

Module Manual

Master of Science (M.Sc.)

Product Development, Materials and Production

Cohort: Winter Term 2023

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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)

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	 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	

ourses

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

Module M0603: Nonli	near Structural Analysis				
Courses					
Title			Гур	Hrs/wk	CP
Nonlinear Structural Analysis (L0277)			Lecture	3	4
Nonlinear Structural Analysis (L027			Recitation Section (small)	1	2
Module Responsible	Prof. Alexander Düster				
Admission Requirements	None				
Recommended Previous	Knowledge of partial differential equations is	recommended.			
Knowledge					
Educational Objectives	After taking part successfully, students have	reached the following	g learning results		
Professional Competence					
Knowledge	Students are able to				
	+ give an overview of the different nonlinear	r phenomena in struct	tural mechanics.		
	+ explain the mechanical background of non	nlinear phenomena in	structural mechanics.		
	+ to specify problems of nonlinear structura	al analysis, to identify	them in a given situation a	nd to explain the	eir mathematical and
	mechanical background.				
Skills	Students are able to				
Skins	+ model nonlinear structural problems.				
	+ select for a given nonlinear structural prob	blem a suitable compu	itational procedure.		
	+ apply finite element procedures for nonline				
	+ critically verify and judge results of nonline	•			
	+ to transfer their knowledge of nonlinear so		new problems.		
Personal Competence					
Social Competence	Students are able to				
	+ solve problems in heterogeneous groups.	.f			
	+ present and discuss their results in front o+ give and accept professional constructive				
	+ give and accept professional constructive	CHUCISIII.			
Autonomy	Students are able to				
Autonomy	+ assess their knowledge by means of exerc	rises and E-Learning			
	+ acquaint themselves with the necessary k		earch oriented tasks		
	+ to transform the acquired knowledge to si		caren onemed tasks		
		, , , , ,			
Workload in Hours	Independent Study Time 124, Study Time in	Lecture 56			
Credit points					
Course achievement					
Examination	Written exam				
Examination duration and	120 min				
scale					
Assignment for the	Civil Engineering: Specialisation Structural En	3 3	. ,		
Following Curricula	Civil Engineering: Specialisation Computation		•	vulcory.	
	International Management and Engineering:	•	Engineering: Elective Comp	ouis01 y	
	Materials Science: Specialisation Modeling: E		con/		
	Mechatronics: Technical Complementary Cou		oui y		
	Mechatronics: Specialisation System Design: Mechatronics: Core Qualification: Elective Co				
	Product Development, Materials and Product		a: Flective Compulsory		
	Naval Architecture and Ocean Engineering: 0				
	Ship and Offshore Technology: Core Qualifica				
	Theoretical Mechanical Engineering: Speciali			irv	
				.,	

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	
	4. Basic equations of continuum mechanics	
	5. Spatial discretization with finite elements	
	6. Solution of nonlinear systems of equations	
	7. Solution of elastoplastic problems	
	8. Stability problems	
	9. Contact problems	
Literature	[1] Alexander Düster, Nonlinear 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

Madula M0742: Thous	mal Engage Cychama
Module M0742: Therr	nai Energy Systems
Courses	
litle .	Typ Hrs/wk CP
hermal Engergy Systems (L0023)	Lecture 3 5
hermal Engergy Systems (L0024)	Recitation Section (large) 1 1
Module Responsible	Prof. Arne Speerforck
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 learning results
Professional Competence	
Knowledge	Students know the different energy conversion stages and the difference between efficiency and annual efficiency. They hav
	increased knowledge in heat and mass transfer, especially in regard to buildings and mobile applications. They are familiar wi
	German energy saving code and other technical relevant rules. They know to differ different heating systems in the domestic ar
	industrial area and how to control such heating systems. They are able to model a furnace and to calculate the transie
	temperatures in a furnace. They have the basic knowledge of emission formations in the flames of small burners and how
	conduct the flue gases into the atmosphere. They are able to model thermodynamic systems with object oriented languages.
Ckilla	Chudante are able to salaulate the heating damand for different heating grateries and to shoot the gritable companyon. They
SKIIIS	Students are able to calculate the heating demand for different heating systems and to choose the suitable components. They a
	able to calculate a pipeline network and have the ability to perform simple planning tasks, regarding solar energy. They can writ Modelica programs and can transfer research knowledge into practice. They are able to perform scientific work in the field
	thermal engineering.
	thermal engineering.
Personal Competence	
•	In lectures and exercises, the students can use many examples and experiments to discuss in small groups in a goal-oriente
Social competence	manner, develop a solution and present it. Within the exercises, the students can independently develop further questions at
	work out targeted solutions.
Autonomy	Students are able to define tasks independently, to develop the necessary knowledge themselves based on the knowledge the
ŕ	have received, and to use suitable means for implementation. In the exercises, the students discuss the methods taught in the
	lectures using complex tasks and critically analyze the results.
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56
Credit points	
Course achievement	
Examination	
Examination duration and	
scale	
Assignment for the	Bioprocess Engineering: Specialisation A - General Bioprocess Engineering: Elective Compulsory
Following Curricula	Energy Systems: Specialisation Energy Systems: Compulsory
	Energy Systems: Specialisation Marine Engineering: Elective Compulsory
	International Management and Engineering: Specialisation II. Energy and Environmental Engineering: Elective Compulsory
	Product Development, Materials and Production: Core Qualification: Elective Compulsory
	Renewable Energies: Core Qualification: Compulsory
	Theoretical Mechanical Engineering: Specialisation Energy Systems: Elective Compulsory
	Process Engineering: Specialisation Process Engineering: Elective Compulsory

