary book:
	1. P. Suetens, "Fundamentals of Medical Imaging", Cambridge Press
	Secondary books:
	- 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		Тур	Hrs/wk	СР
Applied Automation (L1592)		Project-/problem-based Learning	3	3
Ergonomics (L0653)		Lecture	2	3
Advanced Training Course SE-ZERT (L2739)		Project-/problem-based Learning	2	3
Elements of Integrated Production Systems (L0927)		Project-/problem-based Learning	2	3
Development Management for Med	hatronics (L1512)	Lecture	2	3
Fatigue & Damage Tolerance (L031	10)	Lecture	2	3
Industry 4.0 for engineers (L2012)		Lecture	2	3
Innovation and Product Manageme	nt (L2168)	Seminar	2	3
Lightweight Design Practical Course	e (L1258)	Project-/problem-based Learning	3	3
Mechanisms, Systems and Process	es of Materials Testing (L0950)	Lecture	2	2
Microsystems Technology (L0724)		Lecture	2	4
Sustainable Industrial Production (L	.2863)	Lecture	2	3
Productivity Management (L0928)		Project-/problem-based Learning	2	2
Productivity Management (L0931)		Recitation Section (small)	1	1
Feedback Control in Medical Techn	ology (L0664)	Lecture	2	3
Structural Mechanics of Fibre Reinf	orced 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	s (L0176)	Lecture	2	2
Reliability in Engineering Dynamics	s (L1303)	Recitation Section (small)	1	2
Reliability of Aircraft Systems (L074	49)	Lecture	2	3
Module Responsible	Prof. Dieter Krause			
Admission Requirements	None			
Recommended Previous	None			
Knowledge				
Educational Objectives	After taking part successfully, students have reached the fo	ollowing learning results		
Professional Competence				
Knowledge				
_	 Students are able to express their extended knowle 	dge and discuss the connection of di	fferent specia	I fields or application
	areas of product development, materials and produc	tion		
	 Students are qualified to connect different special field 	elds with each other		
Skills	 Students can apply specialized solution strategies ar 	nd new scientific methods in selected	areas	
	 Students are able to transfer learned skills to new ar 	id diffilowii problems and can develo	p own solution	тарргоаспеѕ
Personal Competence				
Social Competence	_			
,				
Autonomy	Students are able to develop their knowledge and sk	cills by autonomous election of course	S.	
Workload in Hours	Depends on choice of courses			
Credit points	12			
Assignment for the	Product Development, Materials and Production: Specialisation Product Development: Elective Compulsory			
Following Curricula	Product Development, Materials and Production: Specialisa	tion Production: Elective Compulsory		
	Product Development, Materials and Production: Specialisa	tion Materials: Elective Compulsory		

Course L1592: Applied Automation		
Тур	Project-/problem-based Learning	
Hrs/wk	3	
СР	3	
Workload in	Independent Study Time 48, Study Time in Lecture 42	
Hours		
Examination	Mündliche Prüfung	
Form		
Examination	30 Minuten	
duration		
and scale		
Lecturer	Prof. Thorsten Schüppstuhl	
Language	DE	
Cycle	WiSe	
Literature	-Project Based Learning -Robot Operating System -Robot structure and description -Motion description -Calibration -Accuracy John J. Craig Introduction to Robotics - Mechanics and Control ISBN: 0131236296 Pearson Education, Inc., 2005 Stefan Hesse Grundlagen der Handhabungstechnik ISBN: 3446418725 München Hanser, 2010 K. Thulasiraman and M. N. S. Swamy Graphs: Theory and Algorithms ISBN: 9781118033104 %CITAVIPICKER£9781118033104£Titel anhand dieser ISBN in Citavi-Projekt übernehmen£% John Wüey & Sons, Inc., 1992	

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

Course L2739: Advanced Training Course SE-ZERT	
Тур	Project-/problem-based Learning
Hrs/wk	2
СР	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Examination Form	Klausur
Examination duration and	120 min
scale	
Lecturer	Prof. Ralf God
Language	DE
Cycle	SoSe
Content	
Literature	INCOSE Systems Engineering Handbuch - Ein Leitfaden für Systemlebenszyklus-Prozesse und -Aktivitäten, GfSE (Hrsg. der
	deutschen Übersetzung), ISBN 978-3-9818805-0-2.
	ISO/IEC 15288 System- und Software-Engineering - System-Lebenszyklus-Prozesse (Systems and Software Engineering - System
	Life Cycle Processes).

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

Course L1512: Development	Management for Mechatronics	
Тур	Lecture	
Hrs/wk	2	
СР	3	
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28	
Examination Form	Mündliche Prüfung	
Examination duration and	30 Minuten	
scale		
Lecturer	NN, Dr. Johannes Nicolas Gebhardt	
Language	DE	
Cycle	SoSe	
Content	 Processes and methods of product development - from idea to market launch 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 Design of processes for product development IT systems for product development Establishment of management standards Typical types of organization 	
Literature	 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	
Тур	Lecture
Hrs/wk	2
СР	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Examination Form	Mündliche Prüfung
Examination duration and	45 min
scale	
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. Kluver Academic Puplisher, Dordrecht, 2001 E. Haibach. Betriebsfestigkeit
	Verfahren und Daten zur Bauteilberechnung. VDI-Verlag, Düsseldorf, 1989

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

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

Course L1258: Lightweight Design Practical Course		
Тур	Project-/problem-based Learning	
Hrs/wk	3	
СР	3	
Workload in Hours	Independent Study Time 48, Study Time in Lecture 42	
Examination Form	Mündliche Prüfung	
Examination duration and	30 min	
scale		
Lecturer	Prof. Dieter Krause	
Language	DE/EN	
Cycle	SoSe	
Content	Development of a sandwich structure made of fibre reinforced plastics	
Literature	 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 Schürmann, H., "Konstruieren mit Faser-Kunststoff-Verbunden", Springer, Berlin, 2005. 	
	 Puck, A., "Festigkeitsanalsyse 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	
Тур	Lecture	
Hrs/wk	2	
СР	2	
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28	
Examination Form	Klausur	
Examination duration and	90 Minuten	
scale		
Lecturer	Dr. Jan Oke Peters	
Language	DE	
Cycle	SoSe	
Content	Application, analysis and discussion of basic and advanced testing methods to ensure correct selection of applicable testing	
	procedure for investigation of part/materials deficiencies 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	E. Macherauch: Praktikum in Werkstoffkunde, Vieweg G. E. Dieter: Mechanical Metallurgy, McGraw-Hill R. Bürgel: Lehr- und Übungsbuch Festigkeitslehre, Vieweg R. Bürgel: Werkstoffe sícher beurteilen und richtig einsetzen, Vieweg	

Course L0724: Microsystems	Technology
Тур	Lecture
Hrs/wk	2
СР	4
Workload in Hours	Independent Study Time 92, Study Time in Lecture 28
Examination Form	Mündliche Prüfung
Examination duration and	30 min
scale	
Lecturer	Prof. Hoc Khiem Trieu
Language	EN
Cycle	
Content	
Content	 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, SUB, 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) 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: spinning current Hall sensor and magneto-transistor; magnetoresistive sensors; magneto resistance, AMR and GMR, fluxgate magnetometer) Chemical and Bio Sensors (thermal gas sensors: spinning current Hall sensor a
Literature	M. Madou: Fundamentals of Microfabrication, CRC Press, 2002
	N. Schwesinger: Lehrbuch Mikrosystemtechnik, Oldenbourg Verlag, 2009
	T. M. Adams, R. A. Layton:Introductory MEMS, Springer, 2010
	C. Codesh W. Differed Jacks deathing to reference to the class of William 2000
	G. Gerlach; W. Dötzel: Introduction to microsystem technology, Wiley, 2008

ourse L2863: Sustainable In	ndustrial Production	
Тур	Lecture	
Hrs/wk	2	
СР	3	
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28	
Examination Form		
Examination duration and	60 min	
scale		
Lecturer	Dr. Simon Markus Kothe	
Language	DE	
Cycle	SoSe	
Content	Industrial production deals with the manufacture of physical products to satisfy human needs using various manufacturing processes that change the form and physical properties of raw materials. Manufacturing is a central driver of economic development and has a major impact on the well-being of humanity. However, the scale of current manufacturing activities results in enormous global energy and material demands that are harmful to both the environment and people. Historically, industria activities were mostly oriented towards economic constraints, while social and environmental consequences were only hardly considered. As a result, today's global consumption rates of many resources and associated emissions often exceed the natura regeneration rate of our planet. In this respect, current industrial production can mostly be described as unsustainable. This is emphasized each year by the Earth Overshoot Day, which marks the day when humanity's ecological footprint exceeds the Earth's annual regenerative capacity. This lecture aims to provide the motivation, analytical methods as well as approaches for sustainable industrial production and to clarify the influence of the production phase in relation to the raw material, use and recycling phases in the entire life cycle of products. For this, the following topics will be highlighted:	
	 Motivation for sustainable production, the 17 Sustainable Development Goals (SDGs) of the UN and their relevance fo tomorrow's manufacturing; raw material vs. production phase vs. use phase vs. recycling/end-of-life phase: importance of the production phase for the environmental impact of manufactured products; 	
	- Typical energy- and resource-intensive processes in industrial production and innovative approaches to increase energy and resource efficiency;	
	- Methodology for optimizing the energy and resource efficiency of industrial manufacturing chains with the three steps o modeling (1), evaluating (2) and improving (3);	
	- Resource efficiency of industrial manufacturing value chains and its assessment using life cycle analysis (LCA);	
	- Exercise: LCA analysis of a manufacturing process (thermoplastic joining of an aircraft fuselage segment) as part of a product life cycle assessment.	
Literature	Litoratur	
Literature	Literatur.	
	- Stefan Alexander (2020): Resource efficiency in manufacturing value chains. Cham: Springer International Publishing.	
	- Hauschild, Michael Z.; Rosenbaum, Ralph K.; Olsen, Stig Irving (Hg.) (2018): Life Cycle Assessment. Theory and Practice. Cham Springer International Publishing.	
	- Kishita, Yusuke; Matsumoto, Mitsutaka; Inoue, Masato; Fukushige, Shinichi (2021): EcoDesign and sustainability. Singapore: Springer.	
	- Schebek, Liselotte; Herrmann, Christoph; Cerdas, Felipe (2019): Progress in Life Cycle Assessment. Cham: Springer Internationa Publishing.	
	- Thiede, Sebastian; Hermann, Christoph (2019): Eco-factories of the future. Cham: Springer Nature Switzerland AG.	
	- Vorlesungsskript.	

Course L0928: Productivity Management		
Тур	Project-/problem-based Learning	
Hrs/wk	2	
СР	2	
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28	
Examination Form	Klausur	
Examination duration and	90 Minuten	
scale		
	Prof. Hermann Lödding	
Language		
Cycle	SoSe	
Content	 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	Bokranz, R.; Landau, K.:Produktivitätsmanagement von Arbeitssystemen. Schäffer-Poeschel, Stuttgart, 2006. Takeda, H.: Das synchrone Produktionssystem: Just-in-Time für das ganze Unternehmen. 5. Aufl., mi-Wirtschaftsbuch, FinanzBuch Verlag, München, 2006. Nakajima, S.: Management der Produktionseinrichtungen (Total Productive Maintenance). Campus Verlag, New York, 1995. Shingo, S.: A Revolution in Manufacturing: The SMED System. Productivity, Inc., 1985	

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

Course L0664: Feedback Control in Medical Technology			
Тур	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	20 min		
scale			
Lecturer	Johannes Kreuzer, Christian Neuhaus		
Language	DE		
Cycle	SoSe		
Content	Always viewed from the engineer's point of view, the lecture is structured as follows:		
Literature	 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 L1514: Structural Mechanics of Fibre Reinforced Composites			
Тур	Typ Lecture		
Hrs/wk	2		
СР	3		
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28		
Examination Form	Mündliche Prüfung		
Examination duration and	30 min		
scale			
Lecturer	Prof. Benedikt Kriegesmann		
Language	EN		
Cycle	WiSe		
Content	Classical laminate theory		
	Rules of mixture		
	Failure mechanisms and criteria of composites		
	Boundary value problems of isotropic and anisotropic shells		
	Stability of composite structures		
	Optimization of laminated composites		
	Modelling composites in FEM		
	Numerical multiscale analysis of textile composites		
	Progressive failure analysis		
Literature	 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		
Тур	Lecture	
Hrs/wk	2	
СР	2	
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28	
Examination Form	Mündliche Prüfung	
Examination duration and	30 min	
scale		
Lecturer	Dr. Stefan Wischhusen	
Language	DE	
Cycle	WiSe	
Content	Lecture about equation-based, physical modelling using the modelling language Modelica and the free simulation tool OpenModelica. • 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	 [1] Modelica Association: "Modelica Language Specification - Version 3.4", Linköping, Sweden, 2 0 1 7 [2] M. Tiller: "Modelica by Example", http://book.xogeny.com, 2014. [3] M. Otter, H. Elmqvist, et al.: "Objektorientierte Modellierung Physikalischer Systeme", at- Automatisierungstechnik (german), Teil 1 - 17, Oldenbourg Verlag, 1999 - 2000. [4] P. Fritzson: "Principles of Object-Oriented Modeling and Simulation with Modelica 3.3", Wiley-IEEE Press, New York, 2015. [5] P. Fritzson: "Introduction to Modeling and Simulation of Technical and Physical Systems with Modelica", Wiley, New York, 2011. 	

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

Course L1513: Technical Design		
Тур	Lecture	
Hrs/wk	2	
СР	3	
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28	
Examination Form	Schriftliche Ausarbeitung	
Examination duration and	10-15 Entwurfszeichnungen, Skizzen und ca. 5-10 A4-Dokumentationsseiten (Themen- und Entwurfsbegründung)	
scale		
Lecturer	Prof. Werner Granzeier	
Language	DE	
Cycle	SoSe	
Content	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	Literatur über technisches Produktdesign Technisches Rendering und Präsentation	

Zeichnen und perspektivisches Entwerfen Literaturhinweise What is Product Design? Laura Slack RotoVision Schweiz 2006 Product Design Now Design and Scetches CollinsDesign and maomao publications Spanien 2006 Ronald B. Kemnitzer, Rendering With Markers - Definitive Techniques for Designers, Illustrators and Architects, Watson, Guptil Puplications, a division of Billboard Publications Inc., New York 1983 Creative Techniques DRAWING Barons Educational Series ISBN-13: 978-0-7641-6182-7 Joseph Ungar, Rendering In Mixed Media - Techniques for Concept Presentation for Designers and Illustrators Watson-Guptil Publication a division of Billboard Publications Inc., New York 1985 AIRWORLD Design und Architektur für die Flugreise Vitra Design Stiftung Weil am Rhein 2004 Airline Design Perter Deslius Jacek Slaski te Neues 2005 Technik und Sicherheit von Passagierflugzeugen Frank Littek Motorbuch Verlag 2003 Jetliner Cabins Jennifer Coutts Clay Cs books England 2006 **BOEING Widebodies** Michael Haenggi motorbooks international USA 2003 form - Zeitschrift für Gestaltung, Verlag form GmbH, Hofgut Ober-Berrbach, 6104 Seeheim-Jugenheim (erscheint vierteljährlich, Verlag form GmbH) design report german magasin, (erscheint monatlich) md - möbel interior design, Konradin-Verlag Robert Kohlhammer GmbH, 7022 Leinfelden-Echterdingen (erscheint monatlich) CAR STYLING, Car Styling Publishing Co. 4-8-16-11F, Kitashinjuku, Shinjuku-ku, Tokio 160, Japan (erscheint vierteljährlich in japanischer und englischer Sprache, in Hamburg erhältlich bei: Overseas Courier Service Deutschland Auto & Design, Corso Frabcia 161, 10139 Torino, Italia

Production"	
(e	erscheint vierteljährlich in italienischer und englischer Sprache alle zwei
M	onate , erhältlich am HBF Hamburg
Al	ERO International,
M	lagazin für Zivilluftfahrt
(e	erscheint monatlich)
Ai	ircraft interior international
Er	ingl. magasin for Aircraft cabin interior
(e	erscheint 2 monatlich)
ae	erotec
Te	echnik- und Branchenmagazin für die Luft- und Raumfahrtindustrie

Course L0379: Ceramics Technology		
Тур	Lecture	
Hrs/wk	2	
СР	3	
Workload in Hours	Independent Study Time 62, Stu	udy Time in Lecture 28
Examination Form	Klausur	
Examination duration and	90 Minuten	
scale		
	Dr. Rolf Janßen	
Language		
Cycle		sing with amphasis an advanced shrushwall agramics. The savers frame wadeningthy an accordan
Content	Introduction to ceramic processing with emphasis on advanced structural ceramics. The course focus predominatly on powder-based processing, e.g. "powder-metauurgical techniques and sintering (soild 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.	
	Content:	1. Introduction
	Inhalt:	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
Literature	W.D. Kingery, "Introduction to C	Ceramics", John Wiley & Sons, New York, 1975
	ASM Engineering Materials Hand	dbook Vol.4 "Ceramics and Glasses", 1991
	D.W. Richerson, "Modern Ceram	nic Engineering", Marcel Decker, New York, 1992
	Skript zur Vorlesung	

Course L0949: Materials Testing		
Тур	Lecture	
Hrs/wk	2	
СР	2	
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28	
Examination Form	Klausur	
Examination duration and	90 Minuten	
scale		
Lecturer	Dr. Jan Oke Peters	
Language	DE	
Cycle	WiSe	
Content		
	Application and analysis of basic mechanical as well as non-destructive testing of materials Determination elastic constants Tensile test Fatigue test (testing with constant stress, strain, or plastiv 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	E. Macherauch: Praktikum in Werkstoffkunde, Vieweg G. E. Dieter: Mechanical Metallurgy, McGraw-Hill	

Course L0176: Reliability in Engineering Dynamics		
Тур	Lecture	
Hrs/wk	/wk 2	
СР	2	
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28	
Examination Form	Klausur	
Examination duration and	90 min.	
scale		
Lecturer	NN	
Language		
Cycle	SoSe SoSe	
Content	Method for calculation and testing of reliability of dynamic machine systems Modeling System identification Simulation Processing of measurement data Damage accumulation Test planning and execution	
Literature	Bertsche, B.: Reliability in Automotive and Mechanical Engineering. Springer, 2008. ISBN: 978-3-540-33969-4 Inman, Daniel J.: Engineering Vibration. Prentice Hall, 3rd Ed., 2007. ISBN-13: 978-0132281737 Dresig, H., Holzweißig, F.: Maschinendynamik, Springer Verlag, 9. Auflage, 2009. ISBN 3540876936. VDA (Hg.): Zuverlässigkeitssicherung bei Automobilherstellern und Lieferanten. Band 3 Teil 2, 3. überarbeitete Auflage, 2004. ISSN 0943-9412	

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

Course L0749: Reliability of Aircraft Systems		
Тур	Lecture	
Hrs/wk	2	
СР	3	
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28	
Examination Form	Klausur	
Examination duration and	90 Minuten	
scale		
Lecturer	Prof. Frank Thielecke, Dr. Andreas Vahl, Dr. Uwe Wieczorek	
Language	DE	
Cycle	WiSe	
Content	 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	• CS 25.1309 • SAE ARP 4754 • SAE ARP 4761	

FIOGUCTION				
Module M1156: Syste	ms Engineering			
Courses				
Title		Тур	Hrs/wk	СР
Systems Engineering (L1547)		Lecture	3	4
Systems Engineering (L1548)		Recitation Section (large)	1	2
	Prof. Ralf God			
Admission Requirements	None			
Recommended Previous				
Knowledge	Mechanics			
	Thermodynamics Electrical Engineering			
	Control Systems			
	Previous knowledge in:			
	Aircraft Cabin Systems			
Educational Objectives	After taking part successfully, students have reached th	e tollowing learning results		
Professional Competence				
Knowledge	Students are able to:			
	 understand systems engineering process models, met 	hods and tools for the development o	f complex System	S
	describe innovation processes and the need for technology.	ology Management		
	explain the aircraft development process and the proc	ess of type certification for aircraft		
	explain the system development process, including re	quirements for systems reliability		
	identify environmental conditions and test procedures	for airborne Equipment		
	value the methodology of requirements-based engine	ering (RBE) and model-based requirer	ments engineering	(MBRE)
Skills	Students are able to:			
SKIIIS		ems		
	plan the process for the development of complex Systems a graphic the development places and development Tacks.			
	organize the development phases and development Tasks assign required business activities and technical Tasks			
	 assign required business activities and technical Tasks apply systems engineering methods and tools 			
	apply systems engineering methods and tools			
Personal Competence				
Social Competence	Students are able to:			
	• understand their responsibilities within a development	team and integrate themselves with	their role in the o	verall process
Autonomy	Students are able to:			
	interact and communicate in a development team whi	ch has distributed tasks		
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56			
Credit points	6			
Course achievement				
Examination				
Examination duration and				
scale	120 Millutes			
	Aircraft Systems Engineering, Core Qualification, Comp.	ulcory		
Assignment for the Following Curricula	Aircraft Systems Engineering: Core Qualification: Compu International Management and Engineering: Specialisati	•	nulcony	
Following Curricula	International Management and Engineering: Specialisati	· ·		mnulsory
			action. Liective CC	ппригоог у
	Mechatronics: Specialisation System Design: Elective Co	•		
	Mechatronics: Specialisation Intelligent Systems and Ro	• •	lcon	
	Product Development, Materials and Production: Specia	·	,	
	Product Development, Materials and Production: Specia	·	-	
	Product Development, Materials and Production: Specia			
	Theoretical Mechanical Engineering: Specialisation Aircr	art Systems Engineering: Elective Cor	npulsory	
	ı			

Course L1547: Systems Engi	neering
Тур	Lecture
Hrs/wk	3
СР	4
Workload in Hours	Independent Study Time 78, Study Time in Lecture 42
Lecturer	Prof. Ralf God
Language	DE
Cycle	SoSe
Content	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.
	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: 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	- 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	
Тур	Recitation Section (large)
Hrs/wk	1
СР	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

Martinia Marca Toule	and all the same			
Module M1161: Turbo	omacninery			
Courses				
Title		Turn	Hrs/wk	СР
Turbomachines (L1562)		Typ Lecture	3	4
Turbomachines (L1563)		Recitation Section (large)	1	2
Module Responsible	Prof. Markus Schatz			
Admission Requirements	None			
Recommended Previous	Technical Thermodynamics I, II, Fluid Dynamics, Heat Trans	fer		
Knowledge				
Educational Objectives	After taking part successfully, students have reached the fo	ollowing learning results		
Professional Competence				
Knowledge	The students can			
	distinguish the physical phenomena of conversion of	energy.		
	understand the different mathematic modelling of tu			
	calculate and evaluate turbomachinery.	•		
Skills	The students are able to			
	- understand the physics of Turbomachinery,			
	- solve excersises self-consistent.			
Personal Competence				
Social Competence	The students are able to			
	discuss in small groups and develop an approach.			
Autonomy	The students are able to			
	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	90 min			
scale				
Assignment for the	Energy Systems: Specialisation Energy Systems: Elective C	ompulsory		
Following Curricula	Energy Systems: Specialisation Marine Engineering: Electiv	e Compulsory		
	Product Development, Materials and Production: Specialisa	tion Product Development: Elective	e Compulsory	
	Product Development, Materials and Production: Specialisa	tion Production: Elective Compulso	ory	
	Product Development, Materials and Production: Specialisa	tion Materials: Elective Compulsor	y	

Course L1562: Turbomachine	95
Тур	Lecture
Hrs/wk	3
СР	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:
Literature	 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	 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

Course L1563: Turbomachines	
Тур	Recitation Section (large)
Hrs/wk	1
СР	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 I P)

Courses				
Title		Тур	Hrs/wk	СР
Applied Automation (L1592)		Project-/problem-based Learning	3	3
Applied Automation (L1592) Ergonomics (L0653)		Lecture	2	3
Advanced Training Course SE-ZERT	(12739)	Project-/problem-based Learning	2	3
Elements of Integrated Production		Project-/problem-based Learning	2	3
Development Management for Med		Lecture	2	3
Fatigue & Damage Tolerance (L031		Lecture	2	3
Industry 4.0 for engineers (L2012)	,	Lecture	2	3
Innovation and Product Manageme	nt (L2168)	Seminar	2	3
Lightweight Design Practical Cours		Project-/problem-based Learning	3	3
Mechanisms, Systems and Process		Lecture	2	2
Microsystems Technology (L0724)	es of Flaterials Festing (Essay)	Lecture	2	4
Sustainable Industrial Production (I	2863)	Lecture	2	3
Productivity Management (L0928)		Project-/problem-based Learning	2	2
Productivity Management (L0931)		Recitation Section (small)	1	1
Feedback Control in Medical Techn	ology (L0664)	Lecture	2	3
Structural Mechanics of Fibre Reinf		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		Recitation Section (small)	1	2
Reliability of Aircraft Systems (L074		Lecture	2	3
Module Responsible	Prof. Dieter Krause			
Admission Requirements	None			
Recommended Previous	None			
Knowledge				
Educational Objectives	After taking part successfully, students have reached the fo	ollowing learning results		
Professional Competence	,	3 3		
Knowledge				
omecge	 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 			
Skills	 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				
Social Competence	-			
Autonomy				
Workload in Hours	Depends on choice of courses			
Credit points	6			
Assignment for the	Product Development, Materials and Production: Specialisa	tion Product Development: Elective Co	ompuisory	
	Product Development, Materials and Production: Specialisa Product Development, Materials and Production: Specialisa	·	ompulsory	

Course L1592	2: Applied Automation
Тур	Project-/problem-based Learning
Hrs/wk	3
CP	3
Workload in	Independent Study Time 48, Study Time in Lecture 42
Hours	
Examination	Mündliche Prüfung
Form	
Examination	30 Minuten
duration	
and scale	
Lecturer	Prof. Thorsten Schüppstuhl
Language	DE
Cycle	WiSe
Content	-Project Based Learning -Robot Operating System -Robot structure and description -Motion description -Calibration -Accuracy John J. Craig Introduction to Robotics - Mechanics and Control ISBN: 0131236296 Pearson Education, Inc., 2005
	Stefan Hesse Grundlagen der Handhabungstechnik ISBN: 3446418725 München Hanser, 2010 K. Thulasiraman and M. N. S. Swamy Graphs: Theory and Algorithms ISBN: 9781118033104 %CITAVIPICKER£9781118033104£Titel anhand dieser ISBN in Citavi-Projekt übernehmen£% John Wüey & Sons, Inc., 1992

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

Course L2739: Advanced Tra	ining Course SE-ZERT
Тур	Project-/problem-based Learning
Hrs/wk	2
СР	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Examination Form	Klausur
Examination duration and	120 min
scale	
Lecturer	Prof. Ralf God
Language	DE
Cycle	SoSe
Content	
Literature	INCOSE Systems Engineering Handbuch - Ein Leitfaden für Systemlebenszyklus-Prozesse und -Aktivitäten, GfSE (Hrsg. der
	deutschen Übersetzung), ISBN 978-3-9818805-0-2.
	ISO/IEC 15288 System- und Software-Engineering - System-Lebenszyklus-Prozesse (Systems and Software Engineering - System
	Life Cycle Processes).