Course L0023: Thermal Engergy Systems		
Тур	Lecture	
Hrs/wk	3	
СР	5	
Workload in Hours	Independent Study Time 108, Study Time in Lecture 42	
Lecturer	Prof. Arne Speerforck	
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 	

ourse 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
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				
Recommended Previous				
Knowledge	Calculus			
	Linear Algebra Train a sain a Machanian			
	Engineering Mechanics			
Educational Objectives	After taking part successfully, students have reached the	e following learning results		
Professional Competence				
Knowledge	Children are able to denote towns and concents (of Mikassian Theory and dovelon th	ana fi inthan	
	Students are able to denote terms and concepts of Students know methods of modeling and simulations.	·		ihrations
	Students know methods of modeling and simulation Students know about concepts of linear and nonlin		a parameter unvell v	ioracions.
	Students know basic tasks of vibration problems of the state of t	•	s.	
	·			
Skills	Students are able to denote methods of Vibration	Theory and develop them further		
	Students are able to apply and expand methods	of modeling and simulation for	free, forced, self-exc	ited and parameter
	driven vibrations.			
	Students are able to solve linear and nonlinear vib	oration problems.		
Personal Competence				
Social Competence				
,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,	Students can analyze vibration problems, work on		also in teams or grou	ıps.
	Students are able to document the results of vibra	ation studies also in groups.		
Autonomy				
	Students are able to individually analyze and solv			
	Students are able to approach individually research	ch 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				
Assignment for the				
Following Curricula				
	Mechanical Engineering and Management: Specialisation Mechatronics: Core Qualification: Compulsory	i Mechatronics: Elective Compulso	ory	
	Biomedical Engineering: Specialisation Artificial Organs	and Regenerative Medicine: Flecti	ve Compulsorv	
	Biomedical Engineering: Specialisation Implants and End	-		
	Biomedical Engineering: Specialisation Medical Technolo			
	Biomedical Engineering: Specialisation Management and			
	Product Development, Materials and Production: Core Qu	ualification: Compulsory		
	Naval Architecture and Ocean Engineering: Core Qualific	ation: Elective Compulsory		
	Theoretical Mechanical Engineering: Core Qualification: I	Elective Compulsory		

Course L0701: Vibration The	ory
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 Vibrations Free vibration Self-excited vibration Parameter driven vibration Forced vibration Multi degree of freedom vibration Continuum vibration Irregular vibration
Literature	German - K. Magnus, K. Popp, W. Sextro: Schwingungen. Physikalische Grundlagen und mathematische Behandlung von Schwingungen. English - K. Magnus: Vibrations.

Module M0808: Finite	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. Benedikt Kriegesmann			
Admission Requirements	None			
Recommended Previous	Mechanics I (Statics, Mechanics of Materials) and I	Mechanics II (Hydrostatics, Kinematics, Dyr	iamics)	
Knowledge	Mathematics I, II, III (in particular differential equa	tions)		
Educational Objectives	After taking part successfully, students have reach	ed the following learning results		
Professional Competence	3,000			
Knowledge	The students possess an in-depth knowledge regarding the derivation of the finite element method and are able to give an overview of the theoretical and methodical basis of the method.		are able to give an	
Skills	The students are capable to handle engineering p		ments, assemblin	ng 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 arrive 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 Lectu	re 56		
Credit points				
Course achievement	Compulsory Bonus Form No 20 % Midterm	Description		
Examination				
Examination duration and	120 min			
scale				
Assignment for the	Civil Engineering: Core Qualification: Compulsory			
Following Curricula	Energy Systems: Core Qualification: Elective Comp	pulsory		
	Aircraft Systems Engineering: Core Qualification: E	Elective Compulsory		
	International Management and Engineering: Speci	alisation II. Mechatronics: Elective Compuls	sory	
	International Management and Engineering: Speci	·	uction: Elective Co	ompulsory
	Aeronautics: Core Qualification: Elective Compulso	ry		
	Mechatronics: Core Qualification: Compulsory			
	Biomedical Engineering: Specialisation Implants an			
	Biomedical Engineering: Specialisation Manageme			
	Biomedical Engineering: Specialisation Medical Te	*		
	Biomedical Engineering: Specialisation Artificial Or Product Development, Materials and Production: C		соприіѕ0гу	
	Technomathematics: Specialisation III. Engineering	• •		
	Theoretical Mechanical Engineering: Core Qualification			
	Theoretical Mechanical Engineering, core Qualifica	acon. Compulsory		

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. Benedikt Kriegesmann
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. Benedikt Kriegesmann
Language	EN
Cycle	WiSe
Content	See interlocking course
Literature	See interlocking course

Module M0846: Contr	ol Systems Theory and Design			
	or bystems Theory and Besign			
Courses				
Title	(1.0555)	Тур	Hrs/wk	СР
Control Systems Theory and Desigr Control Systems Theory and Desigr		Lecture Recitation Section (small)	2	4
Module Responsible	NN	Recitation Section (Small)	-	2
	None			
	Introduction to Control Systems			
Knowledge	•			
Educational Objectives	After taking part successfully, students have rea	ached the following learning results		
Professional Competence				
Knowledge Skills	 Students can explain how linear dynamic systems are represented as state space models; they can interpret the system response to initial states or external excitation as trajectories in state space They can explain the system properties controllability and observability, and their relationship to state feedback and state estimation, respectively They can explain the significance of a minimal realisation They can explain observer-based state feedback and how it can be used to achieve tracking and disturbance rejection They can extend all of the above to multi-input multi-output systems They can explain the z-transform and its relationship with the Laplace Transform They can explain state space models and transfer function models of discrete-time systems They can explain the experimental identification of ARX models of dynamic systems, and how the identification problem car be solved by solving a normal equation They can explain how a state space model can be constructed from a discrete-time impulse response 			
Personal Competence Social Competence Autonomy	Students can work in small groups on specific problems to arrive at joint solutions.			
	Independent Study Time 124, Study Time in Lec	cture 56		
Credit points				
Course achievement				
Examination	Written exam			
Examination duration and scale	120 min			
	Electrical Engineering: Core Qualification: Comp	ulsory		
•	Energy Systems: Core Qualification: Elective Co	•		
	Aircraft Systems Engineering: Core Qualification	•		
	Aeronautics: Core Qualification: Elective Compu	• •		
	Mechanical Engineering and Management: Spec	ialisation Mechatronics: Elective Compulsory		
	Mechatronics: Core Qualification: Compulsory			
	Biomedical Engineering: Specialisation Artificial	*	Compulsory	
	Biomedical Engineering: Specialisation Implants			
	Biomedical Engineering: Specialisation Medical			
	Biomedical Engineering: Specialisation Manager Product Development, Materials and Production		ompuisory	
	Theoretical Mechanical Engineering: Core Qualif	• •		

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	NN	
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	
	- Maday/Jillulik	
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	NN
Language	EN
Cycle	WiSe
Content	See interlocking course
Literature	See interlocking course

Module M1173: Appli	ed Statistics			
Courses				
Title		Тур	Hrs/wk	СР
Applied Statistics (L1584)		Lecture	2	3
Applied Statistics (L1586)		Project-/problem-based Learning	2	2
Applied Statistics (L1585)		Recitation Section (small)	1	1
Module Responsible	Prof. Michael Morlock			
Admission Requirements	None			
Recommended Previous	Basic knowledge of statistical methods			
Knowledge				
Educational Objectives	After taking part successfully, students have reached the following	ng learning results		
Professional Competence				
Knowledge	Students can explain the statistical methods and 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 presentation of results			
Autonomy	To understand and interpret the question and solve			
Workload in Hours	Independent Study Time 110, Study Time in Lecture 70			
Credit points	6			
Course achievement	None			
Examination	Written exam			
Examination duration and	90 minutes, 28 questions			
scale				
Assignment for the	Mechanical Engineering and Management: Specialisation Manag	ement: Elective Compulsory		
Following Curricula	Mechatronics: Specialisation Intelligent Systems and Robotics: Elective Compulsory			
	Mechatronics: Specialisation System Design: Elective Compulsor	у		
	Mechatronics: Core Qualification: Elective Compulsory			
	Biomedical Engineering: Core Qualification: Compulsory			
	Product Development, Materials and Production: Core Qualificati	on: Elective Compulsory		
	Theoretical Mechanical Engineering: Specialisation Bio- and Med	ical Technology: Elective Compu	Isory	

Course L1584: Applied Statis	tics
Тур	Lecture
Hrs/wk	2
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	stics
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 M1150: Contin	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 mechanics as taught, e.g., in the modules Engineering	Mechanics I and Engineering	g Mechanics II a	t TUHH (forces and
Knowledge	moments, stress, linear strain, free-body principle, linear-elastic constitutive laws, strain energy); basics of mathematics as taught, e.g., in the modules Mathematics I and Mathematics II at TUHH			
Educational Objectives	After taking part successfully, students have reached the followin	g learning results		
Professional Competence				
Knowledge	In this module, students learn the fundamental concepts of nonlinear continuum mechanics. This theory enables students to describe arbitrary deformations of continuous bodies (solid, liquid or gaseous) under arbitrary loads. The module is a continuation of the basic module Engineering Mechanics II (elastostatics), the limiting assumptions (isotropic, linear-elastic material behavior, small deformations, simple geometries) of which are successively eliminated.			
	First, the students learn the necessary fundamentals of tensor ca of arbitrarily deformable bodies is dealt with. The students learn a body and for formulating the balance equations for mass, mo students know which constitutive assumptions have to be made f	the mathematical formalism f mentum, energy and entropy	or characterizing in various form	g the stress state of s. Furthermore, the
Skills	The students can set up balance laws and apply basics of defor research contexts.	mation theory to specific asp	ects, both in ap	plied contexts as in
Personal Competence				
Social Competence	The students are able to develop solutions also for complex prob form and to develop ideas further.	lems of solid mechanics, to pr	resent them to s	pecialists in written
Autonomy	The students are able to assess their own strengths and weakness problems in the area of continuum mechanics and acquire the kn		and on their ow	n 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 Compulsory			
Following Curricula	Mechanical Engineering and Management: Specialisation Material	s: Elective Compulsory		
	Biomedical Engineering: Specialisation Artificial Organs and Rege		mpulsory	
	Biomedical Engineering: Specialisation Implants and Endoprosthe			
	Biomedical Engineering: Specialisation Medical Technology and C	•	-	
	Biomedical Engineering: Specialisation Management and Business		pulsory	
	Product Development, Materials and Production: Core Qualification Theoretical Mechanical Engineering: Core Qualification: Elective C			
	Theoretical Piechanical Engineering. Core Qualification. Elective C	ompaisory		

Course L1533: Continuum Me	echanics
Hrs/wk	Lecture 2
CP	
	Independent Study Time 62, Study Time in Lecture 28
	Prof. Christian Cyron
Language	DE
Cycle	WiSe
Content	Continuum mechanics is a general theory to describe the effect of mechanical forces on continuous mechanical (both solid and fluid) bodies. An important part of continuum mechanics is the mathematical description of strains and stresses as well as the stress-strain response of continuous mechanical bodies. The lecture continuum mechanics builds on the foundations tought in the lecture Engineering Mechanics II (Elastostatics) but extends them significantly while in the lecture Engineering Mechanics II (Elastostatics) but extends them significantly while in the lecture Engineering Mechanics II (Elastostatics) the focus was by and large limited to small deformations of simple bodies under simple loading, the lecture continuum mechanics introduces a general mathematical framework to deal with arbitrarily shaped bodies under arbitrary loading undergoing very general kinds of deformations. This lecture focuses primarily on theoretical aspects of continuum mechanics but its content is key to numerous applications in modern engineering, for example, in production, automotive, and biomedical engineering. The lecture covers: • Fundamentals of tensor calculus • Transformation invariance • Tensor algebra • Tensor analysis • Kinematics • Material and spatial description • Deformation of infinitesimal line, area and volume elements • Material and spatial description • Deformation of infinitesimal line, area and volume elements • Strain measures • Time derivatives • Partial / material time derivatives • Objectivity • Strain measures • Transport theorems • Balance of mary fundamental theorem • Stress tensors (Cauchy, 1, and 2, Piola-Kirchhoff, Kirchhoff stress tensor) • Balance of angular momentum • Balance of angular momentum • Balance of angular momentum • Balance of energy • Clausius-Duhem inequality • Constitutive assumptions • Fluids • Ilastic solids • Hyperelasticity • Material symmetry • Elasto-plastic solids • Material solids • Analysis • Initial-boundary value problems and their numerica
	R. Greve: Kontinuumsmechanik: Ein Grundkurs für Ingenieure und Physiker I-S. Liu: Continuum Mechanics, Springer