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

Course L1512: Development	Management for Mechatronics
Тур	Lecture
Hrs/wk	2
СР	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Examination Form	Mündliche Prüfung
Examination duration and	30 Minuten
scale	
Lecturer	NN, Dr. Johannes Nicolas Gebhardt
Language	DE
Cycle	SoSe
Content	Processes and methods of product development - from idea to market launch 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 Design of processes for product development IT systems for product development Establishment of management standards Typical types of organization
Literature	 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	
Тур	Lecture
Hrs/wk	2
СР	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Examination Form	Mündliche Prüfung
Examination duration and	45 min
scale	
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. Kluver Academic Puplisher, Dordrecht, 2001 E. Haibach. Betriebsfestigkeit
	Verfahren und Daten zur Bauteilberechnung. VDI-Verlag, Düsseldorf, 1989

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

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

Course L1258: Lightweight Design Practical Course		
Тур	Project-/problem-based Learning	
Hrs/wk	3	
СР	3	
Workload in Hours	Independent Study Time 48, Study Time in Lecture 42	
Examination Form	Mündliche Prüfung	
Examination duration and	30 min	
scale		
Lecturer	Prof. Dieter Krause	
Language	DE/EN	
Cycle	SoSe	
Content	Development of a sandwich structure made of fibre reinforced plastics	
	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	Schürmann, H., "Konstruieren mit Faser-Kunststoff-Verbunden", Springer, Berlin, 2005.	
	Puck, A., "Festigkeitsanalsyse 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.	
L		

Course L0950: Mechanisms,	Systems and Processes of Materials Testing
Тур	Lecture
Hrs/wk	2
СР	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Examination Form	Klausur
Examination duration and	90 Minuten
scale	
Lecturer	Dr. Jan Oke Peters
Language	DE
Cycle	SoSe
Content	Application, analysis and discussion of basic and advanced testing methods to ensure correct selection of applicable testing procedure for investigation of part/materials deficiencies 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	 E. Macherauch: Praktikum in Werkstoffkunde, Vieweg G. E. Dieter: Mechanical Metallurgy, McGraw-Hill R. Bürgel: Lehr- und Übungsbuch Festigkeitslehre, Vieweg R. Bürgel: Werkstoffe sícher beurteilen und richtig einsetzen, Vieweg

Course L0724: Microsystems	Technology
Тур	Lecture
Hrs/wk	2
СР	4
Workload in Hours	Independent Study Time 92, Study Time in Lecture 28
Examination Form	Mündliche Prüfung
Examination duration and	30 min
scale	
Lecturer	Prof. Hoc Khiem Trieu
Language	EN
Cycle	WiSe
Content	 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, m
	 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	M. Madou: Fundamentals of Microfabrication, CRC Press, 2002
	N. Schwesinger: Lehrbuch Mikrosystemtechnik, Oldenbourg Verlag, 2009
	T. M. Adams, R. A. Layton:Introductory MEMS, Springer, 2010 G. Gerlach; W. Dötzel: Introduction to microsystem technology, Wiley, 2008
	L

ourse L2863: Sustainable In	ndustrial Production
Тур	Lecture
Hrs/wk	2
СР	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Examination Form	Klausur
Examination duration and	60 min
scale	
Lecturer	Dr. Simon Markus Kothe
Language	DE
Cycle	SoSe
Content	Industrial production deals with the manufacture of physical products to satisfy human needs using various manufacturing processes that change the form and physical properties of raw materials. Manufacturing is a central driver of economic development and has a major impact on the well-being of humanity. However, the scale of current manufacturing activities results in enormous global energy and material demands that are harmful to both the environment and people. Historically, industria activities were mostly oriented towards economic constraints, while social and environmental consequences were only hardly considered. As a result, today's global consumption rates of many resources and associated emissions often exceed the natura regeneration rate of our planet. In this respect, current industrial production can mostly be described as unsustainable. This is emphasized each year by the Earth Overshoot Day, which marks the day when humanity's ecological footprint exceeds the Earth's annual regenerative capacity. This lecture aims to provide the motivation, analytical methods as well as approaches for sustainable industrial production and to clarify the influence of the production phase in relation to the raw material, use and recycling phases in the entire life cycle of products. For this, the following topics will be highlighted:
	 Motivation for sustainable production, the 17 Sustainable Development Goals (SDGs) of the UN and their relevance fo tomorrow's manufacturing; raw material vs. production phase vs. use phase vs. recycling/end-of-life phase: importance of the production phase for the environmental impact of manufactured products;
	- Typical energy- and resource-intensive processes in industrial production and innovative approaches to increase energy and resource efficiency;
	- Methodology for optimizing the energy and resource efficiency of industrial manufacturing chains with the three steps o modeling (1), evaluating (2) and improving (3);
	- Resource efficiency of industrial manufacturing value chains and its assessment using life cycle analysis (LCA);
	- Exercise: LCA analysis of a manufacturing process (thermoplastic joining of an aircraft fuselage segment) as part of a product life cycle assessment.
Literature	Litoratur
Literature	Literatur.
	- Stefan Alexander (2020): Resource efficiency in manufacturing value chains. Cham: Springer International Publishing.
	- Hauschild, Michael Z.; Rosenbaum, Ralph K.; Olsen, Stig Irving (Hg.) (2018): Life Cycle Assessment. Theory and Practice. Cham Springer International Publishing.
	- Kishita, Yusuke; Matsumoto, Mitsutaka; Inoue, Masato; Fukushige, Shinichi (2021): EcoDesign and sustainability. Singapore: Springer.
	- Schebek, Liselotte; Herrmann, Christoph; Cerdas, Felipe (2019): Progress in Life Cycle Assessment. Cham: Springer Internationa Publishing.
	- Thiede, Sebastian; Hermann, Christoph (2019): Eco-factories of the future. Cham: Springer Nature Switzerland AG.
	- Vorlesungsskript.

Course L0928: Productivity Management	
Тур	Project-/problem-based Learning
Hrs/wk	2
СР	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Examination Form	Klausur
Examination duration and	90 Minuten
scale	
	Prof. Hermann Lödding
Language	
Cycle	SoSe
Content	 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	Bokranz, R.; Landau, K.:Produktivitätsmanagement von Arbeitssystemen. Schäffer-Poeschel, Stuttgart, 2006. Takeda, H.: Das synchrone Produktionssystem: Just-in-Time für das ganze Unternehmen. 5. Aufl., mi-Wirtschaftsbuch, FinanzBuch Verlag, München, 2006. Nakajima, S.: Management der Produktionseinrichtungen (Total Productive Maintenance). Campus Verlag, New York, 1995. Shingo, S.: A Revolution in Manufacturing: The SMED System. Productivity, Inc., 1985

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

Course L0664: Feedback Control in Medical Technology	
Тур	Lecture
Hrs/wk	2
СР	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Examination Form	Mündliche Prüfung
Examination duration and	20 min
scale	
Lecturer	Johannes Kreuzer, Christian Neuhaus
Language	DE
Cycle	SoSe
Content	Always viewed from the engineer's point of view, the lecture is structured as follows: 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 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.
Literature	 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 L1514: Structural Mechanics of Fibre Reinforced Composites			
Тур	Lecture		
Hrs/wk	2		
СР	3		
Workload in Hours	dependent Study Time 62, Study Time in Lecture 28		
Examination Form	Mündliche Prüfung		
Examination duration and	30 min		
scale			
Lecturer	Prof. Benedikt Kriegesmann		
Language	EN		
Cycle	WiSe		
Content	Classical laminate theory		
	Rules of mixture		
	Failure mechanisms and criteria of composites		
	Boundary value problems of isotropic and anisotropic shells		
	Stability of composite structures		
	Optimization of laminated composites		
	Modelling composites in FEM		
	Numerical multiscale analysis of textile composites		
	Progressive failure analysis		
Literature	 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		
Тур	Lecture	
Hrs/wk	2	
СР	2	
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28	
Examination Form	Mündliche Prüfung	
Examination duration and	30 min	
scale		
Lecturer	Dr. Stefan Wischhusen	
Language	DE	
Cycle	WiSe	
Content	Lecture about equation-based, physical modelling using the modelling language Modelica and the free simulation tool OpenModelica. • 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	 [1] Modelica Association: "Modelica Language Specification - Version 3.4", Linköping, Sweden, 2 0 1 7 [2] M. Tiller: "Modelica by Example", http://book.xogeny.com, 2014. [3] M. Otter, H. Elmqvist, et al.: "Objektorientierte Modellierung Physikalischer Systeme", at- Automatisierungstechnik (german), Teil 1 - 17, Oldenbourg Verlag, 1999 - 2000. [4] P. Fritzson: "Principles of Object-Oriented Modeling and Simulation with Modelica 3.3", Wiley-IEEE Press, New York, 2015. [5] P. Fritzson: "Introduction to Modeling and Simulation of Technical and Physical Systems with Modelica", Wiley, New York, 2011. 	

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

Course L1513: Technical Design			
Тур	Lecture		
Hrs/wk			
СР	3		
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28		
Examination Form	Schriftliche Ausarbeitung		
Examination duration and	10-15 Entwurfszeichnungen, Skizzen und ca. 5-10 A4-Dokumentationsseiten (Themen- und Entwurfsbegründung)		
scale			
Lecturer	Prof. Werner Granzeier		
Language	DE		
Cycle	SoSe		
Content	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	Literatur über technisches Produktdesign		
	Technisches Rendering und Präsentation		
	[170]		

Zeichnen und perspektivisches Entwerfen Literaturhinweise What is Product Design? Laura Slack RotoVision Schweiz 2006 Product Design Now Design and Scetches CollinsDesign and maomao publications Spanien 2006 Ronald B. Kemnitzer, Rendering With Markers - Definitive Techniques for Designers, Illustrators and Architects, Watson, Guptil Puplications, a division of Billboard Publications Inc., New York 1983 Creative Techniques DRAWING Barons Educational Series ISBN-13: 978-0-7641-6182-7 Joseph Ungar, Rendering In Mixed Media - Techniques for Concept Presentation for Designers and Illustrators Watson-Guptil Publication a division of Billboard Publications Inc., New York 1985 AIRWORLD Design und Architektur für die Flugreise Vitra Design Stiftung Weil am Rhein 2004 Airline Design Perter Deslius Jacek Slaski te Neues 2005 Technik und Sicherheit von Passagierflugzeugen Frank Littek Motorbuch Verlag 2003 Jetliner Cabins Jennifer Coutts Clay Cs books England 2006 **BOEING Widebodies** Michael Haenggi motorbooks international USA 2003 form - Zeitschrift für Gestaltung, Verlag form GmbH, Hofgut Ober-Berrbach, 6104 Seeheim-Jugenheim (erscheint vierteljährlich, Verlag form GmbH) design report german magasin, (erscheint monatlich) md - möbel interior design, Konradin-Verlag Robert Kohlhammer GmbH, 7022 Leinfelden-Echterdingen (erscheint monatlich) CAR STYLING, Car Styling Publishing Co. 4-8-16-11F, Kitashinjuku, Shinjuku-ku, Tokio 160, Japan (erscheint vierteljährlich in japanischer und englischer Sprache, in Hamburg erhältlich bei: Overseas Courier Service Deutschland Auto & Design, Corso Frabcia 161, 10139 Torino, Italia

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		(erscheint vierteljährlich in italienischer und englischer Sprache alle zwei
		Monate , erhältlich am HBF Hamburg
		AERO International,
		Magazin für Zivilluftfahrt
		(erscheint monatlich)
		Aircraft interior international
		Engl. magasin for Aircraft cabin interior
		(erscheint 2 monatlich)
		aerotec
		Technik- und Branchenmagazin für die Luft- und Raumfahrtindustrie
L		

Course L0379: Ceramics Technology			
Тур	Lecture		
Hrs/wk	2		
СР	3		
Workload in Hours	Independent Study Time 62, Stu	udy Time in Lecture 28	
Examination Form	Klausur		
Examination duration and	90 Minuten		
scale			
Lecturer	Dr. Rolf Janßen		
Language	DE/EN		
Cycle	WiSe		
Content	based processing, e.g. "powder and cement science as well as addressed Examples will be di	ntroduction to ceramic processing with emphasis on advanced structural ceramics. The course focus predominatly on powder based processing, e.g. "powder-metauurgical techniques and sintering (soild state and liquid phase). Also, some aspects of glast 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 are pecific applications of ceramic components. Content: 1. Introduction	
Literature	ASM Engineering Materials Hand	Ceramics", John Wiley & Sons, New York, 1975 dbook Vol.4 "Ceramics and Glasses", 1991 nic Engineering", Marcel Decker, New York, 1992	
	Skript zur Vorlesung		

Course L0949: Materials Testing		
Тур	Lecture	
Hrs/wk	2	
СР	2	
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28	
Examination Form	Klausur	
Examination duration and	90 Minuten	
scale		
Lecturer	Dr. Jan Oke Peters	
Language	DE	
Cycle	WiSe	
Content		
	Application and analysis of basic mechanical as well as non-destructive testing of materials Determination elastic constants Tensile test Fatigue test (testing with constant stress, strain, or plastiv 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	E. Macherauch: Praktikum in Werkstoffkunde, Vieweg G. E. Dieter: Mechanical Metallurgy, McGraw-Hill	

Course L0176: Reliability in Engineering Dynamics		
Тур	Lecture	
Hrs/wk	2	
СР		
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28	
Examination Form	Klausur	
Examination duration and	90 min.	
scale		
Lecturer	NN	
Language		
Cycle	SoSe SoSe	
Content	Method for calculation and testing of reliability of dynamic machine systems Modeling System identification Simulation Processing of measurement data Damage accumulation Test planning and execution	
Literature	Bertsche, B.: Reliability in Automotive and Mechanical Engineering. Springer, 2008. ISBN: 978-3-540-33969-4 Inman, Daniel J.: Engineering Vibration. Prentice Hall, 3rd Ed., 2007. ISBN-13: 978-0132281737 Dresig, H., Holzweißig, F.: Maschinendynamik, Springer Verlag, 9. Auflage, 2009. ISBN 3540876936. VDA (Hg.): Zuverlässigkeitssicherung bei Automobilherstellern und Lieferanten. Band 3 Teil 2, 3. überarbeitete Auflage, 2004. ISSN 0943-9412	

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

Course L0749: Reliability of Aircraft Systems		
Тур	Lecture	
Hrs/wk	2	
СР	3	
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28	
Examination Form	Klausur	
Examination duration and	90 Minuten	
scale		
Lecturer	Prof. Frank Thielecke, Dr. Andreas Vahl, Dr. Uwe Wieczorek	
Language	DE	
Cycle	WiSe	
Content	 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	• CS 25.1309 • SAE ARP 4754 • SAE ARP 4761	

Module M1226: Mech	anical Properties			
Courses				
Title		Тур	Hrs/wk	СР
Mechanical Behaviour of Brittle Mat		Lecture	2	3
Dislocation Theory of Plasticity (L16	562)	Lecture	2	3
Module Responsible	Dr. Erica Lilleodden			
Admission Requirements	None			
Recommended Previous	Basics in Materials Science I/II			
Knowledge				
Educational Objectives	After taking part successfully, students have reached the	ne following learning results		
Professional Competence				
Knowledge	Students can explain basic principles of crystallograp	phy, statics (free body diagram	ns, tractions) and therm	odynamics (energy
	minimization, energy barriers, entropy)			
Skille	Students are capable of using standardized calculation	mothods: tonsor calculations de	orivativos intograls ton	or transformations
Skills	Students are capable of using standardized calculation	methods, tensor calculations, di	erivatives, integrals, ten	sor transformations
Personal Competence				
Social Competence	Students can provide appropriate feedback and handle	feedback on their own performa	ance constructively.	
Autonomy	Autonomy Students are able to			
	- assess their own strengths and weaknesses			
	- assess their own state of learning in specific terms an	d to define further work steps or	n this basis guided by te	achers.
	- work independently based on lectures and notes to so	olve problems, and to ask for hel	p or clarifications when	needed
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56			
Credit points	6			
Course achievement	None			
Examination	Written exam			
Examination duration and	90 min			
scale				
Assignment for the	Materials Science: Core Qualification: Compulsory			
Following Curricula	Mechanical Engineering and Management: Specialisation	on Materials: Elective Compulsor	у	
	Product Development, Materials and Production: Specia	alisation Product Development: E	Elective Compulsory	
	Product Development, Materials and Production: Specia	alisation Production: Elective Cor	mpulsory	
	Product Development, Materials and Production: Specia	alisation Materials: Compulsory		
	Theoretical Mechanical Engineering: Specialisation Mat	erials Science: Elective Compuls	ory	

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

Course L1662: Dislocation Theory of Plasticity		
	Lecture	
Hrs/wk		
СР	3	
	Independent Study Time 62, Study Time in Lecture 28	
Lecturer	Dr. Erica Lilleodden	
Language	DE/EN	
Cycle	SoSe	
Content	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.	
	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.	
Literature	Vorlesungsskript Aktuelle Publikationen Bücher: Introduction to Dislocations, by D. Hull and D.J. Bacon Theory of Dislocations, by J.P. Hirth and J. Lothe Physical Metallurgy, by Peter Hassen	

Production" Module M0940: Ontimal and Pobust Control					
Module M0840: Optimal and Robust Control					
ourses					
itle		Тур	Hrs/wk	СР	
ptimal and Robust Control (L0658 ptimal and Robust Control (L0659		Lecture Recitation Section (small)	2	3 3	
Module Responsible		Recitation Section (Smarr)	2	3	
Admission Requirements					
Recommended Previous	None				
Knowledge	Classical control (frequency response, root locus)			
· ·	State space methods				
	Linear algebra, singular value decomposition				
Educational Objectives	After taking part successfully, students have reached the	he following learning results			
Professional Competence					
Knowledge	Students can explain the significance of the mat	riv Piccati equation for the solution of	I O problems		
	They can explain the duality between optimal state.				
	They can explain how the H2 and H-infinity norm			straints.	
	They can explain how an LQG design problem ca				
	They can explain how model uncertainty can be	represented in a way that lends itself	to robust contro	ller design	
	They can explain how - based on the small gair	n theorem - a robust controller can gu	arantee stability	and performance	
	an uncertain plant.				
	They understand how analysis and synthesis cor	nditions on feedback loops can be repr	esented as linea	matrix inequalities	
Skills					
	Students are capable of designing and tuning LQ	·			
	They are capable of representing a H2 or H-infin software tools for solving it.	ity design problem in the form of a ge	neralized plant, a	and of using standa	
	software tools for solving it.They are capable of translating time and frequence	ancy domain specifications for control	loons into const	raints on closed lo	
	sensitivity functions, and of carrying out a mixed		100p3 IIIto corisi	iranits on closed-ic	
	They are capable of constructing an LFT uncer		, and of designi	ng a mixed-object	
	robust controller.	,		,	
	They are capable of formulating analysis and sy	nthesis conditions as linear matrix ine	qualities (LMI), a	and of using standa	
	LMI-solvers for solving them.				
	They can carry out all of the above using standa	rd software tools (Matlab robust contro	ol toolbox).		
Personal Competence					
Social Competence	Students can work in small groups on specific problems	s to arrive at joint solutions.			
Autonomy					
	solve given problems.				
	Independent Study Time 124, Study Time in Lecture 56	5			
Credit points	†				
Course achievement Examination					
Examination duration and					
scale	30 111111				
-	Electrical Engineering: Specialisation Control and Powe		ulsory		
Following Curricula					
	Aircraft Systems Engineering: Core Qualification: Electi				
	Mechatronics: Specialisation Intelligent Systems and Ro Mechatronics: Specialisation System Design: Elective C				
	Biomedical Engineering: Specialisation Artificial Organs		Compulsory		
	Biomedical Engineering: Specialisation Implants and Er	-	20.11pui301 y		
	Biomedical Engineering: Specialisation Implants and El		pulsory		
	Biomedical Engineering: Specialisation Management ar				
	Product Development, Materials and Production: Specia				
	Product Development, Materials and Production: Specia	alisation Production: Elective Compulso	ory		
	Product Development, Materials and Production: Specia	alisation Materials: Elective Compulsor	у		
	Theoretical Mechanical Engineering: Core Qualification:	: Elective Compulsory			

Course L0658: Optimal and Robust Control			
Тур	Lecture		
Hrs/wk	2		
СР	3		
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28		
Lecturer	Prof. Herbert Werner		
Language	EN		
Cycle	SoSe		
Content	 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 H2 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 (H2, 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	 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. Postlewhaite "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 		

ourse L0659: Optimal and Robust Control		
Тур	Recitation Section (small)	
Hrs/wk	2	
СР	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 M1690: Aircra	aft Design II (Special Air Vehicle Design	1)		
Courses				
Title Aircraft Design II (Conceptual Desig	on of Rotorcraft, special operations aircraft, UAV) (L0844) on of Rotorcraft, special operations aircraft, UAV) (L0847)	Typ Lecture Recitation Section (large)	Hrs/wk 3 2	CP 3 3
Module Responsible	Prof. Volker Gollnick			
Admission Requirements	None			
Recommended Previous	Aircraft Design I (Design of Transport Aircraft)			
Knowledge	Air Transportation Systems			
Educational Objectives	After taking part successfully, students have reached the	e following learning results		
Professional Competence				
Knowledge	Understanding of various flight systems and its special unmanned air systems)	characteristics (supersonic aircraft,	rotorcraft, high p	erformance aircraft
	Understanding of pro's and con's and physical characte	ristics of different air systems		
	Understanding of special mission requirements and its ir	npact on systems definition and conc	eptual design	
	Intensified knowledge of performance design on various	air systems		
Skills	Understanding and application of design and calculation	methods		
	Understanding of interdisciplinary and integrative interd	ependencies		
	mission oriented technical definition of air systems			
	special conceptual calculation methods for special equip	ment characteristics		
	assessment of different design solutions			
Personal Competence				
Social Competence	Working in teams for focused solutions			
	communication, assertiveness, technical persuasion			
Autonomy	Organisation of worksflows and strategies for solutions			
	structured task analysis and definition of solutions			
Workload in Hours	Independent Study Time 110, Study Time in Lecture 70			
Credit points	6			
Course achievement	None			
Examination				
Examination duration and scale	180 min			
Assignment for the	Aircraft Systems Engineering: Core Qualification: Elective	e Compulsory		
Following Curricula	International Management and Engineering: Specialisation		pulsory	
•	Product Development, Materials and Production: Special	,		
	Product Development, Materials and Production: Special	isation Production: Elective Compulso	ory	
	Theoretical Mechanical Engineering: Specialisation Aircra	aft Systems Engineering: Elective Cor	mpulsory	

Course L0844: Aircraft Desig	n II (Conceptual Design of Rotorcraft, special operations aircraft, UAV)
Тур	Lecture
Hrs/wk	3
СР	3
Workload in Hours	Independent Study Time 48, Study Time in Lecture 42
Lecturer	Prof. Volker Gollnick, Dr. Bernd Liebhardt, Jens Thöben
Language	DE/EN
Cycle	SoSe
Content	Design of supersonic civil aircraft Principles of high performance and special operations aircraft design Principles of Rotorcraft Design Principles of Unmanned Air Systems design, air taxis, electric aircraft
Literature	Gareth Padfield: Helicopter Flight Dynamics, butterworth ltd. Raymond Prouty: Helicopter Performance Stability and Control, Krieger Publ. Klaus Hünecke: Das Kampfflugzeug von Heute, Motorbuch Verlag Jay Gundelach: Designing Unmanned Aircraft Systems - Configurative Approach, AIAA

Course L0847: Aircraft Desig	ourse L0847: Aircraft Design II (Conceptual Design of Rotorcraft, special operations aircraft, UAV)	
Тур	Recitation Section (large)	
Hrs/wk	2	
СР	3	
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28	
Lecturer	Prof. Volker Gollnick, Dr. Bernd Liebhardt, Jens Thöben	
Language	DE/EN	
Cycle	SoSe	
Content	See interlocking course	
Literature	See interlocking course	