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

Course L1534: Continuum Me	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	The exercise on Continuum Mechanics explains the theoretical content of the lecture on Continuum Mechanics by way of a series		
	of specific example problems.		
Literature	R. Greve: Kontinuumsmechanik: Ein Grundkurs für Ingenieure und Physiker		
	I-S. Liu: Continuum Mechanics, Springer		
	1 of East Continuant / Contained, Springer		

Module M1204: Mode	lling and Optimization in Dynamics			
Courses				
Title Flexible Multibody Systems (L1632)		Typ Lecture	Hrs/wk	CP 3
Optimization of dynamical systems		Lecture	2	3
Module Responsible				
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 t	he following learning results		
Professional Competence				
Knowledge	Students demonstrate basic knowledge and understa multibody systems and methods for optimizing dynam			x rigid and flexible
Skills	Students are able			
	+ to think holistically			
	+ to independently, securly and critically analyze and optimize basic problems of the dynamics of rigid and flexible multibody systems			
	+ to describe dynamics problems mathematically			
	+ to optimize dynamics problems			
Personal Competence Social Competence	Students are able to			
	+ solve problems in heterogeneous groups and to docu	ument the corresponding resul	ts.	
Autonomy	Students are able to			
	+ assess their knowledge by means of exercises.			
	+ acquaint themselves with the necessary knowledge	to solve research oriented task	KS.	
Worldood in Userra	Independent Childy Time 124 Childy Time in Leature E	-		
Workload in Hours	Independent Study Time 124, Study Time in Lecture 50)		
Credit points				
Course achievement				
Examination				
Examination duration and scale	ISO IIIIII			
	Aircraft Systems Engineering: Core Qualification: Electi	ve Compulsory		
_	Aeronautics: Core Qualification: Elective Compulsory	ve compulsory		
. onewing curricula	Mechatronics: Specialisation Intelligent Systems and R	obotics: Elective Compulsory		
	Mechatronics: Specialisation intelligent Systems and K			
	Mechatronics: Core Qualification: Elective Compulsory	paisoi y		
	Product Development, Materials and Production: Core	Qualification: Elective Compuls	sorv	
	Theoretical Mechanical Engineering: Core Qualification	•	,	

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. Svenja Drücker
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 M1151: Mate	rials Modeling
Courses	
Title	Typ Hrs/wk CP
Material Modeling (L1535)	Lecture 2 3
Material Modeling (L1536)	Recitation Section (small) 2 3
Module Responsible	Prof. Christian Cyron
Admission Requirements	None
Recommended Previous	Basics of mechanics as taught, e.g., in the modules Engineering Mechanics I and Engineering Mechanics II at TUHH (forces and
Knowledge	moments, stress, linear strain, free-body principle, linear-elastic constitutive laws, strain energy); basics of mathematics as taught
	e.g., in the modules Mathematics I and Mathematics II at TUHH
Educational Objectives	After taking part successfully, students have reached the following learning results
Professional Competence	
•	The students understand the theoretical foundations of anisotropic elasticity, viscoelasticity and elasto-plasticity in the realm of
	three-dimensional (linear) continuum mechanics. In the area of anisotropic elasticity, they know the concept of material symmetr
	and its application in orthotropic, transversely isotropic and isotropic materials. They understand the concept of stiffness an
	compliance and how both can be characterized by appropriate parameters. Moreover, the students understand viscoelasticity bot
	in the time and frequency domain using the concepts of relaxation modulus, creep modulus, storage modulus and loss modulus. I
	the area of elasto-plasticity, the students know the concept of yield stress or (in higher dimensions) yield surface and of plasti
	potential. Additionally, the know the concepts of ideal plasticity, hardening and weakening. Moreover, they know von-Mise
	plasticity as a specific model of elasto-plasticity.
Skills	The students can independently identify and solve problems in the area of materials modeling and acquire the knowledge to do so
	This holds in particular for the area fo anisotropically elastic, viscoelastic and elasto-plastic material behavior. In these areas, the
	students can independently develop models for complex material behavior. To this end, they have the ability to read and
	understand relevant literature and identify the relevant results reported there. Moreover, they can implement models which the
	developed or found in the literature in computational software (e.g., based on the finite element method) and use it for practical collections.
Davisanal Commetence	calculations.
Personal Competence	
Social Competence	The students are able to develop constitutive models for materials and present them to specialists. Moreover, they have the abilit to discuss challenging problems of materials modeling with experts using the proper terminolog, to identify and ask critical
	questions in such discussions and to identify and discuss potential caveats in models presented to them.
Autonomy	The students have the ability to independently develop abstract models that allow them to classify observed phenomena within a
	more general abstract framework and to predict their further evolution. Moreover, the students understand the advantages bu
	also limitations of mathematical models and can thus independently decide when and to which extent they make sense as a basi
	for decisions.
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56
Credit points	6
Course achievement	
Examination	
Examination duration and scale	
Assignment for the	Materials Science: Specialisation Modeling: Elective Compulsory
Following Curricula	
	Biomedical Engineering: Specialisation Artificial Organs and Regenerative Medicine: Elective Compulsory
	Biomedical Engineering: Specialisation Implants and Endoprostheses: Elective Compulsory
	Biomedical Engineering: Specialisation Medical Technology and Control Theory: Elective Compulsory
	Biomedical Engineering: Specialisation Management and Business Administration: Elective Compulsory
	Product Development, Materials and Production: Core Qualification: Elective Compulsory
	Theoretical Mechanical Engineering: Specialisation Simulation Technology: Elective Compulsory
	Theoretical Mechanical Engineering: Specialisation Materials Science: Elective Compulsory
	Theoretical Mechanical Engineering: Specialisation Product Development and Production: Elective Compulsory
	Theoretical Mechanical Engineering: Specialisation Bio- and Medical Technology: Elective Compulsory

Course L1535: Material Modeling			
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	Empfohlene Literatur / Recommended literature: 1) Dietmar Gross, Werner Hauger, Peter Wriggers, Technische Mechanik 4, Springer 2018, DOI: 10.1007/978-3-662-55694-8 2) Peter Haupt, Continuum Mechanics and Theory of Materials, Springer 2002, DOI: 10.1007/978-3-662-04775-0		

Course L1536: Material Mode	ourse 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		

Courses Fittle						
Title						
liah Order FEM (LOSCO)				Тур	Hrs/wk	CP
ligh-Order FEM (L0280)				Lecture	3	4
High-Order FEM (L0281)				Recitation Section (large)	1	2
•	Prof. Alexander Düste	er				
•	lone					
Recommended Previous K	Cnowledge of partial	differential equations	s is recommended.			
Knowledge						
Educational Objectives A	After taking part succ	cessfully, students ha	ave reached the following	ng learning results		
Professional Competence						
Knowledge S	Students are able to					
4	⊢ give an overview o	of the different (h, p, h	hp) finite element proce	edures.		
4	explain high-order	finite element proced	dures.			
4	specify problems	of finite element pro	ocedures, to identify t	hem in a given situation ar	nd to explain the	ir mathematical ar
n	nechanical backgrou	ınd.				
Ckille (Students are able to					
	Students are able to		-l	da 1		
			olems of structural med			
				inite element procedure.		
		ults of high-order finit				
+	+ transfer their know	vledge of high-order f	finite elements to new p	oroblems.		
Personal Competence						
Social Competence S	Students are able to					
· ·	+ solve problems in heterogeneous groups.					
	+ present and discuss their results in front of others.					
	+ give and accept professional constructive criticism.					
	3					
*	Students are able to					
			ercises and E-Learning			
			y knowledge to solve re	esearch oriented tasks.		
+	+ to transform the acquired knowledge to similar problems.					
Workload in Hours	ndependent Study T	ime 124, Study Time	in Lecture 56			
Credit points 6	5					
Course achievement C	Compulsory Bonus	Form	Description			
N	lo 10 %	Presentation	Forschendes	Lernen		
Examination V	Vritten exam					
Examination duration and 1	20 min					
scale						
Assignment for the	Civil Engineering: Spo	ecialisation Computat	tional Engineering: Elec	ctive Compulsory		
Following Curricula	nternational Manage	ement and Engineerin	ng: Specialisation II. Pro	duct Development and Prod	uction: Elective Co	ompulsory
И	Materials Science: Sp	ecialisation Modeling	g: Elective Compulsory			
4	Mechanical Engineer	ing and Management	: Specialisation Produc	t Development and Production	on: Elective Comp	ulsory
	-		Course: Elective Compu			-
	Product Development, Materials and Production: Core Qualification: Elective Compulsory					
l'	Naval Architecture and Ocean Engineering: Core Qualification: Elective Compulsory					
N						
			gineering Science: Elec			

Course L0280: High-Order FE	M
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: Technical Acoustics I (Acoustic Waves, Noise Protection, Psycho Acoustics)				
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	ves, Noise Protection, Psycho Acoustics) (L0518)	Recitation Section (large)	2	3
Module Responsible	Prof. Benedikt Kriegesmann			
Admission Requirements	None			
Recommended Previous	Mechanics I (Statics, Mechanics of Materials) and Mech	anics II (Hydrostatics, Kinematics, Dyna	amics)	
Knowledge	Mathematics I, II, III (in particular differential equations)			
Educational Objectives	After taking part successfully, students have reached the	ne following learning results		
Professional Competence				
Knowledge	The students possess an in-depth knowledge in acous	tics regarding acoustic waves, noise	protection, and p	sycho acoustics and
	are able to give an overview of the corresponding theorem	retical and methodical basis.		
Skills	The students are capable to handle engineering	problems in acoustics by theory-ba	ased application	of the demanding
	methodologies and measurement procedures treated within the module.			
Personal Competence				
Social Competence	Students can work in small groups on specific problems	to arrive at joint solutions.		
Δutonomy	The students are able to independently solve challen	The students are able to independently solve challenging acoustical problems in the areas treated within the module. Possible		
Autonomy	conflicting issues and limitations can be identified and the results are critically scrutinized.			
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56	i .		
Credit points	6			
Course achievement	None			
Examination	Written exam			
Examination duration and	90 min			
scale				
Assignment for the	, , , , , , , , , , , , , , , , , , , ,			
Following Curricula	International Management and Engineering: Specialisat	ion II. Aviation Systems: Elective Com	oulsory	
	Aeronautics: Core Qualification: Elective Compulsory			
	Mechatronics: Core Qualification: Elective Compulsory	Nuclification Florities Council		
	Product Development, Materials and Production: Core C			
	Technomathematics: Specialisation III. Engineering Scientifical Mechanical Engineering: Specialisation Processing		rtivo Compulsario	
	Theoretical Mechanical Engineering: Specialisation Proc Theoretical Mechanical Engineering: Specialisation Sim	•		
	meoretical Mechanical Engineering. Specialisation Sim	alacion recimology. Elective Compulso	ı y	

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	DrIng. Sören Keuchel	
Language	EN	
Cycle	SoSe 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	

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

Course 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	DrIng. Sören Keuchel
Language	EN
Cycle	SoSe
Content	See interlocking course
Literature	See interlocking course