Title Typ Letters Typ Typ Letters Typ Typ Letters Typ Typ Letters Typ Typ Typ	Module M1343: Struc	ture and properties of fibre-polymer-	composites		
Sincuture and progenties of fiber polymer composites (L1984) Intrustume and progenties of fiber polymer composites (L1984) Recommended Previous Bascisc commended Previous Bascisc chemistry / physics / materials science Recommended Previous Bascisc chemistry / physics / materials science Recommended Previous Bascisc chemistry / physics / materials science Recommended Previous Bascisc chemistry / physics / materials science Recommended Previous Bascisc chemistry / physics / materials science Beducational Objectives Recommended Previous Bascisc chemistry / physics / materials science Recommended Previous Bascisc chemistry / physics / materials science Recommended Previous Bascisc chemistry / physics / materials science Recommended Previous Bascisc chemistry / physics / materials science Brofessional Competence Knowledge Budents can use the knowledge of fiber-reinforced composites (FRIP) and its constituents to play (fiber / matrix) and define the interactions of chemical structure of the polymers, their processing with the different fiber types, including to explanation the interactions of chemical structure of the polymers, their processing with the different fiber types, including to explanation their interactions of chemical structure of the polymers, their processing with the different fiber types, including to explanation their interactions are explained the complex relationships structure-property relationship and the interactions of chemical structure of the polymers, their processing with the different fiber types, including to explanation their interactionships and structure of the polymers, their processing with the different fiber types, including to explanation their different materials. • subject of the interactionships and explanation and properties (modulus, strength) to calculate an evaluate the different materials. • approximate sizing using the network theory of the structural elements implement and evaluate. • assess possible consequences of their professional activity.	Courses				
Size and properties of fiber polymer composites (1514) Module Responsible Prof. 80do Fiedler	Title		Тур	Hrs/wk	СР
Module Responsible Prof. Bod Fielder Module Responsible Prof. Bod Fielder Mission Requirements (None) Recommended Previous Basics: chemistry physics / materials science Recommended Previous Basics: chemistry physics / materials science Foressional Competence Knowledge Educational Objectives Butdents can use the knowledge of fiber-reinforced composites (FIPP) and its constituents to play (fiber / matrix) and define the interactions or chemical structure of the polymers, their processing with the different fiber types, including to explain the interactions of chemical structure of the polymers, their processing with the different fiber types, including to explain the interactions of chemical structure of the polymers, their processing with the different fiber types, including to explain the interactions of chemical structure of the polymers, their processing with the different fiber types, including to explain elighboring contexts (e.g. sustainability, environmental protection). Skillor Skillor Skillor Students are capable of using standarded calculation methods in a given context to mechanical properties (modulus, strength) to calculate an evaluate the different materials. approximate sizing using the network theory of the structural elements implement and evaluate. activities are able to assess their own strengths and weaknesses. assess their own s	Structure and properties of fibre-po	lymer-composites (L1894)	Lecture	2	3
Module Responsible Admission Requirements None Recommended Previous Recommended Previous Recommended Previous Selection of Dejectives After taking part successfully, students have reached the following learning results Professional Competence Knowledge Students can use the knowledge of fiber-reinforced composites (FRP) and its constituents to play (fiber / matrix) and define the cessary testing and analysis. 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). Skillis Students are capable of • using standardized calculation methods in a given context to mechanical properties (modulus, strength) to calculate an 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. Personal Competence Social Competence					
Admission Requirements Recommended Previous Basics: chemistry / physics / materials science Knowledge Educational Objectives Knowledge After taking part successfully, students have reached the following learning results 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 explanelly properties of chemical structure of the polymers, their processing with the different fiber types, including to explanelly properties of the interactions of chemical structure of the polymers, their processing with the different fiber types, including to explanelly properties of the interactions of chemical structure of the polymers, their processing with the different fiber types, including to explanelly processing with the different fiber types, including to explanelly processing with the different fiber types, including to explanelly processing with the different fiber types, including to explanelly processing with the different fiber types, including to explanelly processing with the different fiber types, including to explanelly processing with the different fiber types, including to explanelly processing with the different fiber types, including to explanelly processing with the different fiber types, including to explanelly processing with the different fiber types, including to explanelly processing with the different fiber types, including to explanelly processing with the different fiber types, including to explanelly processing with the different fiber types, including to explanelly processing with the different fiber types, including to explanelly processing with the different fiber types, including to explanelly processing with the different fiber types, including to explanelly processing with the different fiber types, including to explanelly processing with the different fiber types, including to explanelly processing with the different fiber types, including to explane			Recitation Section (large)	1	1
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evaluate the different materials.	Skills	Students are capable of			
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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	Following Curricula	Aircraft Systems Engineering: Core Qualification: Electi	ve Compulsory		
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Product Development, Materials and Production: Specialisation Materials: Compulsory		·	·	ompulsory	
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Panawahla Engraios: Spacialization Riconardy Systems: Flactive 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		* '			

Course L1894: Structure and	properties of fibre-polymer-composites
Тур	Lecture
Hrs/wk	2
СР	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Prof. Bodo Fiedler
Language	EN
Cycle	SoSe
Content	- 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
Literature	Daniel, Ishai: Engineering Mechanics of Composites Materials, Oxford University Press
	Mallick: Fibre-Reinforced Composites, Marcel Deckker, New York
	Manick: Fibre-Reinforced Composites, Marcel Deckker, New York

Course L2614: Structure and	urse L2614: Structure and properties of fibre-polymer-composites	
Тур	Project-/problem-based Learning	
Hrs/wk	2	
СР	2	
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28	
Lecturer	Prof. Bodo Fiedler	
Language	DE/EN	
Cycle	SoSe	
Content		
Literature		

Course L2613: Structure and	Course L2613: Structure and properties of fibre-polymer-composites	
Тур	Recitation Section (large)	
Hrs/wk	1	
СР	1	
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14	
Lecturer	Prof. Bodo Fiedler	
Language	EN	
Cycle	SoSe	
Content		
Literature		

Module M1344: Proce	essing of fibre-polymer-composites			
Courses				
Title		Тур	Hrs/wk	СР
Processing of fibre-polymer-compos	sites (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 in the basics of chemistry / physics / materi	als science		
Knowledge				
Educational Objectives	After taking part successfully, students have reached the	ne following learning results		
Professional Competence				
Knowledge	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.			
Skills	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 relative the interactions of chemical structure of the polym	ers, their processing with the different	fiber types,	including to explain
	neighboring contexts (e.g. sustainability, environmenta	l protection).		
Personal Competence				
Social Competence Autonomy	Students are able to cooperate in small, mixed-subject context of civil engineering. They are able to effective audience. Students have the ability to develop alterna discuss advantages as well as drawbacks. Students are capable of independently solving mechagaps in as well as extent their knowledge using the lite	y present and explain their results alone tive approaches to an engineering proble inical engineering problems using provide	or in groups i m independe ed literature.	in front of a qualified intly or in groups and
	meaningfully extend given problems and pragmatically	solve them by means of corresponding so	olutions and c	oncepts.
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56	;		
Credit points	6			
Course achievement	None			
Examination	Written exam			
Examination duration and	90 min			
scale				
Assignment for the	Materials Science: Specialisation Engineering Materials	Elective Compulsory		
Following Curricula	Mechanical Engineering and Management: Specialisation	on Materials: Elective Compulsory		
	Product Development, Materials and Production: Specia	alisation Product Development: Elective Co	mpulsory	
	Product Development, Materials and Production: Specia	alisation Production: Elective Compulsory		
	Product Development, Materials and Production: Specia	lisation Materials: Elective Compulsory		

Course L1895: Processing of	Course L1895: Processing of fibre-polymer-composites		
Тур	Lecture		
Hrs/wk	2		
СР	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		

Course L1516: From Molecul	e to Composites Part
Тур	Project-/problem-based Learning
Hrs/wk	2
СР	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Prof. Bodo Fiedler
Language	DE/EN
Cycle	SoSe
Content	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). 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. 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"). After the test during the "customer / supplier conversation" there is a mutual feedback-talk ("lessons learned") in order to ensure the continuous improvement.
Literature	Customer Request ("Handout")

Module M1174: Autor	mation Technology and Systems			
Courses				
Title		Тур	Hrs/wk	СР
Automation Technology and System		Lecture	4	4
Automation Technology and System		Project-/problem-based Learning	1	1
Automation Technology and Syster		Recitation Section (small)	1	1
	Prof. Thorsten Schüppstuhl			
Admission Requirements	None			
	without major course assessment			
Knowledge				
Educational Objectives	After taking part successfully, students have reached the	ne following learning results		
Professional Competence				
Knowledge	Students			
	know the characteristic components of an autom	nation systems and have good understand	ling of their int	teraction
	know methods for a systematical analysis of auto-		ing or aren in	.craction
	have special competences in industrial robot bas			
Skills	Students are able to			
	analyze complex Automation tasks			
	develop application based concepts and solution	S		
	design subsystems and integrate into one system			
	investigate and evaluate safety of machinery			
	 create simple programs for robots and programs 	nable logic controllers		
	design of circuit for pneumatic applications	-		
Personal Competence				
Social Competence	Students are able to			
	- find solutions for automation and handling tasks in gro	oups		
	- develop solutions in a production environment with q	ualified personnel at technical level and r	epresent decis	ions.
Autonomy	Students are able to			
, , ,				
	analyze automation tasks independently			
	generate programs for robots and programmable			
	develop solutions for practice oriented tasks of a			
	design safety concepts for automation application			
	assess consequences of their professional action	is and responsibilities		
Workload in Hours	Independent Study Time 96, Study Time in Lecture 84			
Credit points				
Course achievement				
	Written exam			
Examination duration and				
scale	120 11111			
	International Management and Engineering: Specialisal	tion II Product Development and Producti	on: Flective Cr	mnulsory
•	Product Development, Materials and Production: Specialisate	·		лприізої у
i onowing curricula	Product Development, Materials and Production: Special Product Development, Materials and Production: Special Production: Spec	·	mpuisoi y	
	Product Development, Materials and Production: Special			
	Theoretical Mechanical Engineering: Specialisation Production	• •	e Compulsory	
		sve.ope a./a i rodaectori. Electiv	- 50pai501y	

Course L2329: Automation T	urse L2329: Automation Technology and Systems	
Тур	Lecture	
Hrs/wk	4	
СР	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		
Тур	Project-/problem-based Learning	
Hrs/wk	1	
СР	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 T	Course L2330: Automation Technology and Systems		
Тур	Recitation Section (small)		
Hrs/wk	1		
СР	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: Robot	tics					
Courses						
Title				Тур	Hrs/wk	СР
Robotics: Modelling and Control (L0	168)			Integrated Lecture	4	4
Robotics: Modelling and Control (L1	.305)			Project-/problem-based Learning	2	2
Module Responsible	Dr. Martin Gomse					
Admission Requirements	None					
Recommended Previous	Fundamentals of elect	rical engineering				
Knowledge	Broad knowledge of m	echanics				
	Broad knowledge of fr	centanies				
	Fundamentals of conti	rol theory				
Educational Objectives	After taking part succe	essfully, students have re	eached the following	ng learning results		
Professional Competence						
Knowledge	Students are able to d	escribe fundamental pro	perties of robots a	and solution approaches for multi	iple problems in	robotics.
Skills	Students are able to d	erive and solve equation	s of motion for va	rious manipulators.		
	Students can generate trajectories in various coordinate systems.					
	Students can design li	Students can design linear and partially nonlinear controllers for robotic manipulators.				
Personal Competence						
-	Students are able to w	ork goal-oriented in sma	Il mixed aroups.			
*	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	Indopondent Study Tir	Independent Study Time 96, Study Time in Lecture 84				
Credit points	6	ne 90, Study Time in Lec	ture 64			
Course achievement	Compulsory Bonus	Form	Description			
Course achievement	Yes None	Subject theoretical		n PBL-Einheiten sowie Erreic	hen des Gesa	amtziels und der
		practical work	jeweiligen Se	ssion-Ziele		
Examination	Written exam					
Examination duration and	120 min					
scale						
Assignment for the	Aircraft Systems Engir	neering: Core Qualificatio	n: Elective Compu	ilsory		
Following Curricula	_			duct Development and Production	on: Elective Con	npulsory
	_			chatronics: Elective Compulsory		
	_	ng and Management: Cor	e Qualification: Co	ompulsory		
		Materials and Bradustia	a. Cassis!!+!- 5	reduct Davidons Flort 0	· manulaa · · ·	
	· ·		•	roduct Development: Elective Co	mpulsory	
				roduction: Elective Compulsory laterials: Elective Compulsory		
	· ·		•	Computer Science: Elective Com	npulsory	
				lopment and Production: Elective		
		5gp				

Course L0168: Robotics: Mod	lelling and Control
Тур	Integrated Lecture
Hrs/wk	4
СР	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		
Тур	Project-/problem-based Learning	
Hrs/wk	2	
СР	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	

FIOUUCLIOII				
Module M0771: Flight	t Physics			
Courses				
Title Aerodynamics and Flight Mechanic Flight Mechanics II (L0730)	s I (L0727)	Typ Lecture Lecture	Hrs/wk 3 2	CP 3 2
Flight Mechanics II (L0731)	T	Recitation Section (large)	1	1
Module Responsible				
Admission Requirements	None			
Recommended Previous Knowledge	Mathematics Mechanics Thermodynamics Aviation			
Educational Objectives	After taking part successfully, students have reached th	e following learning results		
	Students are able to Describe the fundamental equations of aerodynal Explain the principles of wings and profiles Explain the aircraft equations of motion Evaluate aircraft performance and stability Describe the dynamics of the longitudinal and lat Describe methods of flight simulation and airborn	eral motion	e and frictional flo	w
	Perform flight mechanic simulations Derive flight mechanic relations from virtual and	real flight test data		
Personal Competence	Children and all the			
	Students are able to: Perform simulations in groups and discuss results Evaluate flight test data in groups, discuss and process are able to: Process teaching content independently Prepare, work out and process simulation models Apply teaching content on virtual and real flight to	resent the results		
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	1	on II. Aviation Systems: Elective Com lisation Product Development: Electiv lisation Production: Elective Compulso lisation Materials: Elective Compulsor	e Compulsory ory	

Course L0727: Aerodynamics	s and Flight Mechanics I
Тур	Lecture
Hrs/wk	3
СР	3
Workload in Hours	Independent Study Time 48, Study Time in Lecture 42
Lecturer	Prof. Frank Thielecke, Dr. Ralf Heinrich
Language	DE
Cycle	WiSe
Content	 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	 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 Mechan	ics II
Тур	Lecture
Hrs/wk	2
СР	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Prof. Frank Thielecke
Language	DE
Cycle	SoSe
Content	 stationary asymmetric flight dynamics of lateral movement methods of flight simulation eyperimental methods of flight mechanics model validation using system identification wind tunnel techniques
Literature	 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

ourse L0731: Flight Mechanics II		
Тур	Recitation Section (large)	
Hrs/wk	1	
СР	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: Produ	ict Planning				
Module Mod13. 1 Tout	ice i idiiiiig				
Courses					
Title			Тур	Hrs/wk	СР
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	Good basic-knowledge of Business Administra	tion			
Knowledge					
Educational Objectives	After taking part successfully, students have r	eached the following	ng learning results		
Professional Competence					
Knowledge	Students will gain insights into:				
	Product Planning				
	Process				
	Methods				
	Design thinking				
	 Process 				
	 Methods 				
	 User integration 				
Skills	Students will gain deep insights into:				
	Product Planning				
	Process-related aspects				
	Organisational-related aspects				
	 Human-Ressource related aspect 	ts			
	 Working-tools, methods and inst 	ruments			
Personal Competence					
Social Competence					
Social Competence	 Interact within a team 				
	 Raise awareness for globabl issues 				
Autonomy					
Autonomy	 Gain access to knowledge sources 				
	 Interpret complex cases 				
	 Develop presentation skills 				
Workload in Hours	Independent Study Time 110, Study Time in L	ecture 70			
Credit points	6	ccuic 70			
Course achievement	Compulsory Bonus Form	Description			
	Yes 20 % Subject theoretical	and			
	practical work				
Examination	Written exam				
Examination duration and	90 minutes				
scale					
Assignment for the	Global Innovation Management: Core Qualifica	ation: Compulsory	<u> </u>		
Following Curricula	International Management and Engineering: S	pecialisation I. Elec	ctives Management: Elective Cor	npulsory	
	Mechanical Engineering and Management: Sp			,	
		_		mnulce":	
	Product Development, Materials and Production		·	inpuisory	
	Product Development, Materials and Production		' '		
	Product Development, Materials and Production	on: Specialisation M	laterials: Elective Compulsory		
	Theoretical Mechanical Engineering: Specialis	ation Product Deve	lopment and Production: Elective	e Compulsory	

Course L0851: Product Plann	ing
Тур	Lecture
Hrs/wk	3
СР	3
Workload in Hours	Independent Study Time 48, Study Time in Lecture 42
Lecturer	Prof. Cornelius Herstatt
Language	EN
Cycle	WiSe
Content	Product Planning Process
	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.: 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 Voluntary presentations in the third hour (articles / case studies) Guest lectures by researchers Lecture on Sustainability with frequent reference to current research Permanent reference to current research Examination: 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.
1144	History K. Caningary C. Dyadyah Daring and Dayslanmanh. 2nd Edition McCray Hill 2010
Literature	Ulrich, K./Eppinger, S.: Product Design and Development, 2nd. Edition, McGraw-Hill 2010

Course L0853: Product Plann	Course L0853: Product Planning Seminar		
Тур	Project-/problem-based Learning		
Hrs/wk	2		
СР	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 choosen independently.		
Literature	See lecture information "Product Planning".		

Courses				
Title		Тур	Hrs/wk	СР
Integrated Pollution Control (L0502 Health, Safety and Environmental I		Lecture Lecture	2	2
Health, Safety and Environmental I		Recitation Section (small)	1	1
Module Responsible		recitation section (smail)		
Admission Requirements	·			
Recommended Previous	None			
Knowledge	 Good knowledge in Technologies for Environment 	ental Protection (end-of-pipe, integrated	solutions)	
imomougo	 Good knowledge of the relevant Environmental 	Legislation		
	Basic knowledge of instruments for Environment	ntal Assessment		
Educational Objectives	After taking part successfully, students have reached	the following learning results		
Professional Competence	Anter taking part succession, y stadents have reactive	the rono ming rearming results		
•	The students are able to describe the basics of reg	gulations, economic instruments, volun	tarv initiatives. f	undamentals of H
	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. Th			
	carry out innovative technical solutions, remediation			
	approaches in the full range of problems in different i			
Skills	Students are able to assess current problems and sit	tuations in the field of environmental p	rotection. They o	an consider the be
	available techniques and to plan and suggest concrete actions in a company- or branch-specific context. By this means they ca			
	solve problems on a technical, administrative and legislative level.			
Personal Competence				
Social Competence	The students can work together in international group	os.		
Autonomy	Students are able to organize their work flow to prep	pare themselves for presentations and	contributions to t	he discussions. The
	can acquire appropriate knowledge by making enquir	ies independently.		
Workload in Hours		70		
Credit points				
Course achievement				
	Written exam			
Examination duration and scale	90 min			
Assignment for the	Civil Engineering: Specialisation Water and Traffic: Ele	ective Compulsory		
Following Curricula			anagement and	Controlling: Flecti
	Compulsory	ionne rrocess Engineering, roces rie	ageee aa	controlling. Electi
	Environmental Engineering: Core Qualification: Comp	ulsory		
	Joint European Master in Environmental Studies - Citie	•	er: Elective Com	nulsory
	Joint European Master in Environmental Studies - Citie	• •		•
Product Development, Materials and Production: Specialisation Product Develop				.p.0.301 y
	Product Development, Materials and Production: Spec			
	Product Development, Materials and Production: Spec			
	Process Engineering: Specialisation Environmental Pro	·	-	
	Water and Environmental Engineering: Specialisation			
	Water and Environmental Engineering: Specialisation Water and Environmental Engineering: Specialisation			
	**acci and Environmental Engineering. Specialisation	Cities. Compulsory		

Course L0502: Integrated Pollution Control		
Тур	Lecture	
Hrs/wk	2	
СР	2	
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28	
Lecturer	Prof. Ralf Otterpohl	
Language	EN	
Cycle	WiSe	
Content	The lecture focusses on:	
	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	Förstner, Ulrich (1998): Integrated Pollution Control, Springer-Verlag Berlin Heidelberg, ISBN 978-3-642-80313-0 Shen, Thomas T. (1999): Industrial Pollution Prevention, Springer-Verlag Berlin Heidelberg, ISBN 978-3-540-65208-3	

Course L0387: Health, Safety	y and Environmental Management
Тур	Lecture
Hrs/wk	2
СР	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Hans-Joachim Nau
Language	EN
Cycle	WiSe
Content	 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	C. Stephan: Industrial Health, Safety and Environmental Management, MV-Verlag, Münster, 2007/2012 (can be found in the library under GTG 315) Exercises can be downloaded from StudIP

Course L0388: Health, Safety	Course L0388: Health, Safety and Environmental Management		
Тур	Recitation Section (small)		
Hrs/wk	1		
СР	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: Susta	inability and Risk Manageme	nt		
Courses				
Title		Тур	Hrs/wk	СР
Safety, Reliability and Risk Assessn		Seminar	2	3
Environment and Sustainability (L0		Lecture	2	3
Module Responsible				
Admission Requirements				
Recommended Previous	none			
Knowledge				
Educational Objectives	After taking part successfully, students hav	e reached the following learning results		
Professional Competence				
Knowledge		niques and to give an overview for the field	of safety and risk as	sessment as well as
	environmental and sustainable engineering	, in detail:		
	 basics in safety and reliability of tech 	nnical facilities		
	safety and reliability analysis method	ds		
	 risk assessment 			
	 Production and usage of bio-char 			
	 energy production and supply 			
	 sustainable product design 			
Skills	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 co	oncepts.	
Personal Competence				
Social Competence				
,	Students can gain knowledge of the subje	ct area from given sources and transform it	to new questions Fu	rthermore they can
riaconomy		rch-oriented duties in for risk management ar		
	the potential social, economic and cultural		,	
	·	·		
Workload in Hours	Independent Study Time 124, Study Time in	n Lecture 56		
Credit points	6			
Course achievement	None			
Examination	Written elaboration			
Examination duration and	Elaboration and presentation (45 minutes in	n groups)		
scale				
Assignment for the	Civil Engineering: Core Qualification: Comp	ulsory		
Following Curricula		- Bioeconomic Process Engineering, Focus	Management and	Controlling: Elective
	Compulsory			
		: Specialisation II. Civil Engineering: Elective (
	·	ction: Specialisation Product Development: Ele		
	·	ction: Specialisation Production: Elective Comp	•	
		ction: Specialisation Materials: Elective Compu	usory	
	Water and Environmental Engineering: Core	e Quanneacion: Compuisory		

Course L1145: Safety, Reliab	ility and Risk Assessment			
Тур	eminar			
Hrs/wk	2			
СР	3			
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28			
Lecturer	Dr. Marco Ritzkowski			
Language	DE			
Cycle	WiSe			
	An introduction in safety and risk assessment is given and some typical problems of structural and environmental engineering are treated: • basics in safety and reliability of technical facilities • safety and reliability analysis methods • risk assessment • practical examples and excursions • discussions and presentations			
Literature	- Vorlesungsunterlagen - Schneider, J., Schlatter, H.P.: Sicherheit und Zuverlässigkeit im Bauwesen. www.risksafety.ch/files/ sicherheit_ und_zuverlaessigkeit.pdf			

Course L0319: Environment	and Sustainability
Тур	Lecture
Hrs/wk	2
СР	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Prof. Kerstin Kuchta
Language	EN
Cycle	WiSe
Content	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.
	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
	Recycling of Wind Turbines
	Alternative Mobility
	Disposal of Nuclear Wastes
	Waste2Energy
	Offshore Wind energy
Literature	Wird in der Veranstaltung bekannt gegeben.