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			
	2.ig.ii.co.iiig (Techanico			
Educational Objectives	After taking part successfully, students have reached t	he following learning results		
Professional Competence				
Knowledge	Students are able to reflect existing terms and containing terms.	concepts in Nonlinear Dynamics and	d to develop and res	earch new terms and
	concepts.	,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,		
	Students are able to denote and expand method	ds of modeling and analysis for nonl	inear dynamical sys	tems.
Skills				
SKIIIS	Students are able to apply existing methods and	procesures of Nonlinear Dynamics		
	Students are able to develop novel methods and	d procedures for nonlinear dynamic	al systems.	
Personal Competence				
Social Competence				
	Students can analyze problems of nonlinear dyn	- ·		
	Students can achieve solution procedures for procedures for procedures.	oblems of nonlinear dynamical syst	ems also in groups.	
Autonomy				
	Students are able to approach given research ta Students are able to identify and followers are able to identify and identify are able to identify and identification are able to identify and identify are able to identify and identification are able to identify and identification are able to identify are able to identify and identification are able to identify and identification are able to identify are able to identify and identify are able to identify are able to ident		ndividually.	
	Students are able to identify and follow up nove	rresearch tasks by themselves.		
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56	5		
Credit points	6			
Course achievement	None			
Examination	Written exam			
Examination duration and	2 Hours			
scale				
Assignment for the				
Following Curricula		tion II. Mechatronics: Elective Comp	oulsory	
	Aeronautics: Core Qualification: Elective Compulsory Mechanical Engineering and Management: Specialisation	on Mechatronics: Elective Compulso	nrv	
	Mechatronics: Core Qualification: Elective Compulsory	o echadromes. Elective compulst	,	
	Biomedical Engineering: Specialisation Artificial Organs	and Regenerative Medicine: Electi	ve Compulsory	
	Biomedical Engineering: Specialisation Implants and Er	-		
	Biomedical Engineering: Specialisation Medical Techno	logy and Control Theory: Elective C	ompulsory	
	Biomedical Engineering: Specialisation Management ar	nd Business Administration: Elective	Compulsory	
	Product Development, Materials and Production: Core (Qualification: Elective Compulsory		
	Theoretical Mechanical Engineering: Core Qualification	: Elective Compulsory		

se L0702: Nonlinear Dyr	namics
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
	One dimensional problems Linear Stability Local Bifurcations Synchronisation Two dimensional problems Limit Cycles Global Bifurcations Chaos Lorenz Equations Fractals and Strange Attractors Predictability and Horizons
Literature	Steven Strogatz: Nonlinear Dynamics and Chaos.

Module M1164: Pract	ical Course Product Development,	, Materials and Production		
Courses				
Title		Тур	Hrs/wk	СР
	nent, Materials and Production (L1566)	Practical Course	6	6
	Prof. Jan Hendrik Dege			
Admission Requirements				
Recommended Previous	Product Development:			
Knowledge	Lectures: Mechanics I-III			
	Lectures: Integrated Product Development	l incl. CAD practical training		
	Materials:			
	Loctures: Structural Motallic Materials, Metallic Me	allic Materials for Aircraft Applications In	atroduction to Matori	als Tosting
	 Lectures: Structural Metallic Materials, Met Lectures: Structure and Properties of Poly 			
	Composites	ymers, structure and Properties of Con	iposices, indiraracear	ing of Folymers an
	Production:			
	Lecture: Production Engineering			
	 Lectures: Forming and Cutting Technology 	, Methods of production process design		
	Lectures: Machine Tools and Robotic			
Educational Objections	After the literary and a second of the secon	shoot the fellowing beautien acculte		
Professional Competence	After taking part successfully, students have reac	thed the following learning results		
	Students can			
, and medge	Stadents can in			
	represent more complex context of differe	·		
	describe functionality of modern measurer	nent instrumentations and machine tech	nologies.	
Skille	Students are capable of			
Skills	Students are capable of			
	applying theoretical knowledge for practical			
	applying provided experimental methods f		of study.	
	analyzing and evaluating experimental res			
	applying modern measurement instrument	lations.		
Personal Competence				
Social Competence	Students can			
	carry out and document experimental worl	k in groups		
	present and discuss experimental results in		<i>/</i> .	
		Ź		
Autonomy	Students are able to			
	 carry out parts of experimental work indep 	endently guided by teachers		
	 choose and apply suitable instruments. 	galaca a, teachers.		
	assess own strengths and weaknesses.			
Workload in Hours	Independent Study Time 96, Study Time in Lectur	re 84		
Credit points	, , , , ,			
Course achievement	None			
Examination	Written elaboration			
Examination duration and				
scale				
-	Biomedical Engineering: Core Qualification: Comp	•		
Following Curricula	Product Development, Materials and Production:	Core Qualification: Compulsory		

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. Jan Hendrik Dege, 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. Thorsten Schüppstuhl
Language	DE
Cycle	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
	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 M1339: Desig	n optimization and probabilistic app	roaches in structural analy	sis	
Courses				
Title Design Optimization and Probabilis	itic Approaches in Structural Analysis (L1873) itic Approaches in Structural Analysis (L1874)	Typ Lecture Recitation Section (large)	Hrs/wk 2 2	CP 3 3
Module Responsible	Prof. Benedikt Kriegesmann			
Admission Requirements	None			
Recommended Previous Knowledge	Technical mechanics Higher math			
Educational Objectives	After taking part successfully, students have reached	the following learning results		
Professional Competence Knowledge	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 optimization and relia	hility analysis		
Skills			ures	
Personal Competence Social Competence Autonomy		k of a home work		
	2 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 scale				
Assignment for the Following Curricula		Qualification: Elective Compulsory		

Time 62, Study Time in Lecture 28
esmann
eoretic basics for design optimization and reliability analysis are taught, where the focus is on the application of
lectures will consist of presentations as well as computer exercises. In the computer exercises, the methods
emented in Matlab for understanding the practical realization.
nts will be considered:
nts will be considered.
ization
ent based methods
c algorithms
ization with constraints
gy optimization
alysis
estic basics
Carlo methods analytic approaches
n optimization
tness measures
ng of design optimization and reliability analysis
State
roduction to Optimum Design. 3rd ed. Boston, MA: Academic Press, 2011.
S. Mahadevan. Probability, Reliability, and Statistical Methods in Engineering Design. John Wiley & Sons New
, 2000.