Module M1024: Metho	ods of Integrated Product Development			
Courses				
Title		Тур	Hrs/wk	СР
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	Basic knowledge of Integrated product development and app	ying CAE systems		
Knowledge				
Educational Objectives	After taking part successfully, students have reached the follo	owing learning results		
Professional Competence				
Knowledge	After passing the module students are able to:			
	explain technical terms of design methodology,			
	describe essential elements of construction managements	ent,		
	describe current problems and the current state of resort	earch of integrated product develop	ment.	
Skills	After passing the module students are able to:			
	 select and apply proper construction methods for nor conditions, 	n-standardized solutions of problem	is as well as ac	dapt new boundary
	solve product development problems with the assistance of a workshop based approach,			
	choose and execute appropriate moderation technique	S.		
Personal Competence	After massing the mandale students are able to			
Social Competence	After passing the module students are able to:			
	 prepare and lead team meetings and moderation proce 	esses,		
	 work in teams on complex tasks, 			
	represent problems and solutions and advance ideas.			
Autonomy	After passing the module students are able to:			
	 give a structured feedback and accept a critical feedba 	ck,		
	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	30 Minuten			
scale				
Assignment for the	Aircraft Systems Engineering: Core Qualification: Elective Cor	npulsory		
Following Curricula	International Management and Engineering: Specialisation II.	Product Development and Production	on: Elective Cor	npulsory
	Mechatronics: Specialisation System Design: Elective Compul	sory		
	Product Development, Materials and Production: Specialisatio	n Product Development: Compulsor	У	
	Product Development, Materials and Production: Specialisatio	n Production: Elective Compulsory		
	Product Development, Materials and Production: Specialisatio	n Materials: Elective Compulsory		
	Theoretical Mechanical Engineering: Specialisation Product De	evelopment and Production: Elective	e Compulsory	

Production"		
Course L1254: Integrated Pr	oduct Development II	
Тур	Lecture	
Hrs/wk	3	
СР	3	
Workload in Hours	Independent Study Time 48, Study Time in Lecture 42	
Lecturer	Prof. Dieter Krause	
Language	DE	
Cycle	WiSe	
Content	Lecture	
	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.	
	Topics of the course include in particular:	
	Methods of product development,	
	Presentation techniques,	
	Industrial Design,	
	Design for variety	
	Modularization methods,	
	Design catalogs,	
	Adapted QFD matrix,	
	Systematic material selection,	
	Assembly oriented design,	
	Construction management	
	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, This is the second of the	
	Technical Supply Chain Management.	
	Exercise (PBL)	
	In the exercise the content presented in the lecture "Integrated Product Development II" and methods of product development and design management will be enhanced.	
	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.	
Literature		
	Andreasen, M.M., Design for Assembly, Berlin, Springer 1985. Ashby M. F. Materials Selection in Machanical Design, München, Spektrum 2007.	
	 Ashby, M. F.: Materials Selection in Mechanical Design, München, Spektrum 2007. Beckmann, H.: Supply Chain Management, Berlin, Springer 2004. 	
	 Beckmann, H.: Supply Chain Management, Benin, 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,	

ourse L1255: Integrated Product Development II		
Тур	Project-/problem-based Learning	
Hrs/wk	2	
СР	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	

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Module M1025: Fluidi	cs			
Courses				
Title Fluidics (L1256) Fluidics (L1371)		Typ Lecture Project-/problem-based Learning	Hrs/wk 2 1	CP 3 2
Fluidics (L1257)	D (D)	Recitation Section (large)	1	1
Module Responsible	Prof. Dieter Krause			
	None Good knowledge of mechanics (stereo statics, elastosta engineering design	tics, hydrostatics, kinematics and	kinetics), flu	id mechanics, and
Educational Objectives	After taking part successfully, students have reached the foll-	owing learning results		
Professional Competence Knowledge	After passing the module students are able to explain structures and functionalities of hydrostatic, preservation of hydraulic components in hydrostatic explain open and closed loop control of hydraulic systems. describe functioning and applications of hydrodynamic and aggregates in plant technology.	draulic systems, ems,		s centrifugal pumps
Skills	 After passing the module students are able to 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 Social Competence	After passing the module students are able to discuss and present functional context in groups, organise teamwork autonomously.			
Autonomy	After passing the module students are able to obtain necessary knowledge for the simulation.			
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56			
Credit points	6			
Course achievement		n hydrostatischer Systeme		
Examination	Written exam			
Examination duration and scale Assignment for the Following Curricula	International Management and Engineering: Specialisation II.	Product Development and Production	on: Elective Co	mpulsory
	Product Development, Materials and Production: Specialisatic Product Development, Materials and Production: Specialisatic Theoretical Mechanical Engineering: Specialisation Product D	on Materials: Elective Compulsory	e Compulsory	

Production"	
Course L1256: Fluidics	
Тур	Lecture
Hrs/wk	2
СР	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
	Prof. Dieter Krause
Language	
Cycle	
Content	Lecture
	Hydrostatics
	physical fundamentals
	hydraulic fluids
	hydrostatic machines .
	• valves
	• components
	hydrostatic transmissions
	examples from industry
	Pneumatics
	generation of compressed air
	pneumatic motors
	Examples of use
	Hydrodynamics
	physical fundamentals
	hydraulic continous-flow machines
	hydrodynamic transmissions
	interoperation of motor and transmission
	Exercise
	Exercise
	Hydrostatics
	and the and design of hydrolical surveys
	reading and design of hydraulic diagrams disconsisting of hydraulic treation and weeking delivers
	dimensioning of hydrostatic traction and working drives
	performance calculation
	Hydrodynamics
	calculation / dimensioning of hydrodynamic torque converters
	calculation / dimensioning of centrifugal pumps
	creating and reading of characteristic curves of pumps and systems
	Field trip
	field trip to a regional company from the hydraulic industry.
	Exercise
	Numerical simulation of hydrostatic systems
	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	Bücher
Literature	DUCHE!
	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, KH.: Dubbel - Taschenbuch für den Maschinenbau, Springer-Verlag, Berlin, aktuelle Auflage
	Skrint zur Vorlasung
	Skript zur Vorlesung

Course L1371: Fluidics	
Тур	Project-/problem-based Learning
Hrs/wk	1
СР	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	
Тур	Recitation Section (large)
Hrs/wk	1
СР	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

Production"				
Module M1155: Aircra	aft Cabin Systems			
Courses				
Title		Тур	Hrs/wk	СР
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	Basic knowledge in:			
Knowledge	Mathematics			
	Mechanics			
	Thermodynamics			
	Electrical Engineering			
	Control Systems			
Educational Objectives	After taking part successfully, students have reached the foll	lowing learning results		
Professional Competence	,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,			
•	Students are able to:			
	describe cabin operations, equipment in the cabin and cab	in Systems		
	explain the functional and non-functional requirements for	•		
	elucidate the necessity of cabin operating systems and em			
	assess the challenges human factors integration in a cabin			
Skills	Students are able to:			
	design a cabin layout for a given business model of an Airli	ine		
	design cabin systems for safe operations			
	 design emergency systems for safe man-machine interacti solve comfort needs and entertainment requirements in th 			
	solve conflort fleeds and entertainment requirements in th	e cabiii		
Personal Competence				
Social Competence	Students are able to:			
	comprehend existing system solutions and explain them or	n the basis of existing requireme	nts	
	discuss with experts in technical language			
	explain system functions			
	classify the criticality of functions			
	describe systems as is			
Autonomy	Students are able to:			
,	independently reflect on lecture content and expert preser	ntations		
	independently develop more in-depth content			
	recognize further areas of knowledge			
Workload in Hours				
Credit points	6			
Course achievement				
Examination	Written exam			
Examination duration and	120 Minutes			
scale				
Assignment for the	Electrical Engineering: Specialisation Control and Power Syst	ems Engineering: Elective Comp	ulsory	
Following Curricula	Energy Systems: Specialisation Energy Systems: Elective Co	mpulsory		
	Aircraft Systems Engineering: Core Qualification: Compulsory	/		
	International Management and Engineering: Specialisation II	. Aviation Systems: Elective Com	pulsory	
	Product Development, Materials and Production: Specialisati			
	Product Development, Materials and Production: Specialisation			
	Product Development, Materials and Production: Specialisati			
	Theoretical Mechanical Engineering: Specialisation Aircraft S	ystems Engineering: Elective Cor	npulsory	

Course L1545: Aircraft Cabin	Systems
Тур	Lecture
Hrs/wk	3
СР	4
Workload in Hours	Independent Study Time 78, Study Time in Lecture 42
Lecturer	Prof. Ralf God
Language	DE
Cycle	WiSe
Content	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.
	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: 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	- Skript zur Vorlesung - Jenkinson, L.R., Simpkin, P., Rhodes, D.: Civil Jet Aircraft Design. London: Arnold, 1999 - Rossow, CC., 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	
Тур	Recitation Section (large)
Hrs/wk	1
СР	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 M1342: Polyn	ieis			
Courses				
Title		Тур	Hrs/wk	СР
Structure and Properties of Polyme		Lecture	2	3
Processing and design with polyme	rs (L1892)	Lecture	2	3
Module Responsible	Dr. Hans Wittich			
Admission Requirements	None			
Recommended Previous	Basics: chemistry / physics / material science	е		
Knowledge				
Educational Objectives	After taking part successfully, students have	reached the following learning results		
Professional Competence				
Knowledge	Students can use the knowledge of plastics a	and define the necessary testing and analy	sis.	
	They can explain the complex relationships s	structure-property relationship and		
	the interactions of chemical structure of the	polymers, including to explain neighboring	contexts (e.g. sustaina	bility, environmenta
	protection).			
Skills	Students are capable of			
	 using standardized calculation methods evaluate the different materials. 	in a given context to mechanical prope	rties (modulus, streng	th) to calculate and
	- selecting appropriate solutions for mechanical recycling problems and sizing example stiffness, corrosion resistance.			
Personal Competence				
Social Competence	Students can			
	- arrive at funded work results in heterogenius groups and document them.			
	- provide appropriate feedback and handle feedback on their own performance constructively.			
Autorom	Charles have a his ha			
Autonomy	Students are able to			
	- assess their own strengths and weaknesses	5.		
	- assess their own state of learning in specific	c terms and to define further work steps or	n this basis.	
	access possible consequences of their profe	assignal activity		
	- assess possible consequences of their profe	essional 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	180 min			
scale				
Assignment for the	Materials Science: Specialisation Engineering	Materials: Elective Compulsory		
Following Curricula	Biomedical Engineering: Specialisation Impla	ants and Endoprostheses: Compulsory		
	Biomedical Engineering: Specialisation Artific	· ·	, ,	
	Biomedical Engineering: Specialisation Mana			
	Biomedical Engineering: Specialisation Medic			
	Product Development, Materials and Product	•	. ,	
	Product Development, Materials and Product			
	Product Development, Materials and Product	·	, ,	
	Theoretical Mechanical Engineering: Speciali	sation Materials Science: Elective Compuls	ы у	

Course L0389: Structure and	Properties of Polymers
Тур	Lecture
Hrs/wk	2
СР	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Dr. Hans Wittich
Language	DE
Cycle	WiSe
Content	- Structure and properties of polymers
	- Structure of macromolecules
	Constitution, Configuration, Conformation, Bonds, Synthesis, Molecular weilight distribution
	- Morphology
	amorph, crystalline, blends
	- Properties
	Elasticity, plasticity, viscoelacity
	- Thermal properties
	- Electrical properties
	- Theoretical modelling
	- Applications
Literature	Ehrenstein: Polymer-Werkstoffe, Carl Hanser Verlag

Course L1892: Processing an	Course L1892: Processing and design with polymers		
Тур	Lecture		
Hrs/wk	2		
СР	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	Manufacturing of Polymers: General Properties; Calendering; Extrusion; Injection Moulding; Thermoforming, Foaming; Joining		
	Designing with Polymers: Materials Selection; Structural Design; Dimensioning		
Literature	Osswald, Menges: Materials Science of Polymers for Engineers, Hanser Verlag		
	Crawford: Plastics engineering, Pergamon Press		
	Michaeli: Einführung in die Kunststoffverarbeitung, Hanser Verlag		
	Konstruieren mit Kunststoffen, Gunter Erhard , Hanser Verlag		

Module M1170: Pheno	omena and Methods in Materials	Science			
Courses					
Title			Тур	Hrs/wk	СР
Experimental Methods for the Char	acterization of Materials (L1580)		Lecture	2	2
Phase equilibria and transformation	ns (L1579)		Lecture	2	2
Übung zu Phänomene und Methode	en der Materialwissenschaft (L2991)		Recitation Section (large)	2	2
Module Responsible	Prof. Jörg Weißmüller				
Admission Requirements	None				
Recommended Previous	Basic knowledge in Materials Science, e.g. Werks	toffwissenschaf	t I/II		
Knowledge					
Educational Objectives	After taking part successfully, students have read	thed the following	ng learning results		
Professional Competence					
Knowledge	The students will be able to explain the propertie	es of advanced	materials along with their ap	plications in tech	nology, in particular
	metallic, ceramic, polymeric, semiconductor, mod	dern composite	materials (biomaterials) and i	nanomaterials.	
Skills	The students will be able to select material co				
	materials considering architectural principles fr			3	
	modern materials science, which enables them to select optimum materials combinations depending on the technical				
	applications.				
Personal Competence					
-	The students are able to present solutions to specialists and to develop ideas further.				
Boolar competence	The stadents are able to present solutions to spe	cianoto ana to a	evelop lacas laralien		
Autonomy	The students are able to				
Autonomy	The students are able to				
	 assess their own strengths and weaknesse 	es.			
	 gather new necessary expertise by their or 	wn.			
Workload in Hours	Independent Chiefe Time OC Chiefe Time in Leatur	04			
Credit points	Independent Study Time 96, Study Time in Lectu	16 04			
Course achievement					
Examination					
Examination duration and	90 min				
scale	36 111111				
Assignment for the	International Management and Engineering: Spec	cialisation II. Pro	duct Development and Produ	ction: Elective Co	ompulsory
Following Curricula	Materials Science: Core Qualification: Compulsory		·		
_	Product Development, Materials and Production:		roduct Development: Elective	Compulsory	
	Product Development, Materials and Production:	•	·		
	Product Development, Materials and Production:	•	•	-	
	Theoretical Mechanical Engineering: Specialisation				

Course L1580: Experimental	Methods for the Characterization of Materials
Тур	Lecture
Hrs/wk	2
СР	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Prof. Shan Shi
Language	EN
Cycle	WiSe
Content	 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		
Тур	Lecture	
Hrs/wk	2	
СР	2	
Workload in Hours	Independent Study Time 32, 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	D.A. Porter, K.E. Easterling, "Phase transformations in metals and alloys", New York, CRC Press, Taylor & Francis, 2009, 3. Auflage Peter Haasen, "Physikalische Metallkunde", Springer 1994 Herbert B. Callen, "Thermodynamics and an introduction to thermostatistics", New York, NY: Wiley, 1985, 2. Auflage. Robert W. Cahn und Peter Haasen, "Physical Metallurgy", Elsevier 1996 H. Ibach, "Physics of Surfaces and Interfaces" 2006, Berlin: Springer.	

Course L2991: Übung zu Phä	ourse L2991: Übung zu Phänomene und Methoden der Materialwissenschaft	
Тур	Recitation Section (large)	
Hrs/wk	2	
СР	2	
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28	
Lecturer	Prof. Shan Shi	
Language	DE	
Cycle	WiSe	
Content		
Literature		

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	See selected module according to FSPO		
Knowledge			
Educational Objectives	After taking part successfully, students have reached the following learning results		
Professional Competence			
Knowledge	see selected module according to FSPO		
Skills	see selected module according to FSPO		
Personal Competence			
Social Competence	see selected module according to FSPO		
Autonomy	see selected module according to FSPO		
Workload in Hours	Depends on choice of courses		
Credit points	6		
Assignment for the	Product Development, Materials and Production: Specialisation Product Development: Elective Compulsory		
Following Curricula	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				
Module MU/63: Aircra	int Energy Systems			
Courses				
Title		Тур	Hrs/wk	СР
Aircraft Energy Systems (L0735)		Lecture	3	4
Aircraft Energy Systems (L0739)		Recitation Section (large)	2	2
Module Responsible	Prof. Frank Thielecke			
Admission Requirements	None			
Recommended Previous	Basic knowledge in:			
Knowledge				
	Mathematics			
	Mechanics The arrest three arrives			
	Thermodynamics Fleetrical Engineering			
	Electrical Engineering Hydraulics			
	Hydraulics Control Systems			
	Control Systems			
Educational Objectives	After taking part successfully, students have reached t	he following learning results		
Professional Competence				
Knowledge	Students are able to:			
	Describe essential components and design point	es of hydraulic plactrical and high lift s	vetome	
	Give an overview of the functionality of air conditional to the functional to t		ystems	
	Explain the need for high-lift systems such as ist			
	Assess the challenge during the design of supply			
	Assess the changing during the design of suppry	y systems of all allerate		
Skille	Students are able to:			
Skills	Students are able to.			
	Design hydraulic and electric supply systems of	aircrafts		
	 Design high-lift systems of aircrafts 			
	 Analyze the thermodynamic behaviour of air cor 	nditioning systems		
Personal Competence				
Social Competence	Students are able to:			
	a Danfarma systems design in average and present out	ad dispuse vegulte		
	 Perform system design in groups and present an 	id discuss results		
Autor	Students are able to			
Autonomy	Students are able to:			
	Reflect the contents of lectures autonomously			
Workload in Hours	Independent Study Time 110, Study Time in Lecture 70			
Credit points				
Course achievement				
Examination				
Examination duration and				
scale				
	Energy Systems: Specialisation Energy Systems: Electi	ve Compulsory		
Following Curricula	Aircraft Systems Engineering: Core Qualification: Comp	• •		
	International Management and Engineering: Specialisa		oulsorv	
	Product Development, Materials and Production: Specials			
	Product Development, Materials and Production: Special			
	Product Development, Materials and Production: Special	·	-	
	Theoretical Mechanical Engineering: Specialisation Airc			
	Theoretical Mechanical Engineering. Specialisation Airc	are systems Engineering. Elective Col	i ipaisoi y	

Course L0735: Aircraft Energy Systems		
Тур	Lecture	
Hrs/wk	3	
СР	4	
Workload in Hours	Independent Study Time 78, Study Time in Lecture 42	
Lecturer	Prof. Frank Thielecke	
Language	DE	
Cycle	WiSe	
Content	 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	 Moir, Seabridge: Aircraft Systems Green: Aircraft Hydraulic Systems Torenbek: Synthesis of Subsonic Airplane Design SAE1991: ARP; Air Conditioning Systems for Subsonic Airplanes 	

ourse L0739: Aircraft Energy Systems	
Тур	Recitation Section (large)
Hrs/wk	2
СР	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		Тур	Hrs/wk	СР
Applied Automation (L1592)		Project-/problem-based Learning	3	3
Ergonomics (L0653)		Lecture	2	3
Advanced Training Course SE-ZERT (L2739)		Project-/problem-based Learning	2	3
Elements of Integrated Production	Systems (L0927)	Project-/problem-based Learning	2	3
Development Management for Med	hatronics (L1512)	Lecture	2	3
Fatigue & Damage Tolerance (L032	.0)	Lecture	2	3
Industry 4.0 for engineers (L2012)		Lecture	2	3
Innovation and Product Manageme	nt (L2168)	Seminar	2	3
Lightweight Design Practical Cours	e (L1258)	Project-/problem-based Learning	3	3
Mechanisms, Systems and Process	es of Materials Testing (L0950)	Lecture	2	2
Microsystems Technology (L0724)	1	Lecture	2	4
Sustainable Industrial Production (I	.2863)	Lecture	2	3
Productivity Management (L0928)	1	Project-/problem-based Learning	2	2
Productivity Management (L0931)	1	Recitation Section (small)	1	1
Feedback Control in Medical Techn	ology (L0664)	Lecture	2	3
Structural Mechanics of Fibre Reinf	orced Composites (L1514)	Lecture	2	3
System Simulation (L1820)	1	Lecture	2	2
System Simulation (L1821)	1	Recitation Section (large)	1	2
Technical Design (L1513)	1	Lecture	2	3
Ceramics Technology (L0379)	1	Lecture	2	3
Materials Testing (L0949)	1	Lecture	2	2
Reliability in Engineering Dynamics	(L0176)	Lecture	2	2
Reliability in Engineering Dynamics	s (L1303)	Recitation Section (small)	1	2
Reliability of Aircraft Systems (L07-	19)	Lecture	2	3
Module Responsible	Prof. Dieter Krause			
Admission Requirements	None			
Recommended Previous	None			
Knowledge				
Educational Objectives	After taking part successfully, students have reached the following	g learning results		
Professional Competence	3,,	<i>y y</i>		
Knowledge				
Knowledge	 Students are able to express their extended knowledge an 	d discuss the connection of dif	ferent special fie	elds or application
	areas of product development, materials and production			
	 Students are qualified to connect different special fields wit 	th each other		
Skills				
	Students can apply specialized solution strategies and new			
	 Students are able to transfer learned skills to new and unkr 	nown problems and can develop	o own solution ap	oproaches
Personal Competence				
•				
Social Competence	-			
Autonomy	Students are able to develop their knowledge and skills by	autonomous election of courses		
	Stadents are usic to develop their knowledge and skills by	aatonomous election of courses		
Workload in Hours	Depends on choice of courses			
Credit points	12			
Assignment for the	Product Development, Materials and Production: Specialisation Pro	oduct Development: Elective Co	ompulsory	
Following Curricula	Product Development, Materials and Production: Specialisation Pro	•		
	Product Development, Materials and Production: Specialisation Ma	sterials: Flective Compulsors		

Course L1592: Applied Automation		
Тур	Project-/problem-based Learning	
Hrs/wk	3	
СР	3	
Workload in	Independent Study Time 48, Study Time in Lecture 42	
Hours		
Examination	Mündliche Prüfung	
Form		
Examination	30 Minuten	
duration		
and scale		
Lecturer	Prof. Thorsten Schüppstuhl	
Language	DE	
Cycle	WiSe	
Literature	-Project Based Learning -Robot Operating System -Robot structure and description -Motion description -Calibration -Accuracy John J. Craig Introduction to Robotics - Mechanics and Control ISBN: 0131236296 Pearson Education, Inc., 2005 Stefan Hesse Grundlagen der Handhabungstechnik ISBN: 3446418725 München Hanser, 2010 K. Thulasiraman and M. N. S. Swamy Graphs: Theory and Algorithms ISBN: 9781118033104 %CITAVIPICKER£9781118033104£Titel anhand dieser ISBN in Citavi-Projekt übernehmen£% John Wüey & Sons, Inc., 1992	

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

Course L2739: Advanced Training Course SE-ZERT		
Тур	Project-/problem-based Learning	
Hrs/wk	2	
СР	3	
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28	
Examination Form	Klausur	
Examination duration and	120 min	
scale		
Lecturer	Prof. Ralf God	
Language	DE	
Cycle	SoSe	
Content		
Literature	INCOSE Systems Engineering Handbuch - Ein Leitfaden für Systemlebenszyklus-Prozesse und -Aktivitäten, GfSE (Hrsg. der	
	deutschen Übersetzung), ISBN 978-3-9818805-0-2.	
	ISO/IEC 15288 System- und Software-Engineering - System-Lebenszyklus-Prozesse (Systems and Software Engineering - System	
	Life Cycle Processes).	

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

Course L1512: Development	Management for Mechatronics
Тур	Lecture
Hrs/wk	2
СР	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Examination Form	Mündliche Prüfung
Examination duration and	30 Minuten
scale	
Lecturer	NN, Dr. Johannes Nicolas Gebhardt
Language	DE
Cycle	SoSe
Content	Processes and methods of product development - from idea to market launch 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 Design of processes for product development IT systems for product development Establishment of management standards Typical types of organization
Literature	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		
Тур	Lecture	
Hrs/wk	2	
СР	3	
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28	
Examination Form	Mündliche Prüfung	
Examination duration and	45 min	
scale		
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. Kluver Academic Puplisher, Dordrecht, 2001 E. Haibach. Betriebsfestigkeit	
	Verfahren und Daten zur Bauteilberechnung. VDI-Verlag, Düsseldorf, 1989	

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

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

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 Lecturer Prof. Dieter Krause Language DE/EN Cycle SoSe Content Development of a sandwich structure made of fibre reinforced plastics • 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 • Schürmann, H., "Konstruieren mit Faser-Kunststoff-Verbunden", Springer, Berlin, 2005.	
Workload in Hours Independent Study Time 48, Study Time in Lecture 42	
Workload in Hours Examination Form Mündliche Prüfung Examination duration and scale Lecturer Prof. Dieter Krause Language DE/EN Cycle SoSe Content Development of a sandwich structure made of fibre reinforced plastics • 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	
Examination Form Mündliche Prüfung Examination duration and scale Lecturer Prof. Dieter Krause Language DE/EN Cycle SoSe Content Development of a sandwich structure made of fibre reinforced plastics • 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	
Examination duration and scale Lecturer Prof. Dieter Krause Language DE/EN Cycle SoSe Content Development of a sandwich structure made of fibre reinforced plastics • 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	
Lecturer Prof. Dieter Krause	
Language DE/EN Cycle SoSe Content Development of a sandwich structure made of fibre reinforced plastics • 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	
Language DE/EN Cycle SoSe Content Development of a sandwich structure made of fibre reinforced plastics • 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	
Cycle SoSe Content Development of a sandwich structure made of fibre reinforced plastics • 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	
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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	
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	
manufacturing of the structure in the composite lab Testing of the developed structure Concept presentation Self-organised teamwork Literature	
Concept presentation Self-organised teamwork Literature	
Self-organised teamwork Literature	
Literature	
Puck, A., "Festigkeitsanalsyse 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 Gn 2005. 	bH.

Course L0950: Mechanisms,	Systems and Processes of Materials Testing
Тур	Lecture
Hrs/wk	2
СР	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Examination Form	Klausur
Examination duration and	90 Minuten
scale	
Lecturer	Dr. Jan Oke Peters
Language	DE
Cycle	SoSe
Content	Application, analysis and discussion of basic and advanced testing methods to ensure correct selection of applicable testing procedure for investigation of part/materials deficiencies • 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	 E. Macherauch: Praktikum in Werkstoffkunde, Vieweg G. E. Dieter: Mechanical Metallurgy, McGraw-Hill R. Bürgel: Lehr- und Übungsbuch Festigkeitslehre, Vieweg R. Bürgel: Werkstoffe sícher beurteilen und richtig einsetzen, Vieweg

Course L0724: Microsystems	Technology
Тур	Lecture
Hrs/wk	2
СР	4
Workload in Hours	Independent Study Time 92, Study Time in Lecture 28
Examination Form	Mündliche Prüfung
Examination duration and	30 min
scale	
Lecturer	Prof. Hoc Khiem Trieu
Language	EN
Cycle	WiSe
Content	
Content	 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, SUB, rapid prototyping) Thermal and Radiation Sensors (temperature measurement, self-generating sensors: Seebeck effect and thermopile; modulating sensors: thermo resistor, Pt-100, spreading resistance sensor, pi junction, NTC and PTC; thermal anemometer, mass flow sensor, photometry, IR sensor: thermopile and bolometer) Mechanical Sensors (strain based and stress based principle, capacitive readout, piezoresistivity, pressure sensor: piezoresistive, capacitive 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: pelistor and thermal conductivity sensor; metal oxide semiconductor gas sensor, cambda probe, MOSFET gas sensor, ph-FET, SAW sensor, principle of biosensor, Clark electrode, enzyme electrode, DNA chip) Micro Actuators, Micr
I thoughton	M. Madau Eundamentals of Microfabrication, CDC Proce, 2002
Literature	M. Madou: Fundamentals of Microfabrication, CRC Press, 2002 N. Schwesinger: Lehrbuch Mikrosystemtechnik, Oldenbourg Verlag, 2009 T. M. Adams, R. A. Layton: Introductory MEMS, Springer, 2010 G. Gerlach; W. Dötzel: Introduction to microsystem technology, Wiley, 2008
	o. Genden, w. Doczel. Indoduction to Inicrosystem technology, whey, 2000

ourse L2863: Sustainable In	ndustrial Production
Тур	Lecture
Hrs/wk	2
СР	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Examination Form	Klausur
Examination duration and	60 min
scale	
Lecturer	Dr. Simon Markus Kothe
Language	DE
Cycle	SoSe
Content	Industrial production deals with the manufacture of physical products to satisfy human needs using various manufacturing processes that change the form and physical properties of raw materials. Manufacturing is a central driver of economic development and has a major impact on the well-being of humanity. However, the scale of current manufacturing activities results in enormous global energy and material demands that are harmful to both the environment and people. Historically, industria activities were mostly oriented towards economic constraints, while social and environmental consequences were only hardly considered. As a result, today's global consumption rates of many resources and associated emissions often exceed the natura regeneration rate of our planet. In this respect, current industrial production can mostly be described as unsustainable. This is emphasized each year by the Earth Overshoot Day, which marks the day when humanity's ecological footprint exceeds the Earth's annual regenerative capacity. This lecture aims to provide the motivation, analytical methods as well as approaches for sustainable industrial production and to clarify the influence of the production phase in relation to the raw material, use and recycling phases in the entire life cycle of products. For this, the following topics will be highlighted:
	 Motivation for sustainable production, the 17 Sustainable Development Goals (SDGs) of the UN and their relevance fo tomorrow's manufacturing; raw material vs. production phase vs. use phase vs. recycling/end-of-life phase: importance of the production phase for the environmental impact of manufactured products;
	- Typical energy- and resource-intensive processes in industrial production and innovative approaches to increase energy and resource efficiency;
	- Methodology for optimizing the energy and resource efficiency of industrial manufacturing chains with the three steps o modeling (1), evaluating (2) and improving (3);
	- Resource efficiency of industrial manufacturing value chains and its assessment using life cycle analysis (LCA);
	- Exercise: LCA analysis of a manufacturing process (thermoplastic joining of an aircraft fuselage segment) as part of a product life cycle assessment.
Literature	Litoratur
Literature	Literatur.
	- Stefan Alexander (2020): Resource efficiency in manufacturing value chains. Cham: Springer International Publishing.
	- Hauschild, Michael Z.; Rosenbaum, Ralph K.; Olsen, Stig Irving (Hg.) (2018): Life Cycle Assessment. Theory and Practice. Cham Springer International Publishing.
	- Kishita, Yusuke; Matsumoto, Mitsutaka; Inoue, Masato; Fukushige, Shinichi (2021): EcoDesign and sustainability. Singapore: Springer.
	- Schebek, Liselotte; Herrmann, Christoph; Cerdas, Felipe (2019): Progress in Life Cycle Assessment. Cham: Springer Internationa Publishing.
	- Thiede, Sebastian; Hermann, Christoph (2019): Eco-factories of the future. Cham: Springer Nature Switzerland AG.
	- Vorlesungsskript.

Course L0928: Productivity Management		
Тур	Project-/problem-based Learning	
Hrs/wk	2	
СР	2	
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28	
Examination Form	Klausur	
Examination duration and	90 Minuten	
scale		
	Prof. Hermann Lödding	
Language		
Cycle	SoSe	
Content	 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	Bokranz, R.; Landau, K.:Produktivitätsmanagement von Arbeitssystemen. Schäffer-Poeschel, Stuttgart, 2006. Takeda, H.: Das synchrone Produktionssystem: Just-in-Time für das ganze Unternehmen. 5. Aufl., mi-Wirtschaftsbuch, FinanzBuch Verlag, München, 2006. Nakajima, S.: Management der Produktionseinrichtungen (Total Productive Maintenance). Campus Verlag, New York, 1995. Shingo, S.: A Revolution in Manufacturing: The SMED System. Productivity, Inc., 1985	

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

Course L0664: Feedback Control in Medical Technology		
Тур	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	20 min	
scale		
Lecturer	Johannes Kreuzer, Christian Neuhaus	
Language	DE	
Cycle	SoSe	
Content	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 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.	
Literature	 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 L1514: Structural Mechanics of Fibre Reinforced Composites	
Тур	Lecture
Hrs/wk	2
СР	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Examination Form	Mündliche Prüfung
Examination duration and	30 min
scale	
Lecturer	Prof. Benedikt Kriegesmann
Language	EN
Cycle	WiSe
Content	Classical laminate theory
	Rules of mixture
	Failure mechanisms and criteria of composites
	Boundary value problems of isotropic and anisotropic shells
	Stability of composite structures
	Optimization of laminated composites
	Modelling composites in FEM
	Numerical multiscale analysis of textile composites
	Progressive failure analysis
Literature	 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 Simul	ation
Тур	Lecture
Hrs/wk	2
СР	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Examination Form	Mündliche Prüfung
Examination duration and	30 min
scale	
Lecturer	Dr. Stefan Wischhusen
Language	DE
Cycle	WiSe
Content	Lecture about equation-based, physical modelling using the modelling language Modelica and the free simulation tool OpenModelica. 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	 [1] Modelica Association: "Modelica Language Specification - Version 3.4", Linköping, Sweden, 2 0 1 7 [2] M. Tiller: "Modelica by Example", http://book.xogeny.com, 2014. [3] M. Otter, H. Elmqvist, et al.: "Objektorientierte Modellierung Physikalischer Systeme", at- Automatisierungstechnik (german), Teil 1 - 17, Oldenbourg Verlag, 1999 - 2000. [4] P. Fritzson: "Principles of Object-Oriented Modeling and Simulation with Modelica 3.3", Wiley-IEEE Press, New York, 2015. [5] P. Fritzson: "Introduction to Modeling and Simulation of Technical and Physical Systems with Modelica", Wiley, New York, 2011.

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

Course L1513: Technical Des	ian
	Lecture T.
Hrs/wk	2
СР	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Examination Form	Schriftliche Ausarbeitung
Examination duration and	10-15 Entwurfszeichnungen, Skizzen und ca. 5-10 A4-Dokumentationsseiten (Themen- und Entwurfsbegründung)
scale	
Lecturer	Prof. Werner Granzeier
Language	DE
Cycle	SoSe
Content	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	Literatur über technisches Produktdesign Technisches Rendering und Präsentation

Zeichnen und perspektivisches Entwerfen Literaturhinweise What is Product Design? Laura Slack RotoVision Schweiz 2006 Product Design Now Design and Scetches CollinsDesign and maomao publications Spanien 2006 Ronald B. Kemnitzer, Rendering With Markers - Definitive Techniques for Designers, Illustrators and Architects, Watson, Guptil Puplications, a division of Billboard Publications Inc., New York 1983 Creative Techniques DRAWING Barons Educational Series ISBN-13: 978-0-7641-6182-7 Joseph Ungar, Rendering In Mixed Media - Techniques for Concept Presentation for Designers and Illustrators Watson-Guptil Publication a division of Billboard Publications Inc., New York 1985 AIRWORLD Design und Architektur für die Flugreise Vitra Design Stiftung Weil am Rhein 2004 Airline Design Perter Deslius Jacek Slaski te Neues 2005 Technik und Sicherheit von Passagierflugzeugen Frank Littek Motorbuch Verlag 2003 Jetliner Cabins Jennifer Coutts Clay Cs books England 2006 **BOEING Widebodies** Michael Haenggi motorbooks international USA 2003 form - Zeitschrift für Gestaltung, Verlag form GmbH, Hofgut Ober-Berrbach, 6104 Seeheim-Jugenheim (erscheint vierteljährlich, Verlag form GmbH) design report german magasin, (erscheint monatlich) md - möbel interior design, Konradin-Verlag Robert Kohlhammer GmbH, 7022 Leinfelden-Echterdingen (erscheint monatlich) CAR STYLING, Car Styling Publishing Co. 4-8-16-11F, Kitashinjuku, Shinjuku-ku, Tokio 160, Japan (erscheint vierteljährlich in japanischer und englischer Sprache, in Hamburg erhältlich bei: Overseas Courier Service Deutschland Auto & Design, Corso Frabcia 161, 10139 Torino, Italia

Production.	
	(erscheint vierteljährlich in italienischer und englischer Sprache alle zwei
	Monate , erhältlich am HBF Hamburg
	AERO International,
	Magazin für Zivilluftfahrt
	(erscheint monatlich)
	Aircraft interior international
	Engl. magasin for Aircraft cabin interior
	(erscheint 2 monatlich)
	aerotec
	Technik- und Branchenmagazin für die Luft- und Raumfahrtindustrie

Course L0379: Ceramics Technology		
Тур	Lecture	
Hrs/wk	2	
СР	3	
Workload in Hours	Independent Study Time 62, Stu	udy Time in Lecture 28
Examination Form	Klausur	
Examination duration and	90 Minuten	
scale		
	Dr. Rolf Janßen	
Language		
Cycle		The second secon
Content	Introduction to ceramic processing with emphasis on advanced structural ceramics. The course focus predominatly on powder-based processing, e.g. "powder-metauurgical techniques and sintering (soild 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.	
	Content:	1. Introduction
	Inhalt:	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
Literature	W.D. Kingery, "Introduction to C	Ceramics", John Wiley & Sons, New York, 1975
	ASM Engineering Materials Hand	dbook Vol.4 "Ceramics and Glasses", 1991
	D.W. Richerson, "Modern Ceram	nic Engineering", Marcel Decker, New York, 1992
	Skript zur Vorlesung	

Course L0949: Materials Testing		
Тур	Lecture	
Hrs/wk	2	
СР	2	
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28	
Examination Form	Klausur	
Examination duration and	90 Minuten	
scale		
Lecturer	Dr. Jan Oke Peters	
Language	DE	
Cycle	WiSe	
Content	Application and analysis of basic mechanical as well as non-destructive testing of materials Determination elastic constants Tensile test Fatigue test (testing with constant stress, strain, or plastiv 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	E. Macherauch: Praktikum in Werkstoffkunde, Vieweg G. E. Dieter: Mechanical Metallurgy, McGraw-Hill	

Course L0176: Reliability in I	ingineering Dynamics
Тур	Lecture
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Examination Form	Klausur
Examination duration and	90 min.
scale	
Lecturer	NN
Language	EN
Cycle	SoSe SoSe
Content	Method for calculation and testing of reliability of dynamic machine systems
	Modeling System identification Simulation Processing of measurement data Damage accumulation Test planning and execution
Literature	Bertsche, B.: Reliability in Automotive and Mechanical Engineering. Springer, 2008. ISBN: 978-3-540-33969-4 Inman, Daniel J.: Engineering Vibration. Prentice Hall, 3rd Ed., 2007. ISBN-13: 978-0132281737 Dresig, H., Holzweißig, F.: Maschinendynamik, Springer Verlag, 9. Auflage, 2009. ISBN 3540876936. VDA (Hg.): Zuverlässigkeitssicherung bei Automobilherstellern und Lieferanten. Band 3 Teil 2, 3. überarbeitete Auflage, 2004. ISSN 0943-9412

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

Course L0749: Reliability of Aircraft Systems		
Тур	Lecture	
Hrs/wk	2	
СР	3	
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28	
Examination Form	Klausur	
Examination duration and	90 Minuten	
scale		
Lecturer	Prof. Frank Thielecke, Dr. Andreas Vahl, Dr. Uwe Wieczorek	
Language	DE	
Cycle	WiSe	
Content	 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 	
	- Tellability dilarysis of electrical and meentalical systems	
Literature	 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	Тур	Hrs/wk	СР
Applied Automation (L1592)	Project-/problem-based Learning	3	3
Ergonomics (L0653)	Lecture	2	3
Advanced Training Course SE-ZER		2	3
Elements of Integrated Production		2	3
Development Management for Med		2	3
Fatigue & Damage Tolerance (L03)		2	3
Industry 4.0 for engineers (L2012)	Lecture	2	3
Innovation and Product Manageme	nt (L2168) Seminar	2	3
Lightweight Design Practical Cours		3	3
Mechanisms, Systems and Process		2	2
Microsystems Technology (L0724)	Lecture	2	4
Sustainable Industrial Production (Lecture Lecture	2	3
Productivity Management (L0928)	Project-/problem-based Learning	2	2
Productivity Management (L0931)	Recitation Section (small)	1	1
Feedback Control in Medical Techn		2	3
Structural Mechanics of Fibre Reinf		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	s (L0176) Lecture	2	2
Reliability in Engineering Dynamics		1	2
Reliability of Aircraft Systems (L07	49) Lecture	2	3
Module Responsible	Prof. Dieter Krause		
Admission Requirements	None		
Recommended Previous	None		
Knowledge			
	After taking part successfully, students have reached the following learning results		
Professional Competence	The country part succession, seadenes have rederied the following realiting results		
-			
Knowledge	Students are able to express their extended knowledge and discuss the connection of dif	fferent speci	al fields or application
	areas of product development, materials and production		
	Students are qualified to connect different special fields with each other		
	- Seasons are quantities to confident different special fields with each other		
Skills			
	Students can apply specialized solution strategies and new scientific methods in selected and selected are selected as a selected and selected are selected as a selected are sele	areas	
1			
	Students are able to transfer learned skills to new and unknown problems and can develop	p own solutio	n approacnes
Dawney Comment	Students are able to transfer learned skills to new and unknown problems and can develop	p own solutio	n approaches
Personal Competence		p own solutio	on approacnes
Personal Competence Social Competence		o own solutio	on approacnes
	-		n approacnes
Social Competence			n approacnes
Social Competence	Students are able to develop their knowledge and skills by autonomous election of courses.		n approacnes
Social Competence Autonomy	Students are able to develop their knowledge and skills by autonomous election of courses Depends on choice of courses		n approacnes
Social Competence Autonomy Workload in Hours	Students are able to develop their knowledge and skills by autonomous election of courses Depends on choice of courses 6	S.	n approacnes
Social Competence Autonomy Workload in Hours Credit points Assignment for the	Students are able to develop their knowledge and skills by autonomous election of courses Depends on choice of courses Beroduct Development, Materials and Production: Specialisation Product Development: Elective Co	S.	n approacnes
Social Competence Autonomy Workload in Hours Credit points	Students are able to develop their knowledge and skills by autonomous election of courses Depends on choice of courses 6 Product Development, Materials and Production: Specialisation Product Development: Elective Co	S.	n approacnes

Course L1592	2: Applied Automation
Тур	Project-/problem-based Learning
Hrs/wk	3
СР	3
Workload in	Independent Study Time 48, Study Time in Lecture 42
Hours	
Examination	Mündliche Prüfung
Form	
Examination	30 Minuten
duration	
and scale	
Lecturer	Prof. Thorsten Schüppstuhl
Language	DE
Cycle	WiSe
Literature	-Project Based Learning -Robot Operating System -Robot structure and description -Motion description -Calibration -Accuracy John J. Craig Introduction to Robotics - Mechanics and Control ISBN: 0131236296 Pearson Education, Inc., 2005 Stefan Hesse Grundlagen der Handhabungstechnik ISBN: 3446418725 München Hanser, 2010 K. Thulasiraman and M. N. S. Swamy Graphs: Theory and Algorithms ISBN: 9781118033104 %CITAVIPICKER£9781118033104£Titel anhand dieser ISBN in Citavi-Projekt übernehmen£% John Wüey & Sons, Inc., 1992

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

Course L2739: Advanced Training Course SE-ZERT		
Тур	Project-/problem-based Learning	
Hrs/wk	2	
СР	3	
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28	
Examination Form	Klausur	
Examination duration and	120 min	
scale		
Lecturer	Prof. Ralf God	
Language	DE	
Cycle	SoSe	
Content		
Literature	INCOSE Systems Engineering Handbuch - Ein Leitfaden für Systemlebenszyklus-Prozesse und -Aktivitäten, GfSE (Hrsg. der	
	deutschen Übersetzung), ISBN 978-3-9818805-0-2.	
	ISO/IEC 15288 System- und Software-Engineering - System-Lebenszyklus-Prozesse (Systems and Software Engineering - System	
	Life Cycle Processes).	

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

Course L1512: Development	Management for Mechatronics
Тур	Lecture
Hrs/wk	2
СР	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Examination Form	Mündliche Prüfung
Examination duration and	30 Minuten
scale	
Lecturer	NN, Dr. Johannes Nicolas Gebhardt
Language	DE
Cycle	SoSe
Content	Processes and methods of product development - from idea to market launch 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 Design of processes for product development IT systems for product development Establishment of management standards Typical types of organization
Literature	 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		
Тур	Lecture	
Hrs/wk	2	
СР	3	
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28	
Examination Form	Mündliche Prüfung	
Examination duration and	45 min	
scale		
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. Kluver Academic Puplisher, Dordrecht, 2001 E. Haibach. Betriebsfestigkeit	
	Verfahren und Daten zur Bauteilberechnung. VDI-Verlag, Düsseldorf, 1989	

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

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

Course L1258: Lightweight Design Practical Course		
Тур	Project-/problem-based Learning	
Hrs/wk	3	
СР	3	
Workload in Hours	Independent Study Time 48, Study Time in Lecture 42	
Examination Form	Mündliche Prüfung	
Examination duration and	30 min	
scale		
Lecturer	Prof. Dieter Krause	
Language	DE/EN	
Cycle	SoSe	
Content	Development of a sandwich structure made of fibre reinforced plastics	
	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	Schürmann, H., "Konstruieren mit Faser-Kunststoff-Verbunden", Springer, Berlin, 2005.	
	Puck, A., "Festigkeitsanalsyse 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. 	
	I	

Course L0950: Mechanisms,	Systems and Processes of Materials Testing
Тур	Lecture
Hrs/wk	2
СР	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Examination Form	Klausur
Examination duration and	90 Minuten
scale	
Lecturer	Dr. Jan Oke Peters
Language	DE
Cycle	SoSe
	Application, analysis and discussion of basic and advanced testing methods to ensure correct selection of applicable testing procedure for investigation of part/materials deficiencies 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	 E. Macherauch: Praktikum in Werkstoffkunde, Vieweg G. E. Dieter: Mechanical Metallurgy, McGraw-Hill R. Bürgel: Lehr- und Übungsbuch Festigkeitslehre, Vieweg R. Bürgel: Werkstoffe sícher beurteilen und richtig einsetzen, Vieweg

Course L0724: Microsystems	Technology
Тур	Lecture
Hrs/wk	2
СР	4
Workload in Hours	Independent Study Time 92, Study Time in Lecture 28
Examination Form	Mündliche Prüfung
Examination duration and	30 min
scale	
Lecturer	Prof. Hoc Khiem Trieu
Language	EN
Cycle	WiSe
Content	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-achip, 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	M. Madou: Fundamentals of Microfabrication, CRC Press, 2002 N. Schwesinger: Lehrbuch Mikrosystemtechnik, Oldenbourg Verlag, 2009
	T. M. Adams, R. A. Layton:Introductory MEMS, Springer, 2010
	G. Gerlach; W. Dötzel: Introduction to microsystem technology, Wiley, 2008

Course L2863: Sustainable In	ndustrial Production
Тур	Lecture
Hrs/wk	2
СР	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Examination Form	
Examination duration and	
scale	
Lecturer	Dr. Simon Markus Kothe
Language	
Cycle	
Content	
	processes that change the form and physical properties of raw materials. Manufacturing is a central driver of economic development and has a major impact on the well-being of humanity. However, the scale of current manufacturing activities results in enormous global energy and material demands that are harmful to both the environment and people. Historically, industrial activities were mostly oriented towards economic constraints, while social and environmental consequences were only hardly considered. As a result, today's global consumption rates of many resources and associated emissions often exceed the natural regeneration rate of our planet. In this respect, current industrial production can mostly be described as unsustainable. This is emphasized each year by the Earth Overshoot Day, which marks the day when humanity's ecological footprint exceeds the Earth' annual regenerative capacity.
	This lecture aims to provide the motivation, analytical methods as well as approaches for sustainable industrial production and t clarify the influence of the production phase in relation to the raw material, use and recycling phases in the entire life cycle of products. For this, the following topics will be highlighted:
	- Motivation for sustainable production, the 17 Sustainable Development Goals (SDGs) of the UN and their relevance for tomorrow's manufacturing;
	- raw material vs. production phase vs. use phase vs. recycling/end-of-life phase: importance of the production phase for the environmental impact of manufactured products;
	- Typical energy- and resource-intensive processes in industrial production and innovative approaches to increase energy an resource efficiency;
	- Methodology for optimizing the energy and resource efficiency of industrial manufacturing chains with the three steps of modeling (1), evaluating (2) and improving (3);
	- Resource efficiency of industrial manufacturing value chains and its assessment using life cycle analysis (LCA);
	- Exercise: LCA analysis of a manufacturing process (thermoplastic joining of an aircraft fuselage segment) as part of a product lif cycle assessment.
Literature	Literatur:
	- Stefan Alexander (2020): Resource efficiency in manufacturing value chains. Cham: Springer International Publishing.
	- Hauschild, Michael Z.; Rosenbaum, Ralph K.; Olsen, Stig Irving (Hg.) (2018): Life Cycle Assessment. Theory and Practice. Cham Springer International Publishing.
	- Kishita, Yusuke; Matsumoto, Mitsutaka; Inoue, Masato; Fukushige, Shinichi (2021): EcoDesign and sustainability. Singapore Springer.
	- Schebek, Liselotte; Herrmann, Christoph; Cerdas, Felipe (2019): Progress in Life Cycle Assessment. Cham: Springer International Publishing.
	- Thiede, Sebastian; Hermann, Christoph (2019): Eco-factories of the future. Cham: Springer Nature Switzerland AG.
	- Vorlesungsskript.

Course L0928: Productivity Management	
Тур	Project-/problem-based Learning
Hrs/wk	2
СР	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Examination Form	Klausur
Examination duration and	90 Minuten
scale	
	Prof. Hermann Lödding
Language	
Cycle	SoSe
Content	 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	Bokranz, R.; Landau, K.:Produktivitätsmanagement von Arbeitssystemen. Schäffer-Poeschel, Stuttgart, 2006. Takeda, H.: Das synchrone Produktionssystem: Just-in-Time für das ganze Unternehmen. 5. Aufl., mi-Wirtschaftsbuch, FinanzBuch Verlag, München, 2006. Nakajima, S.: Management der Produktionseinrichtungen (Total Productive Maintenance). Campus Verlag, New York, 1995. Shingo, S.: A Revolution in Manufacturing: The SMED System. Productivity, Inc., 1985

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

Course L0664: Feedback Control in Medical Technology	
Тур	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	20 min
scale	
Lecturer	Johannes Kreuzer, Christian Neuhaus
Language	DE
Cycle	SoSe
Content	Always viewed from the engineer's point of view, the lecture is structured as follows: 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 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.
Literature	 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.

	chanics of Fibre Reinforced Composites
	Lecture
Hrs/wk	
СР	
	Independent Study Time 62, Study Time in Lecture 28
Examination Form	Mündliche Prüfung
Examination duration and	30 min
scale	
	Prof. Benedikt Kriegesmann
Language	
Cycle	
Content	Classical laminate theory
	Rules of mixture
	Failure mechanisms and criteria of composites
	Boundary value problems of isotropic and anisotropic shells
	Stability of composite structures
	Optimization of laminated composites
	Modelling composites in FEM
	Numerical multiscale analysis of textile composites
	Progressive failure analysis
Literature	 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	
Тур	Lecture
Hrs/wk	2
СР	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Examination Form	Mündliche Prüfung
Examination duration and	30 min
scale	
Lecturer	Dr. Stefan Wischhusen
Language	DE
Cycle	WiSe
Content	Lecture about equation-based, physical modelling using the modelling language Modelica and the free simulation tool OpenModelica. • 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	 [1] Modelica Association: "Modelica Language Specification - Version 3.4", Linköping, Sweden, 2 0 1 7 [2] M. Tiller: "Modelica by Example", http://book.xogeny.com, 2014. [3] M. Otter, H. Elmqvist, et al.: "Objektorientierte Modellierung Physikalischer Systeme", at- Automatisierungstechnik (german), Teil 1 - 17, Oldenbourg Verlag, 1999 - 2000. [4] P. Fritzson: "Principles of Object-Oriented Modeling and Simulation with Modelica 3.3", Wiley-IEEE Press, New York, 2015. [5] P. Fritzson: "Introduction to Modeling and Simulation of Technical and Physical Systems with Modelica", Wiley, New York, 2011.