Course L1874: Design Optim	ourse 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: Technical Acoustics II (Room Acoustics, Computational Methods)				
Courses				
Title		Тур	Hrs/wk	СР
	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				
	Technical Acoustics I (Acoustic Waves, Noise Protection	, Psycho Acoustics)		
Knowledge	Mechanics I (Statics, Mechanics of Materials) and Mech	anics II (Hydrostatics, Kinematics, Dyna	mics)	
	Mathematics I, II, III (in particular differential equations)		
Educational Objectives	After taking part successfully, students have reached t	ne following learning results		
Professional Competence				
Knowledge	The students possess an in-depth knowledge in acous	tics regarding room acoustics and con	nputational meth	ods and are able to
	give an overview of the corresponding theoretical and	methodical basis.		
Skills	The students are capable to handle engineering problems in acoustics by theory-based application of the demanding			
	computational methods and procedures treated within the module.			
Personal Competence	la			
Social Competence	Students can work in small groups on specific problems to arrive at joint solutions.			
Autonomy	The students are able to independently solve challenging acoustical problems in the areas treated within the module. Possible			
	conflicting issues and limitations can be identified and	the results are critically scrutinized.		
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56			
Credit points	6			
Course achievement	None			
Examination	Oral exam			
Examination duration and	20 min			
scale				
Assignment for the	Aircraft Systems Engineering: Core Qualification: Electi	ve Compulsory		
Following Curricula	Aeronautics: Core Qualification: Elective Compulsory			
	Mechatronics: Specialisation System Design: Elective C	ompulsory		
	Mechatronics: Core Qualification: Elective Compulsory			
	Product Development, Materials and Production: Core (• •		
	Theoretical Mechanical Engineering: Specialisation Production Mechanical Engineering: Specialisation Simple Production S	•		
	Theoretical Mechanical Engineering: Specialisation Sim	uiation Technology: Elective Compulsor	У	

Course I 0519: Technical Aco	ustics II (Room Acoustics, Computational Methods)
	Lecture
Hrs/wk	
CP	
	Independent Study Time 62, Study Time in Lecture 28
	DrIng. Sören Keuchel
Language	
Cycle	
	- 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

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

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 Following Curricula

Module M1184: Resea	arch Project Product Development, Materials and Production	
Courses		
Title	Typ Hrs/wk CP	
Module Responsible	Dozenten des Studiengangs	
Admission Requirements	None	
	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 their peers and supervisors.	
Autonomy	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	Product Development, Materials and Production: Core Qualification: Compulsory	
Following Curricula		

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.

an design products on the cutting edge of technology, calculate and actively promote the development of products using modern methods.				
Module M0763: Aircraft 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			
	Fluid mechanics			
Educational Objectives	After taking part successfully, students have reached t	he following learning results		
Professional Competence				
Knowledge	Students are able to:			
	Assess challenges during the design of aircraft expressions.	nergy systems		
	 Describe essential components and design point 	s of hydraulic and electrical supply sys	stems	
	Give an overview of the functionality of air cond	tioning systems		
	Describe different system concepts for de-icing			
	Identify constraints for the electrification of aircr		ncepts and limita	tions
	Describe architectures for fuel supply systems a	- ·		_
	Explain possible approaches for the integration of the integratio	or fuel cell systems and evaluate zero-	emission concept	.5
Skills	Students are able to:			
	Design by draulic and electric supply systems of	aircrafts		
	 Design hydraulic and electric supply systems of Analyze the thermodynamic behavior of air cond 			
	Design ice protection systems	intolling systems		
	Apply possible electrification concepts to existin	g aircraft systems		
	Design fuel supply systems	-		
	Perform the design of a fuel cell system			
B				
Personal Competence	Students are able to			
Social Competence	Students are able to:			
	Perform system design in groups and present ar	d discuss results		
	Present systems engineering problems and discrete.	uss solutions with experts		
Autonomy	Students are able to:			
	Deflect on the content of last was automorphism			
	Reflect on the content of lectures autonomously Apply methods learned in the course of exercise			
	Identify complex system dependencies autonom	·	and design proces	SAS
	- Identity complex system dependencies autonom	iously and abstract simplified models t	ma aesign proces	,363
Workload in Hours	Independent Study Time 110, Study Time in Lecture 70)		
Credit points	6			
Course achievement	None			
Examination	Written exam			
Examination duration and	165 Minutes			
scale				
Assignment for the	Energy Systems: Specialisation Energy Systems: Electi	, ,		
Following Curricula	Aircraft Systems Engineering: Core Qualification: Comp			
	International Management and Engineering: Specialisa	tion II. Aviation Systems: Elective Com	pulsory	
	Aeronautics: Core Qualification: Compulsory	alication Product Douglapment, Flastin	o Compulsory	
	Product Development, Materials and Production: Special Product Development Produc	•		
	Product Development, Materials and Production: Special Product Development, Materials and Product Development Product Dev			
	Theoretical Mechanical Engineering: Specialisation Airc	·	-	
		5,5cc5 Engineering. Elective Col	,	

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 	

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	

Courses				
Title		Тур	Hrs/wk	CP
Methods of Product Development (Lecture	3	3
Methods of Product Development (Project-/problem-based Learning	2	3
Module Responsible	Prof. Dieter Krause			
Admission Requirements	None			
Recommended Previous	Basic knowledge of Integrated product development ar	d applying CAE systems		
Knowledge				
Educational Objectives	After taking part successfully, students have reached the	ne 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	agement,		
	describe current problems and the current state	of research of integrated product develop	ment.	
Skills	After passing the module students are able to:			
	 select and apply proper construction methods f 	or non-standardized solutions of problen	ns as well as	adapt new bounda
	conditions,			
	solve product development problems with the as			
	 choose and execute appropriate moderation technique 	iniques.		
Personal Competence				
Social Competence	After passing the module students are able to:			
	a warneys and load tooms magatings and made watio			
	 prepare and lead team meetings and moderation work in teams on complex tasks, 	i processes,		
	 represent problems and solutions and advance in 	doas		
	represent problems and solutions and davance in	aeus.		
Autonomy	After passing the module students are able to:			
	give a structured feedback and accept a critical	feedback		
	 implement the accepted feedback autonomous. 	coupacity		
	,			
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		<u></u>	
scale				
Assignment for the	Aircraft Systems Engineering: Core Qualification: Electi	ve Compulsory		
Following Curricula	International Management and Engineering: Specialisat	ion II. Product Development and Producti	on: Elective C	ompulsory
	Aeronautics: Core Qualification: Elective Compulsory			
	Mechatronics: Specialisation System Design: Elective C	ompulsory		
	Mechatronics: Core Qualification: Elective Compulsory			
	Product Development, Materials and Production: Specia		ry	
	Product Development, Materials and Production: Specia			
	Product Development, Materials and Production: Specia	• •		
	Theoretical Mechanical Engineering: Specialisation Prod	luct Development and Production: Electiv	e Compulsory	