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

Course L1513: Technical Design			
Тур	Lecture		
Hrs/wk			
СР	3		
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28		
Examination Form	Schriftliche Ausarbeitung		
Examination duration and	10-15 Entwurfszeichnungen, Skizzen und ca. 5-10 A4-Dokumentationsseiten (Themen- und Entwurfsbegründung)		
scale			
Lecturer	Prof. Werner Granzeier		
Language	DE CONTRACTOR OF THE CONTRACTO		
Cycle	SoSe		
Content	 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	Literatur über technisches Produktdesign		
	Technisches Rendering und Präsentation		
[226]			

Zeichnen und perspektivisches Entwerfen Literaturhinweise What is Product Design? Laura Slack RotoVision Schweiz 2006 Product Design Now Design and Scetches CollinsDesign and maomao publications Spanien 2006 Ronald B. Kemnitzer, Rendering With Markers - Definitive Techniques for Designers, Illustrators and Architects, Watson, Guptil Puplications, a division of Billboard Publications Inc., New York 1983 Creative Techniques DRAWING Barons Educational Series ISBN-13: 978-0-7641-6182-7 Joseph Ungar, Rendering In Mixed Media - Techniques for Concept Presentation for Designers and Illustrators Watson-Guptil Publication a division of Billboard Publications Inc., New York 1985 AIRWORLD Design und Architektur für die Flugreise Vitra Design Stiftung Weil am Rhein 2004 Airline Design Perter Deslius Jacek Slaski te Neues 2005 Technik und Sicherheit von Passagierflugzeugen Frank Littek Motorbuch Verlag 2003 Jetliner Cabins Jennifer Coutts Clay Cs books England 2006 **BOEING Widebodies** Michael Haenggi motorbooks international USA 2003 form - Zeitschrift für Gestaltung, Verlag form GmbH, Hofgut Ober-Berrbach, 6104 Seeheim-Jugenheim (erscheint vierteljährlich, Verlag form GmbH) design report german magasin, (erscheint monatlich) md - möbel interior design, Konradin-Verlag Robert Kohlhammer GmbH, 7022 Leinfelden-Echterdingen (erscheint monatlich) CAR STYLING, Car Styling Publishing Co. 4-8-16-11F, Kitashinjuku, Shinjuku-ku, Tokio 160, Japan (erscheint vierteljährlich in japanischer und englischer Sprache, in Hamburg erhältlich bei: Overseas Courier Service Deutschland Auto & Design, Corso Frabcia 161, 10139 Torino, Italia

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	(erscheint vierteljährlich in italienischer und englischer Sprache alle zwei
	Monate , erhältlich am HBF Hamburg
	AERO International,
	Magazin für Zivilluftfahrt
	(erscheint monatlich)
	Aircraft interior international
	Engl. magasin for Aircraft cabin interior
	(erscheint 2 monatlich)
	aerotec
	Technik- und Branchenmagazin für die Luft- und Raumfahrtindustrie

and cement science as well as new developments in powderless forming techniques of ceramics and ceramic composites	Course L0379: Ceramics Tech	inology		
Workload in Hours Examination Form Klausur Examination duration and scale Lecturer Dr. Rolf Janßen Cycle WiSe Content Introduction to ceramic processing with emphasis on advanced structural ceramics. The course focus predominatly on potential and defense science as well as new developments in powderless forming techniques of ceramic and reamic composites addressed Examples will be discussed in order to give engineering students an understanding of technology developmen specific applications of ceramic components. Content: 1. Introduction Inhalt: 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 Literature W.D. Kingery, "Introduction to Ceramics", John Wiley & Sons, New York, 1975 ASM Engineering Materials Handbook Vol.4 "Ceramics and Glasses", 1991	Тур	ecture		
Examination Form Klausur	Hrs/wk			
Examination Form Examination duration and scale Lecturer Dr. Rolf Janßen Language Cycle Content Introduction to ceramic processing with emphasis on advanced structural ceramics. The course focus predominatly on processing processing, e.g. "powder-metauurgical techniques and sintering (solid state and liquid phase). Also, some aspects of and cement science as well as new developments in powderless forming techniques of ceramics and ceramic composites addressed Examples will be discussed in order to give engineering students an understanding of technology development specific applications of ceramic components. Content: 1. Introduction Inhalt: 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 Literature W.D. Kingery, "Introduction to Ceramics", John Wiley & Sons, New York, 1975 ASM Engineering Materials Handbook Vol. 4. "Ceramics and Glasses", 1991	СР	3		
Examination duration and scale Lecturer Dr. Rolf Janßen Language DE/EN Cycle WiSe Content Introduction to ceramic processing with emphasis on advanced structural ceramics. The course focus predominatly on pobased processing, e.g. "powder-metauurgical techniques and sintering (solid state and liquid phase). Also, some aspects of and cement science as well as new developments in powderless forming techniques of ceramics and ceramic composites addressed Examples will be discussed in order to give engineering students an understanding of technology developmen specific applications of ceramic components. Content: 1. Introduction Inhalt: 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 Literature W.D. Kingery, "Introduction to Ceramics", John Wiley & Sons, New York, 1975 ASM Engineering Materials Handbook Vol.4. "Ceramics and Glasses", 1991	Workload in Hours	Independent Study Time 62, Stu	dy Time in Lecture 28	
Lecturer Language DE/EN Cycle Content	Examination Form	Klausur		
Lecturer Language DE/EN Cycle Wise Content Introduction to ceramic processing with emphasis on advanced structural ceramics. The course focus predominatly on portion based processing, e.g. "powder-metauurgical techniques and sintering (soild state and liquid phase). Also, some aspects of and cement science as well as new developments in powderless forming techniques of ceramics and ceramic composites addressed Examples will be discussed in order to give engineering students an understanding of technology development specific applications of ceramic components. Content: 1. Introduction Inhalt: 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 Literature W.D. Kingery, "Introduction to Ceramics", John Wiley & Sons, New York, 1975 ASM Engineering Materials Handbook Vol.4 "Ceramics and Glasses", 1991	Examination duration and	90 Minuten		
Language DE/EN Cycle WiSe Content Introduction to ceramic processing with emphasis on advanced structural ceramics. The course focus predominatly on potential processing, e.g. "powder-metauurgical techniques and sintering (soild state and liquid phase). Also, some aspects of and cement science as well as new developments in powderless forming techniques of ceramics and ceramic composites addressed Examples will be discussed in order to give engineering students an understanding of technology developmen specific applications of ceramic components. Content: 1. Introduction Inhalt: 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 Literature W.D. Kingery, "Introduction to Ceramics", John Wiley & Sons, New York, 1975 ASM Engineering Materials Handbook Vol.4 "Ceramics and Glasses", 1991	scale			
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ASM Engineering Materials Handbook Vol.4 "Ceramics and Glasses", 1991	Content	Introduction to ceramic processing with emphasis on advanced structural ceramics. The course focus predominatly on powd based processing, e.g. "powder-metauurgical techniques and sintering (soild state and liquid phase). Also, some aspects of gla and cement science as well as new developments in powderless forming techniques of ceramics and ceramic composites will addressed Examples will be discussed in order to give engineering students an understanding of technology development a specific applications of ceramic components. Content: 1. Introduction Inhalt: 2. Raw materials 3. Powder fabrication 4. Powder processing 5. Shape-forming processes 6. Densification, sintering 7. Glass and Cement technology		
D.W. Richerson, "Modern Ceramic Engineering", Marcel Decker, New York, 1992	Literature			
Skript zur Vorlesung			ic Engineering", Marcel Decker, New York, 1992	

Course L0949: Materials Testing		
Тур	Lecture	
Hrs/wk	2	
СР	2	
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28	
Examination Form	Klausur	
Examination duration and	90 Minuten	
scale		
Lecturer	Dr. Jan Oke Peters	
Language	DE	
Cycle	WiSe	
Content Application and analysis of basic mechanical as well as non-destructive testing of materials Determination elastic constants Tensile test Fatigue test (testing with constant stress, strain, or plastiv strain amplitude, low and high cycle fatigue, mean streed crack growth upon static loading (stress intensity factor, fracture toughness) Creep test Hardness test Charpy impact test Non destructive testing		
Literature	E. Macherauch: Praktikum in Werkstoffkunde, Vieweg G. E. Dieter: Mechanical Metallurgy, McGraw-Hill	

Course L0176: Reliability in Engineering Dynamics			
Тур	cture		
Hrs/wk			
СР	2		
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28		
Examination Form	Klausur		
Examination duration and	90 min.		
scale			
Lecturer	NN		
Language	EN		
Cycle	SoSe		
	Method for calculation and testing of reliability of dynamic machine systems Modeling System identification Simulation Processing of measurement data Damage accumulation Test planning and execution		
Literature	Bertsche, B.: Reliability in Automotive and Mechanical Engineering. Springer, 2008. ISBN: 978-3-540-33969-4 Inman, Daniel J.: Engineering Vibration. Prentice Hall, 3rd Ed., 2007. ISBN-13: 978-0132281737 Dresig, H., Holzweißig, F.: Maschinendynamik, Springer Verlag, 9. Auflage, 2009. ISBN 3540876936. VDA (Hg.): Zuverlässigkeitssicherung bei Automobilherstellern und Lieferanten. Band 3 Teil 2, 3. überarbeitete Auflage, 2004. ISSN 0943-9412		

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

Course L0749: Reliability of	Course L0749: Reliability of Aircraft Systems		
Тур	Lecture		
Hrs/wk	2		
СР	3		
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28		
Examination Form	Klausur		
Examination duration and	90 Minuten		
scale			
Lecturer	Prof. Frank Thielecke, Dr. Andreas Vahl, Dr. Uwe Wieczorek		
Language	E		
Cycle	NiSe		
Content	 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	• CS 25.1309 • SAE ARP 4754 • SAE ARP 4761		

Module M1193: Cabin	Systems Engineering			
Courses				
Courses				
Title		Тур	Hrs/wk	СР
•	nology in cabin electronics and avionics (L1557) nology in cabin electronics and avionics (L1558)	Lecture Recitation Section (small)	2 1	2 1
Model-Based Systems Engineering		Project-/problem-based Learning	3	3
Module Responsible		,,		
Admission Requirements				
Recommended Previous				
Knowledge	Mathematics			
Knowieuge	Mechanics			
	Thermodynamics			
	Electrical Engineering			
	Control Systems			
	Previous knowledge in:			
	Systems Engineering			
Educational Objectives	After taking part successfully, students have reached the follo	wing learning results		
Professional Competence				
Knowledge	Students are able to:			
	describe the structure and operation of computer architecture	res		
	• explain the structure and operation of digital communication	Networks		
	explain architectures of cabin electronics, integrated modula	r avionics (IMA) and Aircraft Data	Communicatio	n Network (ADCN)
	• understand the approach of Model-Based Systems Engine	ering (MBSE) in the design of ha	rdware and so	oftware-based cabin
	systems			
Skills	Students are able to:			
SKIIIS	understand, operate and maintain a Minicomputer			
	 build up a network communication and communicate with ot 	her network participants		
	 connect a minicomputer with a cabin management system (. 		a AFDX®-Net	work
	model system functions by means of formal languages SysM	L/UML and generate software code	from the mod	lels
	execute software code on a minicomputer			
Personal Competence				
-	Students are able to:			
	• elaborate partial results and merge with others to form a cor	nplete solution		
A	Chudanta ara abla ta			
Autonomy	Students are able to:			
	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	120 minutes			
scale				
_	Aircraft Systems Engineering: Specialisation Aircraft Systems:	, ,		
Following Curricula	International Management and Engineering: Specialisation II. Aviation Systems: Elective Compulsory			
	Product Development, Materials and Production: Specialisation	·	ompulsory	
	Product Development, Materials and Production: Specialisation	, ,		
	Product Development, Materials and Production: Specialisation		.laam.	
	Theoretical Mechanical Engineering: Specialisation Aircraft Sys	sterns Engineering: Elective Compu	пьогу	

Course L1557: Computer and	d communication technology in cabin electronics and avionics
Тур	Lecture
Hrs/wk	2
СР	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Prof. Ralf God
Language	DE
Cycle	WiSe
Content	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. 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: 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	

Тур	Recitation Section (small)
Hrs/wk	1
СР	1
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14
	Prof. Ralf God
Language	DE
Cycle	WiSe
Content	The objective of the lecture with the corresponding exercise is the acquisition of knowledge of computer and communicati technology in electronic systems in the cabin and in aircraft. For the system engineer the strong interaction of softwa mechanical and electronic system components nowadays requires a basic understanding of cabin electronics and avionics. The course teaches the basics of design and functionality of computers and data networks. Subsequently it focuses on curre principles and applications in integrated modular avionics (IMA), aircraft data communication networks (ADCN), cabin electron and cabin networks: 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	- Skript zur Vorlesung - Schnabel, P.: Computertechnik-Fibel: Grundlagen Computertechnik, Mikroprozessortechnik, Halbleiterspeicher, Schnittstellen u Peripherie. Books on Demand; 1. Auflage, 2003 - Schnabel, P.: Netzwerktechnik-Fibel: Grundlagen, Übertragungstechnik und Protokolle, Anwendungen und Dienste, Sicherhe Books on Demand; 1. Auflage, 2004 - Wüst, K.: Mikroprozessortechnik: Grundlagen, Architekturen und Programmierung von Mikroprozessoren, Mikrocontrollern u Signalprozessoren. Viewed Verlag; 2. aktualisierte und erweiterte Auflage, 2006

Тур	Project-/problem-based Learning	
Hrs/wk	3	
СР	3	
Workload in Hours	Independent Study Time 48, Study Time in Lecture 42	
Lecturer	Prof. Ralf God	
Language	DE	
Cycle	SoSe	
Content	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®):	
	• 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	- 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	

FIOGUCTION					
Module M0511: Electi	ical Energy from Solar Radiatio	on and Wind Power			
Courses					
Title		Тур	Hrs/wk	СР	
Sustainability Management (L0007		Lecture	2	1	
Hydro Power Use (L0013) Wind Turbine Plants (L0011)		Lecture Lecture	1 2	1 3	
Wind Energy Use - Focus Offshore (L0012)	Lecture	1	1	
Module Responsible	Dr. Isabel Höfer				
Admission Requirements	None				
Recommended Previous	Module: Technical Thermodynamics I,				
Knowledge					
	Module: Technical Thermodynamics II,				
	Module: Fundamentals of Fluid Mechanics				
Educational Objectives	After taking part successfully, students have r	reached the following learning results			
Professional Competence	Du anding this madule students are conlain	in detail Impulation of wind turbines wi	bla a mantiacilar faccia as	fusing analysis	
Knowieage	By ending this module students can explain offshore conditions and can critical comment				
	to describe fundamentally the use of water po				
	in the implementation of renewable energy pr	- ·	reproduce and explain	the Busic procedu.	
	Through active discussions of various topics			derstanding and th	
	application of the theoretical background and	are thus able to transfer what they have	learned in practice.		
Skills	Students are able to apply the acquired the	eoretical foundations on exemplary wate	r or wind power syster	ns and evaluate ar	
	assess technically the resulting relationships	in the context of dimensioning and oper	ation of these energy s	systems. They can	
	compare critically the special procedure for the implementation of renewable energy projects in countries outside Europe with th				
	in principle applied approach in Europe and ca	an apply this procedure on exemplary the	oretical projects.		
Personal Competence	Chudonto con discuss esiantific tooles quinist e				
Social Competence	Students can discuss scientific tasks subjet-s	pecificiy and multidisciplinary within a ser	mmar.		
Autonomy	Students can independently exploit sources	in the context of the emphasis of the le	cture material to clear	the contents of the	
riaconomy	lecture and to acquire the particular knowledge		cture material to creat	tire contents or ti	
		,			
Workload in Hours	Independent Study Time 96, Study Time in Le	cture 84			
Credit points 6					
Course achievement	None				
Examination	Written exam				
	2.5 hours written exam + written elaboration	(incl. presentation) in sustainability mana	gement		
scale					
-	Civil Engineering: Specialisation Structural En				
Following Curricula	Civil Engineering: Specialisation Geotechnical				
	Civil Engineering: Specialisation Coastal Engineering: Elective Compulsory				
	International Management and Engineering: Specialisation II. Energy and Environmental Engineering: Elective Compulsory International Management and Engineering: Specialisation II. Renewable Energy: 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	·			
	Renewable Energies: Core Qualification: Comp	pulsory			
	Theoretical Mechanical Engineering: Specialis	ation Energy Systems: Elective Compulso	ry		
	Process Engineering: Specialisation Environmental Process Engineering: Elective Compulsory				
	Water and Environmental Engineering: Specia				
	Water and Environmental Engineering: Specia	lisation Cities: Elective Compulsory			

Course L0007: Sustainability	Management
Тур	Lecture
Hrs/wk	2
СР	1
Workload in Hours	Independent Study Time 2, Study Time in Lecture 28
Lecturer	Dr. Anne Rödl
Language	DE
Cycle	SoSe
Content	The lecture "Sustainability Management" gives an insight into the different aspects and dimensions of sustainability. First, essential terms and definitions, significant developments of the last years, and legal framework conditions are explained. The various aspects of sustainability are then presented and discussed in detail. The lecture mainly focuses on concepts for the implementation of the topic sustainability in companies:
	 What is "sustainability"? Why is this concept an important topic for companies? What opportunities and business risks are addressed or are associated with it? How can the often mentioned three pillars of sustainability - economy, ecology, and social- be meaningfully integrated into corporate management despite their sometimes contradictory tendencies, and how a corresponding compromise can be found? What concepts or frameworks exist for the implementation of sustainability management in companies? Which sustainability labels exist for products or companies? What do they have in common, and where do they differ? Furthermore, the lecture is intended to provide insights into the concrete implementation of sustainability aspects into business practice. External lecturers from companies will be invited to report on how sustainability is integrated into their daily processes. In the course of an independently carried out group work, the students will analyze and discuss the implementation of sustainability aspects based on short case studies. By studying and comparing best practice examples, the students will learn about corporate decisions' effects and implications. It should become clear which risks or opportunities are associated if sustainability aspects are taken into account in management decisions.
Literature	Die folgenden Bücher bieten einen Überblick: Engelfried, J. (2011) Nachhaltiges Umweltmanagement. München: Oldenbourg Verlag. 2. Auflage Corsten H., Roth S. (Hrsg.) (2011) Nachhaltigkeit - Unternehmerisches Handeln in globaler Verantwortung. Wiesbaden: Gabler Verlag.

Course L0013: Hydro Power I	Use		
Тур	Lecture		
Hrs/wk			
СР	1		
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14		
Lecturer	Prof. Stefan Achleitner		
Language	DE		
Cycle	SoSe		
Content	 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	 Schröder, W.; Euler, G.; Schneider, K.: Grundlagen des Wasserbaus; Werner, Düsseldorf, 1999, 4. Auflage Quaschning, 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
Тур	Lecture
Hrs/wk	2
СР	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Dr. Rudolf Zellermann
Language	DE
Cycle	SoSe
Content	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
Тур	Lecture
Hrs/wk	1
СР	1
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14
Lecturer	Prof. Martin Skiba
Language	DE
Cycle	SoSe
Content	 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	 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, Heidel-berg, 1997, 3. Auflage Hau, E.: Windkraftanalagen; 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: Robot	tics and Naviga	tion in Medicine				
Courses						
Title Robotics and Navigation in Medicin Robotics and Navigation in Medicin Robotics and Navigation in Medicin	e (L0338)			Typ Lecture Project Seminar Recitation Section (small)	Hrs/wk 2 2 1	CP 3 2
Module Responsible	1	efer				_
Admission Requirements	None	Cici				
Recommended Previous Knowledge	• principles of m	ath (algebra, analysis/ca ogramming, e.g., in Java ab skills				
Educational Objectives	After taking part succ	essfully, students have	reached the following	ng learning results		
Professional Competence Knowledge Skills	detail. Systems can systems regarding de	be evaluated with respections and limitations.	ect to collision det	clinical contexts and illust ection and safety and re s and robotic systems for m	gulations. Student	s can assess typical
Personal Competence Social Competence Autonomy	The students discuss the results of other groups, provide helpful feedback and can incoorporate feedback into their work. 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 Ti	me 110, Study Time in	Lecture 70			
Credit points	6					
Course achievement	Yes 10 %	Form Written elaboration Presentation	Description			
Examination	Written exam					
Examination duration and	90 minutes					
scale Assignment for the		pecialisation II: Intelliger				
Following Curricula	International Manage International Manage Mechatronics: Specia Biomedical Engineeri Biomedical Engineeri Biomedical Engineeri Biomedical Engineeri Product Development	ment and Engineering: 'i lisation Intelligent Syste ng: Specialisation Artific ng: Specialisation Impla ng: Specialisation Medic ng: Specialisation Mana c, Materials and Producti	Specialisation II. Ele Specialisation II. Pro ms and Robotics: El ial Organs and Rege nts and Endoprosthe al Technology and O gement and Busines on: Specialisation P	ctrical Engineering: Elective cess Engineering and Biote	chnology: Elective compulsory mpulsory Compulsory ve Compulsory	Compulsory
	·			laterials: Elective Compulso ical Technology: Elective Co	-	

avigation in Medicine
Lecture
3
ndependent Study Time 62, Study Time in Lecture 28
Prof. Alexander Schlaefer
EN
5oSe
kinematics
calibration
tracking systems
navigation and image guidance
motion compensation
The seminar extends and complements the contents of the lecture with respect to recent research results.
Spong et al.: Robot Modeling and Control, 2005
Froccaz: Medical Robotics, 2012
Further literature will be given in the lecture.
2 3 r o = 6 r

Course L0338: Robotics and	Course L0338: Robotics and Navigation in Medicine		
Тур	Project Seminar		
Hrs/wk	2		
СР	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		
Тур	Recitation Section (small)	
Hrs/wk	1	
СР	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	t Control Systems			
Courses				
Title Flight Control Systems (L0736)		Typ Lecture	Hrs/wk	CP 4
Flight Control Systems (L0740)		Recitation Section (large)	2	2
Module Responsible	Prof. Frank Thielecke			
Admission Requirements	None			
Recommended Previous	basic knowledge of:			
Knowledge	mathematics			
	mechanics			
	thermo dynamics			
	electronics			
	fluid technology			
	control technology			
Educational Objectives	After taking part successfully, students have reached	the following learning results		
Professional Competence				
Knowledge	Students are able to			
	describe the structure of primary flight control s corresponding properties and applications. explain different configurations and designs an		high lift systems i	n general along with
Skills	size primary flight control actuation systems perform a controller design process for the fligh design high-lift kinematics	it control actuators		
Personal Competence				
Social Competence	Students are able to:			
	Develop joint solutions in mixed teams			
Autonomy	Students are able to:			
	derive requirements and perform appropriate y circumstances in a self-reliant manner	et simplified design processes for airco	raft systems from	complex issues and
Workload in Hours	Independent Study Time 110, Study Time in Lecture 7	0		
Credit points	6			
Course achievement	None			
Examination	Written exam			
Examination duration and scale	165 Minutes			
Assignment for the	Aircraft Systems Engineering: Core Qualification: Com	pulsory		
Following Curricula	International Management and Engineering: Specialisa	ation II. Aviation Systems: Elective Com	pulsory	
	Product Development, Materials and Production: Speci	alisation Product Development: Electiv	e Compulsory	
	Product Development, Materials and Production: Speci	•	,	
	Product Development, Materials and Production: Speci	·	-	
	Theoretical Mechanical Engineering: Specialisation Air	craft Systems Engineering: Elective Cor	mpulsory	

Course L0736: Flight Control	Systems
Тур	Lecture
Hrs/wk	3
СР	4
Workload in Hours	Independent Study Time 78, Study Time in Lecture 42
Lecturer	Prof. Frank Thielecke
Language	DE
Cycle	SoSe
Content	 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-skit 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	 Moir, Seabridge: Aircraft Systems Torenbek: Synthesis of Subsonic Airplane Design Curry: Aircraft Landing Gear Design: Principles and Practices

Course L0740: Flight Control Systems		
Тур	Recitation Section (large)	
Hrs/wk	2	
СР	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: Medic	an inaging 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	
•	After taking part successfully, students have reached the following learning results
Professional Competence	
Knowledge	Students can:
	Students can.
	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 now spatial and temporal resolution can be inhibenced and now to characterize the images generated, Explain which image reconstruction methods are used to generate images;
	2.plain milan maga reconstruction methods are asea to generate mages,
	Describe and explain the main clinical uses of the different systems.
Skills	Students are able to:
	Explain the physical processes of images and assign to the systems the basic mathematical or physical equations required;
	 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;
	Select a suitable imaging system for an application.
Personal Competence	
Social Competence	none
Autonomy	Students can:
	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	
Course achievement	
Examination	
Examination duration and	
scale	
Assignment for the	Electrical Engineering: Specialisation Medical Technology: Elective Compulsory
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
	Theoretical Mechanical Engineering: Specialisation Bio- and Medical Technology: Elective Compulsory

Course L0819: Medical Imaging Systems				
Тур	Lecture			
Hrs/wk	4			
СР	6			
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56			
Lecturer	Dr. Michael Grass, Dr. Frank Michael Weber, Dr. Sven Prevrhal, Dr. Tim Nielsen			
Language	DE			
Cycle	SoSe			
Content				
Literature	Primary book:			
	1. P. Suetens, "Fundamentals of Medical Imaging", Cambridge Press			
	Secondary books:			
	- 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.			

Floduction						
Module M1156: Syste	ms Engineering					
Courses						
Title		Тур	Hrs/wk	СР		
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	Mechanics					
	• Thermodynamics					
	Electrical Engineering					
	Control Systems					
	Previous knowledge in:					
	Aircraft Cabin Systems					
Educational Objectives						
Professional Competence						
Knowledge	Students are able to:					
	 understand systems engineering process models, methods and tools for the development of complex Systems 					
	describe innovation processes and the need for technol	logy 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)					
Skills	Students are able to:					
Skiiis	• 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 					
	apply systems engineering methods and tools					
Personal Competence						
Social Competence	Students are able to:					
	• understand their responsibilities within a development	team and integrate themselves with	their role in the o	verall process		
_						
Autonomy	Students are able to:					
	 interact and communicate in a development team whi 	ch has distributed tasks				
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56					
Credit points	6					
Course achievement						
Examination						
Examination duration and						
scale	120 mildes					
Assignment for the	Aircraft Systems Engineering: Care Qualification: Communication	lsory				
Following Curricula						
ronowing Curricula		•		mnulsony		
	International Management and Engineering: Specialisation		action. Liective CC	пиривон у		
	Mechatronics: Specialisation System Design: Elective Compulsory					
	Mechatronics: Specialisation Intelligent Systems and Robotics: 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: Special	·				
	Theoretical Mechanical Engineering: Specialisation Aircra	art Systems Engineering: Elective Cor	npulsory			
	ı					

Course L1547: Systems Engi	neering
Тур	Lecture
Hrs/wk	3
СР	4
Workload in Hours	Independent Study Time 78, Study Time in Lecture 42
Lecturer	Prof. Ralf God
Language	DE
Cycle	SoSe
Content	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. 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: 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	- 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		
Тур	Recitation Section (large)	
Hrs/wk	1	
СР	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: Turbo	omachinery			
Courses				
Title	Тур		Hrs/wk	СР
Turbomachines (L1562)	Lectu	re	3	4
Turbomachines (L1563)	Recit	ation Section (large)	1	2
Module Responsible	Prof. Markus Schatz			
Admission Requirements	None			
Recommended Previous	Technical Thermodynamics I, II, Fluid Dynamics, Heat Transfer			
Knowledge				
Educational Objectives	After taking part successfully, students have reached the following lea	rning results		
Professional Competence				
Knowledge	The students can			
	distinguish the physical phenomena of conversion of energy,			
	understand the different mathematic modelling of turbomachine	ery,		
	calculate and evaluate turbomachinery.			
Ckille	The students are able to			
SKIIIS	The students are able to			
	- understand the physics of Turbomachinery,			
	- solve excersises self-consistent.			
Personal Competence				
·	The students are able to			
Social Competence	The students are able to			
	discuss in small groups and develop an approach.			
Autonomy	The students are able to			
	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	90 min			
scale				
Assignment for the				
Following Curricula				
	Product Development, Materials and Production: Specialisation Produc			
	Product Development, Materials and Production: Specialisation Produc		У	
	Product Development, Materials and Production: Specialisation Materia	lls: Elective Compulsory		

Course L1562: Turbomachine	ourse L1562: Turbomachines			
Тур	Lecture			
Hrs/wk				
СР	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:			
Literature	 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	 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 			

Course L1563: Turbomachines		
Тур	Recitation Section (large)	
Hrs/wk	1	
СР	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: Mech	anical Properties				
Courses					
Title		Тур	Hrs/wk	СР	
Mechanical Behaviour of Brittle Mat		Lecture	2	3	
Dislocation Theory of Plasticity (L16	562)	Lecture	2	3	
Module Responsible	Dr. Erica Lilleodden				
Admission Requirements	None				
Recommended Previous	Basics in Materials Science I/II				
Knowledge					
Educational Objectives	After taking part successfully, students have reached the	ne following learning results			
Professional Competence					
Knowledge	Students can explain basic principles of crystallograp	hy, statics (free body diagram	ns, tractions) and therm	nodynamics (energy	
	minimization, energy barriers, entropy)				
Skills					
SKIIIS	Students are capable of using standardized calculation methods: tensor calculations, derivatives, integrals, tensor transformations				
Personal Competence					
Social Competence	Students can provide appropriate feedback and handle feedback on their own performance constructively.				
Autonomy	Students are able to				
	- assess their own strengths and weaknesses				
	- assess their own state of learning in specific terms and	- 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			needed	
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56				
Credit points	6				
Course achievement	None				
Examination	Written exam				
Examination duration and	90 min				
scale					
Assignment for the	Materials Science: Core Qualification: Compulsory				
Following Curricula	Mechanical Engineering and Management: Specialisation	n Materials: Elective Compulsor	-y		
	Product Development, Materials and Production: Specia	lisation Product Development: I	Elective Compulsory		
	Product Development, Materials and Production: Specia	lisation Production: Elective Co	mpulsory		
	Product Development, Materials and Production: Specia	lisation Materials: Compulsory			
	Theoretical Mechanical Engineering: Specialisation Mate	erials Science: Elective Compuls	sory		

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

Course L1662: Dislocation Th	
,,,	Lecture
Hrs/wk	
СР	
	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Dr. Erica Lilleodden
Language	
Cycle	SoSe
Content	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.
	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.
Literature	Vorlesungsskript Aktuelle Publikationen Bücher: Introduction to Dislocations, by D. Hull and D.J. Bacon Theory of Dislocations, by J.P. Hirth and J. Lothe Physical Metallurgy, by Peter Hassen

Module M0840: Optin	nal and Robust Control			
Courses				
Title		Тур	Hrs/wk	СР
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	Classical control (frequency response, root locu	s)		
	State space methods			
	 Linear algebra, singular value decomposition 			
Educational Objectives	After taking part successfully, students have reached	the following learning results		
Professional Competence				
Knowledge				
	Students can explain the significance of the ma			
	They can explain the duality between optimal s			harden be
	 They can explain how the H2 and H-infinity nor They can explain how an LQG design problem or 			
	They can explain how an EQG design problem to They can explain how model uncertainty can be			
	They can explain how - based on the small ga			
	an uncertain plant.	cco. c a robuse controller cuit ge	arantee stability	and performance to
	They understand how analysis and synthesis co	onditions on feedback loops can be repr	esented as linear	matrix inequalities.
		·		•
Skills	 Students are capable of designing and tuning L 	QG controllers for multivariable plant m	nodels.	
	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 s 	synthesis conditions as linear matrix ine	equalities (LMI), a	nd of using standard
	LMI-solvers for solving them.			
	 They can carry out all of the above using stand 	ard software tools (Matlab robust contr	ol toolbox).	
Personal Competence				
Social Competence	Students can work in small groups on specific problem	ns to arrive at joint solutions.		
Autonomy	Students are able to find required information in sour	ces provided (lecture notes, literature,	software docume	ntation) and use it to
	solve given problems.			
Workload in Hours	Independent Study Time 124, Study Time in Lecture 5	66		
Credit points	6			
Course achievement	None			
Examination	Oral exam			
Examination duration and	30 min			
scale				
Assignment for the	Floatrical Engineering, Specialisation Central and Dow	or Systems Engineering, Elective Comp	ulcon	
Assignment for the Following Curricula	Electrical Engineering: Specialisation Control and Pow Energy Systems: Core Qualification: Elective Compuls		uisory	
Tollowing Curricula	Aircraft Systems Engineering: Core Qualification: Elec	,		
	Mechatronics: Specialisation Intelligent Systems and I			
	Mechatronics: Specialisation System Design: Elective	' '		
	Biomedical Engineering: Specialisation Artificial Organ		Compulsory	
	Biomedical Engineering: Specialisation Implants and E	•		
	Biomedical Engineering: Specialisation Medical Techn		pulsory	
	Biomedical Engineering: Specialisation Management a	,	. ,	
	Product Development, Materials and Production: Spec			
	Product Development, Materials and Production: Spec			
	Product Development, Materials and Production: Spec	ialisation Materials: Elective Compulsor	у	
	Theoretical Mechanical Engineering: Core Qualification	n: Elective Compulsory		

Course L0658: Optimal and F	Robust Control		
Тур	Lecture		
Hrs/wk	2		
СР	3		
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28		
Lecturer	of. Herbert Werner		
Language	EN		
Cycle	SoSe		
Content	 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 H2 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 (H2, 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	 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. Postlewhaite "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 		

ourse L0659: Optimal and Robust Control		
Тур	Recitation Section (small)	
Hrs/wk	2	
СР	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: Struc	ture and properties of fibre-poly	mer-composites		
Courses				
Title		Тур	Hrs/wk	СР
Structure and properties of fibre-po	lymer-composites (L1894)	Lecture	2	3
Structure and properties of fibre-po		Project-/problem-based L	=	2
Structure and properties of fibre-po	lymer-composites (L2613)	Recitation Section (large)) 1	1
Module Responsible				
Admission Requirements	None			
	Basics: chemistry / physics / materials science			
Knowledge				
Educational Objectives	After taking part successfully, students have re	ached the following learning results		
Professional Competence				
Knowledge	Students can use the knowledge of fiber-rein necessary testing and analysis.	forced composites (FRP) and its constitue	ents to play (fiber / m	atrix) and define the
	They can explain the complex relationships str	ucture-property relationship and		
	the interactions of chemical structure of the	e polymers their processing with the o	different fiber types	including to explain
	neighboring contexts (e.g. sustainability, envir		amerent liber types,	melading to explain
Skills	Students are capable of			
	 using standardized calculation methods 	in a given context to mechanical prope	erties (modulus, stren	gth) to calculate and
	evaluate the different materials.			
	 approximate sizing using the network th 	eory of the structural elements implemen	nt and evaluate.	
	 selecting appropriate solutions for mech 	anical recycling problems and sizing exan	nple stiffness, corrosio	on resistance.
Personal Competence				
Social Competence	Students can			
Social competence	Students Can			
	arrive at funded work results in heterogenius groups and document them.			
	 provide appropriate feedback and handl 	e feedback on their own performance con	structively.	
	6			
Autonomy	Students are able to			
	- assess their own strengths and weaknesses.			
	- assess their own state of learning in specific t	erms and to define further work steps on	this basis.	
	- assess possible consequences of their profess	ional activity.		
Workload in Hours	Independent Study Time 110, Study Time in Le	cture /U		
Credit points				
Course achievement				
Examination	Written exam			
Examination duration and	90 min			
scale				
-	Energy Systems: Core Qualification: Elective Co			
Following Curricula	Aircraft Systems Engineering: Core Qualificatio	' '	.	
	International Management and Engineering: Specialisation II. Product Development and Production: Elective Compulsory			
	Materials Science: Specialisation Engineering N	• •		
	Mechanical Engineering and Management: Cor	• •	activa Commularia	
	Product Development, Materials and Production	·		
	Product Development, Materials and Production	·	ipuis01 y	
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 Wind Energies			
	Theoretical Mechanical Engineering: Specialisa		arv.	
	medical mechanical Engineering, specialisa	aon Materiais Science. Liective Compuiso	'' J	

Course L1894: Structure and properties of fibre-polymer-composites		
Тур	Lecture	
Hrs/wk	2	
СР	3	
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28	
Lecturer	Prof. Bodo Fiedler	
Language	EN	
Cycle	SoSe	
Content	- 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 Deckker, New York	

Course L2614: Structure and	Course L2614: Structure and properties of fibre-polymer-composites		
Тур	Project-/problem-based Learning		
Hrs/wk	2		
СР	2		
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28		
Lecturer	Prof. Bodo Fiedler		
Language	DE/EN		
Cycle	SoSe		
Content			
Literature			

Course L2613: Structure and	Course L2613: Structure and properties of fibre-polymer-composites		
Тур	Recitation Section (large)		
Hrs/wk	1		
СР	1		
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14		
Lecturer	Prof. Bodo Fiedler		
Language	EN		
Cycle	SoSe		
Content			
Literature			

Module M1344: Proce	essing of fibre-polymer-composites			
Courses				
Title		Тур	Hrs/wk	СР
Processing of fibre-polymer-compos	sites (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 in the basics of chemistry / physics / mat	erials science		
Knowledge				
Educational Objectives	After taking part successfully, students have reached	d the following learning results		
Professional Competence				
Knowledge	Students are able to give a summary of the technic relationships. They are capable of describing and language. They can explain the typical process of so	communicating relevant problems and ques	stions using a	·
Skills	Students can use the knowledge of fiber-reinforced testing and analysis.	composites (FRP) and its constituents (fiber ,	matrix) and	define the necessary
	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				
Social Competence	Students are able to cooperate in small, mixed-subj context of civil engineering. They are able to effect audience. Students have the ability to develop alter discuss advantages as well as drawbacks.	vely present and explain their results alone	or in groups	in front of a qualified
Autonomy				
Workload in Hours	Independent Study Time 124, Study Time in Lecture	56		
Credit points	6			
Course achievement	None			
Examination	Written exam			
Examination duration and	90 min			
scale				
Assignment for the	Materials Science: Specialisation Engineering Materi	als: Elective Compulsory	_	
Following Curricula	Mechanical Engineering and Management: Specialis	ation Materials: Elective Compulsory		
	Product Development, Materials and Production: Spe	ecialisation Product Development: Elective Co	mpulsory	
	Product Development, Materials and Production: Spe	ecialisation Production: Elective Compulsory		
	Product Development, Materials and Production: Spe	ecialisation Materials: Elective Compulsory		

Course L1895: Processing of	Course L1895: Processing of fibre-polymer-composites		
Тур	Lecture		
Hrs/wk	2		
СР	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		

Course L1516: From Molecul	e to Composites Part
Тур	Project-/problem-based Learning
Hrs/wk	2
СР	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Prof. Bodo Fiedler
Language	DE/EN
Cycle	SoSe
Content	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). 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. 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"). After the test during the "customer / supplier conversation" there is a mutual feedback-talk ("lessons learned") in order to ensure the continuous improvement.
Literature	Customer Request ("Handout")

Module M1174: Autor	nation Technology and Systems			
Module MII/4. Autor	nation reciniology and systems			
Courses				
litle		Тур	Hrs/wk	СР
automation Technology and Syster	ns (L2329)	Lecture	4	4
utomation Technology and Syster	ms (L2331)	Project-/problem-based Learning	1	1
utomation Technology and Syster	ns (L2330)	Recitation Section (small)	1	1
Module Responsible	Prof. Thorsten Schüppstuhl			
Admission Requirements	None			
Recommended Previous	without major course assessment			
Knowledge				
Educational Objectives	After taking part successfully, students have reached	the following learning results		
Professional Competence				
Knowledge	Students			
	 know the characteristic components of an autor 	mation systems and have good understand	ding of their int	eraction
	know methods for a systematical analysis of au		aning or circui mic	er decion
	have special competences in industrial robot ba			
Skills	Students are able to			
	analyze complex Automation tasks			
	 develop application based concepts and solutio 	ns		
	 design subsystems and integrate into one systems 			
	investigate and evaluate safety of machinery			
	 create simple programs for robots and program 	mable logic controllers		
	 design of circuit for pneumatic applications 			
D				
Personal Competence	Charles have a shift ha			
Social Competence	Students are able to			
	- find solutions for automation and handling tasks in g	roups		
	- develop solutions in a production environment with	gualified personnel at technical level and	roprosont docis	ions
	- develop solutions in a production environment with	qualified personner at technical level and i	epresent decis	10115.
Autonomy	Students are able to			
	analyze automation tasks independently			
	generate programs for robots and programmab	le logic devices autonomously		
	develop solutions for practice oriented tasks of			
	 design safety concepts for automation application 			
	assess consequences of their professional action			
	' '	·		
Workload in Hours	Independent Study Time 96, Study Time in Lecture 84			
Credit points	6			
Course achievement	None			
Examination	Written exam			
Examination duration and	120 min			
scale				
Assignment for the	International Management and Engineering: Specialisa	ation II. Product Development and Product	ion: Elective Co	mpulsory
Following Curricula	Product Development, Materials and Production: Spec	alisation Product Development: Elective C	ompulsory	
	Product Development, Materials and Production: Spec	alisation Production: Compulsory		
	Product Development, Materials and Production: Spec	alisation Materials: Elective Compulsory		
	Theoretical Mechanical Engineering: Specialisation Pro	duct Development and Production: Elective	e Compulsory	

Course L2329: Automation To	ourse L2329: Automation Technology and Systems		
Тур	Lecture		
Hrs/wk	4		
СР	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 T	Course L2331: Automation Technology and Systems		
Тур	Project-/problem-based Learning		
Hrs/wk	1		
СР	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 T	Course L2330: Automation Technology and Systems		
Тур	Recitation Section (small)		
Hrs/wk	1		
СР	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	Courses					
Title				Тур	Hrs/wk	СР
Robotics: Modelling and Control (L0168)				Integrated Lecture	4	4
Robotics: Modelling and Control (L1	.305)			Project-/problem-based Learning	2	2
Module Responsible	Dr. Martin Gomse					
Admission Requirements	None					
Recommended Previous	Fundamentals of elect	rical engineering				
Knowledge	Broad knowledge of m	echanics				
	Broad knowledge of fr	rectionies				
	Fundamentals of conti	rol theory				
Educational Objectives	After taking part succe	essfully, students have re	eached the following	ng learning results		
Professional Competence						
Knowledge	Students are able to d	escribe fundamental pro	perties of robots a	and solution approaches for multi	iple problems in	robotics.
Skills	Students are able to d	erive and solve equation	s of motion for va	rious manipulators.		
	Students can generate trajectories in various coordinate systems.					
	Students can design li	Students can design linear and partially nonlinear controllers for robotic manipulators.				
Personal Competence						
-	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	ne 90, Study Time in Lec	ture 64			
Course achievement	Compulsory Bonus	Form	Description			
Course achievement	Yes None	Subject theoretical		n PBL-Einheiten sowie Erreic	hen des Gesa	amtziels und der
		practical work	jeweiligen Se	ssion-Ziele		
Examination	Written exam					
Examination duration and	120 min					
scale						
Assignment for the	Aircraft Systems Engineering: Core Qualification: Elective Compulsory					
Following Curricula	International Management and Engineering: Specialisation II. Product Development and Production: Elective Compulsory			npulsory		
	International Management and Engineering: Specialisation II. Mechatronics: Elective Compulsory					
	_	ng and Management: Cor	e Qualification: Co	ompulsory		
		Materials and Bradustia	a. Cassis!!+!- 5	reduct Davidons Flort 0	· manulaa · · ·	
	· ·	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				
		Theoretical Mechanical Engineering: Specialisation Robotics and Computer Science: Elective Compulsory Theoretical Mechanical Engineering: Specialisation Product Development and Production: Elective Compulsory				
		5gp				

Course L0168: Robotics: Mod	Course L0168: Robotics: Modelling and Control		
Тур	Integrated Lecture		
Hrs/wk	4		
СР	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	
Тур	Project-/problem-based Learning
Hrs/wk	2
СР	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

Production"				
Module M0771: Flight	t Physics			
Courses				
Title		Тур	Hrs/wk	СР
Aerodynamics and Flight Mechanic	s 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	Basic knowledge in:			
Knowledge				
	Mathematics			
	Mechanics			
	Thermodynamics			
	Aviation			
Educational Objectives	After taking part successfully, students have reached the	e following learning results		
Professional Competence	5 p	5 5		
•	Students are able to			
Kilowieuge	Stadents are able to			
	 Describe the fundamental equations of aerodynar 	nics for compressible, incompressible	and frictional flo	W
	Explain the principles of wings and profiles			
	 Explain the aircraft equations of motion 			
	 Evaluate aircraft performance and stability 			
	Describe the dynamics of the longitudinal and late	eral motion		
	Describe methods of flight simulation and airborn	e measurement technology		
Skills	Students are able to Perform flight mechanic simulations Derive flight mechanic relations from virtual and relations.	eal flight test data		
Personal Competence				
Social Competence	Students are able to:			
	Perform simulations in groups and discuss results			
	Evaluate flight test data in groups, discuss and pr	ecent the recults		
	Evaluate hight test data in groups, discuss and pr	esent the results		
Autonomy	Students are able to:			
	Process teaching content independently			
	Prepare, work out and process simulation models	independently		
	Apply teaching content on virtual and real flight to			
Mr	Independent Chiefe Time OC Chiefe T			
Workload in Hours Credit points				
Course achievement				
Examination	Written exam			
Examination duration and	120 Minutes (WS) + 90 Minutes (SS)			
scale	Alicenta Contagned Franciscopies Co. Co. 195 - 11	I		
Assignment for the	Aircraft Systems Engineering: Core Qualification: Compu	•		
Following Curricula	International Management and Engineering: Specialisation	•		
	Product Development, Materials and Production: Special	·		
	Product Development, Materials and Production: Special	·	-	
	Product Development, Materials and Production: Special	·	-	
	Theoretical Mechanical Engineering: Specialisation Aircra	art Systems Engineering: Elective Cor	npulsory	

Course L0727: Aerodynamics	s and Flight Mechanics I
Тур	Lecture
Hrs/wk	3
СР	3
Workload in Hours	Independent Study Time 48, Study Time in Lecture 42
Lecturer	Prof. Frank Thielecke, Dr. Ralf Heinrich
Language	DE
Cycle	WiSe
Content	 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	 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 Mechan	nics II
Тур	Lecture
Hrs/wk	2
СР	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Prof. Frank Thielecke
Language	
Cycle	SoSe
Content	stationary asymmetric flight dynamics of lateral movement methods of flight simulation eyperimental methods of flight mechanics model validation using system identification wind tunnel techniques
Literature	 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	
Тур	Recitation Section (large)
Hrs/wk	1
СР	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: Produ	ect Planning			
Courses				
Title		Тур	Hrs/wk	СР
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	Good basic-knowledge of Business Administration			
Knowledge				
	After taking part successfully, students have reached the	following learning results		
Professional Competence				
Knowledge	Students will gain insights into:			
	Product Planning			
	• Process			
	 Methods 			
	Design thinking			
	 Process 			
	 Methods 			
	 User integration 			
Skills	Students will gain deep insights into:			
	Product Planning			
	 Process-related aspects 			
	 Organisational-related aspects 			
	 Human-Ressource related aspects 			
	 Working-tools, methods and instruments 			
	0			
Personal Competence				
Social Competence				
,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,	Interact within a team			
	 Raise awareness for globabl issues 			
Autonomy				
•	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 Descrip	otion		
	Yes 20 % Subject theoretical and			
	practical work			
Examination				
Examination duration and	90 minutes			
scale	Clabel Innovation Management Comp Confidential Co	leen.		
Assignment for the	Global Innovation Management: Core Qualification: Comp	·	nnulsor,	
Following Curricula	International Management and Engineering: Specialisatio Mechanical Engineering and Management: Specialisation		ripuisoi y	
	Product Development, Materials and Production: Specialisation		nmnulsory	
	Product Development, Materials and Production: Specialis	·	Jiiipuisoi y	
	Product Development, Materials and Production: Specialis	• • •		
	Theoretical Mechanical Engineering: Specialisation Product		e Compulsorv	
	3	2.36	p	

Course L0851: Product Plann	ing
Тур	Lecture
Hrs/wk	3
СР	3
Workload in Hours	Independent Study Time 48, Study Time in Lecture 42
Lecturer	Prof. Cornelius Herstatt
Language	EN
Cycle	WiSe
Content	Product Planning Process
	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.: • 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 Voluntary presentations in the third hour (articles / case studies) - Guest lectures by researchers - Lecture on Sustainability with frequent reference to current research - Permanent reference to current research Examination: 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.
Literature	Ulrich, K./Eppinger, S.: Product Design and Development, 2nd. Edition, McGraw-Hill 2010
	L Control of the Cont

Course L0853: Product Planning Seminar		
Тур	Project-/problem-based Learning	
Hrs/wk	2	
СР	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 choosen independantly.	
Literature	See lecture information "Product Planning".	

Courses				
Fitle		Тур	Hrs/wk	СР
Integrated Pollution Control (L0502) Health, Safety and Environmental Management (L0387)		Lecture Lecture	2	2
Health, Safety and Environmental N		Recitation Section (small)	1	1
Module Responsible	-	rectation section (smail)		
Admission Requirements	·			
Recommended Previous				
Knowledge	 Good knowledge in Technologies for Env 	vironmental Protection (end-of-pipe, integrate	ed solutions)	
i.i.o.ii.ougo	 Good knowledge of the relevant Environ 	mental Legislation		
	Basic knowledge of instruments for Envi	ronmental Assessment		
Educational Objectives	After taking part successfully, students have re	eached the following learning results		
Professional Competence	,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,			
•	The students are able to describe the basics	of regulations, economic instruments, volu	ıntarv initiatives.	fundamentals of H
	legislation ISO 14001, EMAS and Responsible			
	substance cycles and approaches from end-			
	knowledge of complex industry related proble			
	carry out innovative technical solutions, reme			
	approaches in the full range of problems in diff			
	,,			
Skills	Students are able to assess current problems	and situations in the field of environmental	protection. They	can consider the be
	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 car			
	solve problems on a technical, administrative a			,
		-		
Personal Competence				
Social Competence	The students can work together in internationa	al groups.		
Autonomy	Students are able to organize their work flow	to prepare themselves for presentations and	contributions to	the discussions. Th
	can acquire appropriate knowledge by making	enquiries independently.		
Workload in Hours	Independent Study Time 110, Study Time in Le	ecture 70		
Credit points				
Course achievement				
Examination				
Examination duration and scale	190 min			
	Civil Engineering: Specialisation Water and Tra	offic: Flortive Compulsory		
Assignment for the Following Curricula	Civil Engineering: Specialisation Water and Tra Bioprocess Engineering: Specialisation C - I		Management and	Controlling: Flecti
ronowing curricula	Compulsory	blocconomic Process Engineering, Focus 1	nanagement and	Controlling. Liect
	Environmental Engineering: Core Qualification:	Compulsory		
	Joint European Master in Environmental Studie		ater: Flective Com	nulsorv
	Joint European Master in Environmental Studie:	• •		
	Product Development, Materials and Production			
	Product Development, Materials and Production			
		p = a a a a a a a culotti. Elective Collipui	;	
			orv	
	Product Development, Materials and Production	n: Specialisation Materials: Elective Compulso	•	
		n: Specialisation Materials: Elective Compulso ntal Process Engineering: Elective Compulso	•	

Course L0502: Integrated Po	llution Control
Тур	Lecture
Hrs/wk	2
СР	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Prof. Ralf Otterpohl
Language	EN
Cycle	WiSe
Content	The lecture focusses on:
	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	Förstner, Ulrich (1998): Integrated Pollution Control, Springer-Verlag Berlin Heidelberg, ISBN 978-3-642-80313-0 Shen, Thomas T. (1999): Industrial Pollution Prevention, Springer-Verlag Berlin Heidelberg, ISBN 978-3-540-65208-3

Course L0387: Health, Safety	y and Environmental Management
Тур	Lecture
Hrs/wk	2
СР	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Hans-Joachim Nau
Language	EN
Cycle	WiSe
Content	 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	C. Stephan: Industrial Health, Safety and Environmental Management, MV-Verlag, Münster, 2007/2012 (can be found in the library under GTG 315) Exercises can be downloaded from StudIP

Course L0388: Health, Safety	ourse L0388: Health, Safety and Environmental Management	
Тур	Recitation Section (small)	
Hrs/wk	1	
СР	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	

ction Planning & Control an	d Digital Enterprise					
Typ Hrs/wk CP						
	Lecture	2	2			
0929)	Lecture	2	2			
0930)	Recitation Section (small)	1	1			
933)	Recitation Section (small)	1	1			
Prof. Hermann Lödding						
None						
Fundamentals of Production and Quality	Management					
After taking part successfully, students h	ave reached the following learning results					
Students can explain the contents of the	module in detail and take a critical position to them					
Students are capable of choosing and ap	·					
. ,		·				
Students can develop joint solutions in m	nixed teams and present them to others.					
-						
Independent Study Time 96, Study Time	in Lecture 84					
None						
Written exam						
180 Minuten						
International Management and Engineeri	ng: Specialisation II. Product Development and Prod	uction: Elective Co	ompulsory			
Logistics, Infrastructure and Mobility: Spe	ecialisation Production and Logistics: Elective Compu	llsory				
Biomedical Engineering: Specialisation A	rtificial 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 M	lanagement and Business Administration: Compulso	ry				
Product Development, Materials and Prod	duction: Specialisation Product Development: Electiv	e Compulsory				
Product Development, Materials and Prod	duction: Specialisation Production: Compulsory					
Product Development, Materials and Prod	duction: Specialisation Materials: Elective Compulsor	у				
Theoretical Mechanical Engineering: Spec	cialisation Product Development and Production: Ele	ctive Compulsory				
	20929) 20930) 20930) 20933) Prof. Hermann Lödding None Fundamentals of Production and Quality After taking part successfully, students in Students can explain the contents of the Students are capable of choosing and ap Students can develop joint solutions in m Independent Study Time 96, Study Time None Written exam 180 Minuten International Management and Engineeri Logistics, Infrastructure and Mobility: Spe Biomedical Engineering: Specialisation A Biomedical Engineering: Specialisation In Biomedical Engineering: Specialisation M Biomedical Engineering: Specialisation M Product Development, Materials and Product Development Product Development Product Development Product Development Product Deve	Degap) Lecture Recitation Section (small) Recitation Section (small) Recitation Section (small) Prof. Hermann Lödding None Fundamentals of Production and Quality Management After taking part successfully, students have reached the following learning results 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 industriations of the students are capable of choosing and applying models and methods from the module to industriations of them Students can develop joint solutions in mixed teams and present them to others. Independent Study Time 96, Study Time in Lecture 84 None Written exam International Management and Engineering: Specialisation II. Product Development and Product Logistics, Infrastructure and Mobility: Specialisation Production and Logistics: Elective Compusionedical Engineering: Specialisation Implants and Endoprostheses: Elective Compusionedical Engineering: Specialisation Medical Technology and Control Theory: Elective Combiomedical Engineering: Specialisation Management and Business Administration: Compulsor Product Development, Materials and Production: Specialisation Product Development: Elective Product Development, Materials and Production: Specialisation Materials: Elective Compulsory Product Development, Materials and Production: Specialisation Materials: Elective Compulsory Product Development, Materials and Production: Specialisation Materials: Elective Compulsory Product Development, Materials and Production: Specialisation Materials: Elective Compulsory Product Development, Materials and Production: Specialisation Materials: Elective Compulsory Product Development, Materials and Production: Specialisation Materials: Elective Compulsory Product Development, Materials and Production: Specialisation Materials: Elective Compulsory Product Development, Materials and Production: Specialisation Materials: Elective Compulsory Product Development.	Typ Hrs/wk Lecture 2 1929) Lecture 2 1930) Recitation Section (small) 1 1933) Recitation Section (small) 1 1 Prof. Hermann Lödding None Fundamentals of Production and Quality Management After taking part successfully, students have reached the following learning results 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. - Independent Study Time 96, Study Time in Lecture 84 6 None Written exam 180 Minuten International Management and Engineering: Specialisation II. Product Development and Production: Elective Compulsory Biomedical Engineering: Specialisation Implants and Endoprostheses: Elective Compulsory Biomedical Engineering: Specialisation Implants and Endoprostheses: Elective Compulsory Biomedical Engineering: Specialisation Management and Busineess Administration: 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 Product Development: Elective Compulsory			

Course L0932: The Digital En	nterprise
Тур	Lecture
Hrs/wk	2
СР	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: 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, AW.: 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		
Тур	Lecture	
Hrs/wk	2	
СР	2	
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28	
Lecturer	Prof. Hermann Lödding	
Language	DE	
Cycle	WiSe	
Content	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	 Vorlesungsskript Lödding, H: Verfahren der Fertigungssteuerung, Springer 2008 Nyhuis, P.; Wiendahl, HP.: Logistische Kennlinien, Springer 2002 	

Course L0930: Production Planning and Control		
Тур	Recitation Section (small)	
Hrs/wk	1	
СР	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		
Тур	Recitation Section (small)	
Hrs/wk	1	
СР	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	Siehe korrespondierende Vorlesung	
	See interlocking course	

Module M0962: Susta	inability and Risk Managemer	nt		
Courses				
Title		Тур	Hrs/wk	СР
Safety, Reliability and Risk Assessm		Seminar	2	3
Environment and Sustainability (L0		Lecture	2	3
Module Responsible				
Admission Requirements				
Recommended Previous	none			
Knowledge				
Educational Objectives	After taking part successfully, students hav	e reached the following learning results		
Professional Competence				
Knowledge		niques and to give an overview for the field	of safety and risk as	sessment as well as
	environmental and sustainable engineering	, in detail:		
	 basics in safety and reliability of tech 	nnical facilities		
	safety and reliability analysis method	ds		
	 risk assessment 			
	 Production and usage of bio-char 			
	 energy production and supply 			
	 sustainable product design 			
Skills	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 co	oncepts.	
Personal Competence				
Social Competence				
·	Students can gain knowledge of the subje	ct area from given sources and transform it	to new questions. Fu	rthermore they can
riaconomy		rch-oriented duties in for risk management ar		
	the potential social, economic and cultural		,	
	·	·		
Workload in Hours	Independent Study Time 124, Study Time in	n Lecture 56		
Credit points	6			
Course achievement	None			
Examination	Written elaboration			
Examination duration and	Elaboration and presentation (45 minutes in	n groups)		
scale				
Assignment for the	Civil Engineering: Core Qualification: Comp	ulsory		
Following Curricula	Bioprocess Engineering: Specialisation C	- Bioeconomic Process Engineering, Focus	Management and	Controlling: Elective
	Compulsory			
		: Specialisation II. Civil Engineering: Elective (
	·	ction: Specialisation Product Development: Ele		
	·	ction: Specialisation Production: Elective Com	•	
		ction: Specialisation Materials: Elective Compu	usory	
	Water and Environmental Engineering: Core	e Qualification: Compulsory		

Course L1145: Safety, Reliab	ility and Risk Assessment
Тур	Seminar
Hrs/wk	2
СР	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Dr. Marco Ritzkowski
Language	DE
Cycle	WiSe
	An introduction in safety and risk assessment is given and some typical problems of structural and environmental engineering are treated: • basics in safety and reliability of technical facilities • safety and reliability analysis methods • risk assessment • practical examples and excursions • discussions and presentations
Literature	- Vorlesungsunterlagen - Schneider, J., Schlatter, H.P.: Sicherheit und Zuverlässigkeit im Bauwesen. www.risksafety.ch/files/ sicherheit_ und_zuverlaessigkeit.pdf

Course L0319: Environment and Sustainability			
Тур	Lecture		
Hrs/wk	2		
СР	3		
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28		
Lecturer	Prof. Kerstin Kuchta		
Language	EN		
Cycle	WiSe		
Content	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.		
	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		
	Recycling of Wind Turbines		
	Alternative Mobility		
	Disposal of Nuclear Wastes		
	Waste2Energy		
	Offshore Wind energy		
Literature	Wird in der Veranstaltung bekannt gegeben.		

Courses					
Title		Тур	Hrs/wk	СР	
Integrated Product Development II	(L1254)	Lecture	3	3	
Integrated Product Development II	(L1255)	Project-/problem-based Learnin	ng 2	3	
Module Responsible	Prof. Dieter Krause				
Admission Requirements	None				
Recommended Previous	Basic knowledge of Integrated product developme	ent and applying CAE systems			
Knowledge					
Educational Objectives	After taking part successfully, students have reac	hed the following learning results			
Professional Competence					
Knowledge	After passing the module students are able to:				
	 explain technical terms of design methodo 	logy,			
	 describe essential elements of construction 	n management,			
	describe current problems and the current	state of research of integrated product deve	lopment.		
Skills	After passing the module students are able to:				
	 select and apply proper construction metl 	nods for non-standardized solutions of prob	lems as well as	adapt new boundar	
	conditions,			,	
	 solve product development problems with the assistance of a workshop based approach, 				
	choose and execute appropriate moderation				
Personal Competence					
•	After passing the module students are able to:				
,					
	prepare and lead team meetings and mode	eration processes,			
	work in teams on complex tasks,				
	 represent problems and solutions and advantage 	nce ideas.			
Autonomy	After passing the module students are able to:				
	 give a structured feedback and accept a cr 	itical feedback.			
	implement the accepted feedback autonom				
Workload in Hours	Independent Chiedu Timo 110 Chiedu Timo in Lech				
Credit points		ine 70			
Course achievement					
Examination					
Examination duration and					
scale	30 Minuten				
Assignment for the	Aircraft Systems Engineering: Core Qualification:	Elective Compulsory			
Following Curricula			stion, Flostivo C	ompulsory	
rollowing curricula			ction. Elective C	ompuisory	
	Mechatronics: Specialisation System Design: Elec		con		
	Product Development, Materials and Production:				
	Product Development, Materials and Production:				
	Product Development, Materials and Production:	•			
	Theoretical Mechanical Engineering: Specialisatio	n Broduct Dovolonment and Broducti Fl-	tivo Communia	,	

Production"				
Course L1254: Integrated Pro	oduct Development II			
Тур	Lecture			
Hrs/wk	3			
СР	3			
Workload in Hours	Independent Study Time 48, Study Time in Lecture 42			
Lecturer	Prof. Dieter Krause			
Language	DE			
Cycle	WiSe			
Content	Lecture			
	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.			
	Topics of the course include in particular:			
	Methods of product development,			
	Presentation techniques,			
	Industrial Design,			
	Design for variety			
	Modularization methods,			
	Design catalogs,			
	Adapted QFD matrix,			
	Systematic material selection,			
	Assembly oriented design,			
	onstruction management			
	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.			
	Exercise (PBL)			
	In the exercise the content presented in the lecture "Integrated Product Development II" and methods of product development and design management will be enhanced.			
	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.			
Litanatura				
Literature	 Andreasen, 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 Pr	urse L1255: Integrated Product Development II		
Тур	Project-/problem-based Learning		
Hrs/wk	2		
СР	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		

Production				
Module M1155: Aircra	aft Cabin Systems			
Courses				
Title	Тур		Hrs/wk	СР
Aircraft Cabin Systems (L1545)	Lecture		3	4
Aircraft Cabin Systems (L1546)	Recitation	on Section (large)	1	2
Module Responsible	Prof. Ralf God			
Admission Requirements	None			
Recommended Previous	Basic knowledge in:			
Knowledge	Mathematics			
	Mechanics			
	Thermodynamics			
	Electrical Engineering			
	Control Systems			
Educational Objectives	After taking part successfully, students have reached the following learni	na results		
Professional Competence		3		
	Students are able to:			
	describe cabin operations, equipment in the cabin and cabin Systems			
	explain the functional and non-functional requirements for cabin Syster	ms		
	elucidate the necessity of cabin operating systems and emergency Systems			
	assess the challenges human factors integration in a cabin environmen	t		
61.11	Chi dente que able te.			
SKIIIS	Students are able to:			
	design a cabin layout for a given business model of an Airline design sabin systems for safe appraisance			
	design cabin systems for safe operations design emergency systems for safe man-machine interaction			
	solve comfort needs and entertainment requirements in the cabin			
	- solve conflort needs and entertainment requirements in the cabin			
Personal Competence				
Social Competence	Students are able to:			
	comprehend existing system solutions and explain them on the basis o	f existing requirements		
	discuss with experts in technical language			
	explain system functions			
	classify the criticality of functions			
	describe systems as is			
Autonomy	Students are able to:			
	independently reflect on lecture content and expert presentations			
	independently develop more in-depth content			
	recognize further areas of knowledge			
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56			
Credit points Course achievement				
Examination				
Examination Examination and				
examination duration and scale				
Assignment for the		aring: Flective Compulse:	rv	
-		ering: Elective Compulso	ТУ	
ronowing Curricula	Energy Systems: Specialisation Energy Systems: Elective Compulsory Aircraft Systems Engineering: Core Qualification: Compulsory			
	International Management and Engineering: Specialisation II. Aviation Sys	stems: Elective Compule	orv	
	Product Development, Materials and Production: Specialisation Product D			
	Product Development, Materials and Production: Specialisation Product D		pui50i y	
	Product Development, Materials and Production: Specialisation Production			
	Theoretical Mechanical Engineering: Specialisation Aircraft Systems Engin		Isory	
	J	, J =:==::: c copu	- ,	

Course L1545: Aircraft Cabin	Systems
Тур	Lecture
Hrs/wk	3
СР	4
Workload in Hours	Independent Study Time 78, Study Time in Lecture 42
Lecturer	Prof. Ralf God
Language	DE
Cycle	WiSe
Content	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.
	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: • 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	- Skript zur Vorlesung - Jenkinson, L.R., Simpkin, P., Rhodes, D.: Civil Jet Aircraft Design. London: Arnold, 1999 - Rossow, CC., 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	Course L1546: Aircraft Cabin Systems	
Тур	Recitation Section (large)	
Hrs/wk	1	
СР	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: Fluidi	cs			
Courses				
Title Fluidics (L1256) Fluidics (L1371)		Typ Lecture Project-/problem-based Learning	Hrs/wk 2 1	CP 3 2
Fluidics (L1257)	T	Recitation Section (large)	1	1
Module Responsible	Prof. Dieter Krause			
	None Good knowledge of mechanics (stereo statics, elastosta engineering design	atics, hydrostatics, kinematics and	kinetics), flu	d mechanics, and
Educational Objectives	After taking part successfully, students have reached the foll	lowing learning results		
Professional Competence Knowledge	After passing the module students are able to explain structures and functionalities of hydrostatic, p explain the interaction of hydraulic components in hyd explain open and closed loop control of hydraulic syst describe functioning and applications of hydrodynami and aggregates in plant technology	draulic systems, ems,		s centrifugal pumps
Skills	After passing the module students are able to • analyse and assess hydraulic and pneumatic compone • design and dimension hydraulic systems for mechanic • perform numerical simulations of hydraulic systems be • select and adapt pump characteristic curves for hydra • dimension hydrodynamic torque converters and brake	cal applications, ased on abstract problem definitions aulic systems	i,	
Personal Competence Social Competence	After passing the module students are able to discuss and present functional context in groups, organise teamwork autonomously.			
Autonomy	After passing the module students are able to • obtain necessary knowledge for the simulation.			
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56			
Credit points	6			
Course achievement		n on hydrostatischer Systeme		
Examination	Written exam			
Examination duration and scale Assignment for the Following Curricula	International Management and Engineering: Specialisation II. International Management and Engineering: Specialisation II. Product Development, Materials and Production: Specialisation	. Product Development and Production on Product Development: Compulsor	on: Elective Co	mpulsory
	Product Development, Materials and Production: Specialisation Product Development, Materials and Production: Specialisation Theoretical Mechanical Engineering: Specialisation Product D	on Materials: Elective Compulsory	e Compulsory	

Production"			
Course L1256: Fluidics			
Тур	Lecture		
Hrs/wk	2		
СР	3		
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28		
	Prof. Dieter Krause		
Language			
Cycle			
Content	Lecture		
	Hydrostatics		
	physical fundamentals		
	hydraulic fluids		
	hydrostatic machines .		
	• valves		
	• components		
	hydrostatic transmissions		
	examples from industry		
	Pneumatics		
	generation of compressed air		
	pneumatic motors		
	Examples of use		
	Hydrodynamics		
	rydiodynamics		
	physical fundamentals		
	hydraulic continous-flow machines		
	hydrodynamic transmissions		
	interoperation of motor and transmission		
	orriso		
	kercise		
	Hydrostatics		
	reading and design of hydraulic diagrams		
	dimensioning of hydrostatic traction and working drives		
	performance calculation		
	Hydrodynamics		
	calculation / dimensioning of hydrodynamic torque converters		
	calculation / dimensioning of centrifugal pumps		
	creating and reading of characteristic curves of pumps and systems		
	Field trip		
	field trip to a regional company from the hydraulic industry.		
	Exercise		
	Numerical simulation of hydrostatic systems		
	 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		
I lhaush	Püchor		
Literature			
	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, KH.: Dubbel - Taschenbuch für den Maschinenbau, Springer-Verlag, Berlin, aktuelle Auflage		
	Clarist Tury Vordening		
	Skript zur Vorlesung		

Course L1371: Fluidics	
Тур	Project-/problem-based Learning
Hrs/wk	1
СР	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	
Тур	Recitation Section (large)
Hrs/wk	1
СР	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		Тур	Hrs/wk	СР
Laser Systems and Process Techno	logies (L1612)	Lecture	2	3
Methods for Analysing Production F	rocesses (L0876)	Lecture	2	3
Module Responsible	Prof. Wolfgang Hintze			
Admission Requirements	None			
Recommended Previous				
Knowledge				
Educational Objectives	After taking part successfully, stude	nts have reached the following learning results		
Professional Competence				
Knowledge				
Skills				
Personal Competence				
Social Competence				
Autonomy				
Workload in Hours	Independent Study Time 124, Study	Time in Lecture 56		
Credit points	6			
Course achievement	None			
Examination	Written exam			
Examination duration and	180 min			
scale				
Assignment for the	Product Development, Materials and Production: Specialisation Product Development: Elective Compulsory			
Following Curricula	Product Development, Materials and	Production: Specialisation Production: Compulsory		
	Product Development, Materials and	Production: Specialisation Materials: Elective Comp	ulsory	
	Theoretical Mechanical Engineering:	Specialisation Product Development and Production	n: Elective Compulsory	

Course L1612: Laser Systems	s and Process Technologies
Тур	Lecture
Hrs/wk	2
СР	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Prof. Claus Emmelmann
Language	EN
Cycle	WiSe
Content	 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	 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	
Тур	Lecture
Hrs/wk	2
СР	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Prof. Wolfgang Hintze
Language	DE
Cycle	WiSe
Content	 Modelling and simulation of maching and forming processes Numerical simulation of forces, temperatures, deformation in machining Analysis of vibration problems in maching (chatter, modal analysis,) Knowledge based process planning Design of experiments Machinability of nonmetallic materials Analysis of interaction between maching process and machine tool systems with regard to process stability and quality Simulation of maching processes by virtual reality methods
Literature	Tönshoff, H.K.; Denkena, B.; Spanen Grundlagen, Springer (2004) Klocke, F.; König, W.; Fertigungsverfahren Umformen, Springer (2006) Weck, M.; Werkzeugmaschinen Fertigungssysteme 3, Springer (2001) Weck, M.; Werkzeugmaschinen Fertigungssysteme 5, Springer (2001)

Module M1342: Polyn	ieis			
Courses				
Title		Тур	Hrs/wk	СР
Structure and Properties of Polymers (L0389)		Lecture	2	3
Processing and design with polyme	rs (L1892)	Lecture	2	3
Module Responsible	Dr. Hans Wittich			
Admission Requirements	None			
Recommended Previous	Basics: chemistry / physics / material science	е		
Knowledge				
Educational Objectives	After taking part successfully, students have	reached the following learning results		
Professional Competence				
Knowledge	Students can use the knowledge of plastics a	and define the necessary testing and analy	sis.	
	They can explain the complex relationships s	structure-property relationship and		
	the interactions of chemical structure of the	polymers, including to explain neighboring	contexts (e.g. sustaina	bility, environmenta
	protection).			
Skills	Students are capable of			
	 using standardized calculation methods evaluate the different materials. 	in a given context to mechanical prope	rties (modulus, streng	th) to calculate and
	- selecting appropriate solutions for mechan	ical recycling problems and sizing example	e stiffness, corrosion res	sistance.
Personal Competence				
Social Competence	Students can			
	- arrive at funded work results in heterogeniu	us groups and document them.		
	- provide appropriate feedback and handle fe	eedback on their own performance constru	ctively.	
Autorom	Charles have a his ha			
Autonomy	Students are able to			
	- assess their own strengths and weaknesses	5.		
	- assess their own state of learning in specific	c terms and to define further work steps or	n this basis.	
	access possible consequences of their profe	ossional activity		
	- assess possible consequences of their profe	essional 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	180 min			
scale				
Assignment for the	Materials Science: Specialisation Engineering	Materials: Elective Compulsory		
Following Curricula	Biomedical Engineering: Specialisation Impla	ants and Endoprostheses: Compulsory		
	Biomedical Engineering: Specialisation Artific	· ·	, ,	
	Biomedical Engineering: Specialisation Mana			
	Biomedical Engineering: Specialisation Medic			
	Product Development, Materials and Product	•	. ,	
	Product Development, Materials and Product			
	Product Development, Materials and Product	·	, ,	
	Theoretical Mechanical Engineering: Speciali	sation Materials Science: Elective Compuls	ы у	

Course L0389: Structure and Properties of Polymers	
Тур	Lecture
Hrs/wk	2
СР	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Dr. Hans Wittich
Language	DE
Cycle	WiSe
Content	- Structure and properties of polymers
	- Structure of macromolecules
	Constitution, Configuration, Conformation, Bonds, Synthesis, Molecular weihght distribution
	- Morphology
	amorph, crystalline, blends
	- Properties
	Elasticity, plasticity, viscoelacity
	- Thermal properties
	- Electrical properties
	- Theoretical modelling
	- Applications
Literature	Ehrenstein: Polymer-Werkstoffe, Carl Hanser Verlag

Course L1892: Processing an	d design with polymers
Тур	Lecture
Hrs/wk	2
СР	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	Manufacturing of Polymers: General Properties; Calendering; Extrusion; Injection Moulding; Thermoforming, Foaming; Joining
	Designing with Polymers: Materials Selection; Structural Design; Dimensioning
Literature	Osswald, Menges: Materials Science of Polymers for Engineers, Hanser Verlag
	Crawford: Plastics engineering, Pergamon Press
	Michaeli: Einführung in die Kunststoffverarbeitung, Hanser Verlag
	Konstruieren mit Kunststoffen, Gunter Erhard , Hanser Verlag

Module M1185: Techr	nical 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	See selected module according to FSPO
Knowledge	
Educational Objectives	After taking part successfully, students have reached the following learning results
Professional Competence	
Knowledge	see selected module according to FSPO
Skills	see selected module according to FSPO
Personal Competence	
Social Competence	see selected module according to FSPO
Autonomy	see selected module according to FSPO
Workload in Hours	Depends on choice of courses
Credit points	6
Assignment for the	Product Development, Materials and Production: Specialisation Product Development: Elective Compulsory
Following Curricula	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			Тур	Hrs/wk	СР
Experimental Methods for the Char	acterization of Materials (L1580)		Lecture	2	2
Phase equilibria and transformation	ns (L1579)		Lecture	2	2
Übung zu Phänomene und Methode	en der Materialwissenschaft (L2991)		Recitation Section (large)	2	2
Module Responsible	Prof. Jörg Weißmüller				
Admission Requirements	None				
Recommended Previous	Basic knowledge in Materials Science, e.g. Werks	toffwissenschaft	t I/II		
Knowledge					
Educational Objectives	After taking part successfully, students have read	thed the following	ng learning results		
Professional Competence					
Knowledge	The students will be able to explain the properti	es of advanced	materials along with their ap	plications in tech	nology, in particular
	metallic, ceramic, polymeric, semiconductor, mo-	dern composite	materials (biomaterials) and	nanomaterials.	
Skills	The students will be able to select material co				
	materials considering architectural principles fr			3	
	modern materials science, which enables th	em to select	optimum materials combin	ations dependir	ng on the technical
	applications.				
Personal Competence					
-	The students are able to present solutions to spe	cialists and to d	evelop ideas further.		
Autonomy	The students are able to				
Autonomy	The students are able to				
	 assess their own strengths and weaknesse 	es.			
	 gather new necessary expertise by their or 	wn.			
Workload in Hours	Independent Study Time 96, Study Time in Lectu	re 84			
Credit points					
Course achievement					
Examination	Written exam				
Examination duration and	90 min				
scale					
Assignment for the	International Management and Engineering: Spec	cialisation II. Pro	duct Development and Produ	ction: Elective Co	ompulsory
Following Curricula	Materials Science: Core Qualification: Compulsory				
-	Product Development, Materials and Production:	Specialisation P	roduct Development: Elective	Compulsory	
	Product Development, Materials and Production:	Specialisation P	roduction: Elective Compulsor	y .	
	Product Development, Materials and Production:	Specialisation M	laterials: Compulsory		
	Theoretical Mechanical Engineering: Specialisation				
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Course L1580: Experimental	Methods for the Characterization of Materials
Тур	Lecture
Hrs/wk	2
СР	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Prof. Shan Shi
Language	EN
Cycle	WiSe
Content	 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	
Тур	Lecture
Hrs/wk	2
СР	2
Workload in Hours	Independent Study Time 32, 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	D.A. Porter, K.E. Easterling, "Phase transformations in metals and alloys", New York, CRC Press, Taylor & Francis, 2009, 3. Auflage Peter Haasen, "Physikalische Metallkunde", Springer 1994 Herbert B. Callen, "Thermodynamics and an introduction to thermostatistics", New York, NY: Wiley, 1985, 2. Auflage. Robert W. Cahn und Peter Haasen, "Physical Metallurgy", Elsevier 1996 H. Ibach, "Physics of Surfaces and Interfaces" 2006, Berlin: Springer.

Course L2991: Übung zu Phä	ourse L2991: Übung zu Phänomene und Methoden der Materialwissenschaft		
Тур	Recitation Section (large)		
Hrs/wk	2		
СР	2		
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28		
Lecturer	Prof. Shan Shi		
Language	DE		
Cycle	WiSe		
Content			
Literature			

Thesis

Module M-002: Maste	r Thesis
Courses	
Title	Typ Hrs/wk CP
Module Responsible	Professoren der TUHH
Admission Requirements	
	According to General Regulations §21 (1):
	At least 60 credit points have to be achieved in study programme. The examinations board decides on exceptions.
Recommended Previous	
Knowledge	
Educational Objectives	After taking part successfully, students have reached the following learning results
Professional Competence	
Knowledge	
	 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 subjections.
	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
	research.
Skills	The students are able:
	To select, apply and, if necessary, develop further methods that are suitable for solving the specialized problem in questio
	To apply knowledge they have acquired and methods they have learnt in the course of their studies to complex and/
	incompletely defined problems in a solution-oriented way.
	 To develop new scientific findings in their subject area and subject them to a critical assessment.
Dansanal Commetence	
Personal Competence Social Competence	Students can
30ciai competence	Students Can
	Both in writing and orally outline a scientific issue for an expert audience accurately, understandably and in a structure
	way.
	Deal with issues competently in an expert discussion and answer them in a manner that is appropriate to the addresser
	while upholding their own assessments and viewpoints convincingly.
Autonomy	Students are able:
riatoriomy	Students are usite.
	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 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	According to General Regulations
scale	
Assignment for the	
Following Curricula	
	Chemical and Bioprocess Engineering: Thesis: Compulsory
	Computer Science: Thesis: Compulsory Electrical Engineering: Thesis: Compulsory
	Energy Systems: Thesis: Compulsory
	Environmental Engineering: Thesis: Compulsory
	Aircraft Systems Engineering: Thesis: Compulsory
	Global Innovation Management: Thesis: Compulsory
	Computer Science in Engineering: Thesis: Compulsory
	Information and Communication Systems: Thesis: Compulsory
	Interdisciplinary Mathematics: Thesis: Compulsory
	International Production Management: 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

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