Production"	
Course L1254: Methods of P	roduct Development
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, Tacknical Supply Chair Management
	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 Mechanical Design, München, Spektrum 2007. Redwards, M. Gwale, Chair Management Partie, Cariners 2004.
	Beckmann, H.: Supply Chain Management, Berlin, Springer 2004. Hartmann, M., Biogor, M., Eurk, R., Bath, H.: Zielgerichtet, mederieren, Ein Handbuch, für Eübrungskräfte, Berater, und
	Hartmann, M., Rieger, M., Funk, R., Rath, U.: Zielgerichtet moderieren. Ein Handbuch für Führungskräfte, Berater und Trainer Weinheim Beltz 2007.
	Trainer, Weinheim, Beltz 2007. • Pahl, G., Beitz, W.: Konstruktionslehre, Berlin, Springer 2006.
	Roth, K.H.: Konstruieren mit Konstruktionskatalogen, Band 1-3, Berlin, Springer 2000.

Course L1255: Methods of Product Development	
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)	Duck Dicker Krause	Recitation Section (large)	1	1
Module Responsible Admission Requirements	Prof. Dieter Krause None			
Recommended Previous Knowledge	Good knowledge of mechanics (stereo statics, elastostatics	s, hydrostatics, kinematics and	kinetics), fluid	d mechanics, and
Educational Objectives	After taking part successfully, students have reached the follow	ing learning results		
	After passing the module students are able to explain structures and functionalities of hydrostatic, pneumatic, and hydrodynamic components, explain the interaction of hydraulic components in hydraulic systems, explain open and closed loop control of hydraulic systems, describe functioning and applications of hydrodynamic torque converters, brakes and clutches as well as centrifugal pumps and aggregates in plant technology 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,			
Personal Competence Social Competence	dimension hydrodynamic torque converters and brakes for the following state of the fol	or mechanical aggregates.		
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				<u> </u>
Course achievement		ydrostatischer Systeme		
Examination	Written exam	yarostatischer Systeme		
Examination duration and scale Assignment for the Following Curricula		oduct Development and Production Product Development: Compulsor		npulsory
	Product Development, Materials and Production: Specialisation Product Development, Materials and Production: Specialisation Theoretical Mechanical Engineering: Specialisation Product Development	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	WiSe
Content	Lecture
	Hydrostatics
	i, uiosalies
	physical fundamentals
	hydraulic fluids
	hydrostatic machines
	• valves
	components
	hydrostatic transmissions
	examples from industry
	Pneumatics
	generation of compressed air
	pneumatic motors
	Examples of use
	Examples of use
	Hydrodynamics
	physical fundamentals
	hydraulic continous-flow machines
	hydrodynamic transmissions
	interoperation of motor and transmission
	Exercise
	Hydrostatics
	a reading and design of hydraulis diagrams
	reading and design of hydraulic diagrams diagrams 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
	Title dip
	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
	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
	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	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

Troduction					
Module M1193: Cabin	Systems Engineering				
Courses					
			_		
Title	analogy in sphin electronics and avionics (L1557)		Typ	Hrs/wk 2	CP
Computer and communication technology in cabin electronics and avionics (L1557) Computer and communication technology in cabin electronics and avionics (L1558) Recitation Section (small)					2
Model-Based Systems Engineering			Project-/problem-based Learning	3	3
			Troject /problem basea Leanning	3	
Module Responsible					
Admission Requirements	None				
	Basic knowledge in: • Mathematics				
Knowledge	Mechanics				
	Thermodynamics				
	· ·				
	Electrical Engineering Control Systems				
	Control Systems				
	Previous knowledge in:				
	Systems Engineering				
Educational Objectives	After taking part successfully, students have reache	d the followi	ng learning results		
Professional Competence					
Knowledge	Students are able to:				
	describe the structure and operation of computer				
	explain the structure and operation of digital community				
	 explain architectures of cabin electronics, integrat 				
	 understand the approach of Model-Based System 	ms Engineer	ing (MBSE) in the design of ha	rdware and s	oftware-based cabin
	systems				
Skills	Students are able to:				
SKIIIS	understand, operate and maintain a Minicomputer				
	build up a network communication and communic		er network participants		
	connect a minicomputer with a cabin managemen			a AFDX®-Ne	twork
	model system functions by means of formal langu				
	execute software code on a minicomputer	-9			
Personal Competence					
Social Competence	Students are able to:				
	form teams of two or small groups for the practical				
	work out partial results themselves and combine t	hem with oth	ners to form an overall solution		
	represent and contribute their own solution				
	take over the guidance of the team				
	contribute in the team				
Autonomy	Students are able to:				
Autonomy	organize and plan their practical tasks				
	further develop their own skills				
	take their own initiative				
	explore their own new ways of solving problems				
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: Core Qualification: Ele	ective Compu	ulsory		
Following Curricula	International Management and Engineering: Special	isation II. Av	iation Systems: Elective Compuls	sory	
	Aeronautics: Core Qualification: Elective Compulsory	/			
	Product Development, Materials and Production: Spe	ecialisation P	Product Development: Elective Co	ompulsory	
	Product Development, Materials and Production: Spe	ecialisation P	Production: Elective Compulsory		
	Product Development, Materials and Production: Spe	ecialisation N	Materials: Elective Compulsory		
	Theoretical Mechanical Engineering: Specialisation A	Aircraft Syste	ems Engineering: Elective Compu	lsory	

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 S	Systems Engineering (MBSE) with SysML/UML		
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	ı			Nectation Section (large)		3
Admission Requirements	None					
Recommended Previous Knowledge	Bachelor Mecl Bachelor Traff 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	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	e various disciplines aft design		
Workload in Hours	Independent Study T	ime 110, Study Tim	e in Lecture 70			
Credit points	6					
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	Aircraft Systems Eng	ineering: Core Qual	ification: Compulsory			
Following Curricula	Aeronautics: Core Que Product Developmer Product Developmer	ualification: Compuls t, Materials and Pro t, Materials and Pro	sory duction: Specialisation F duction: Specialisation F	iation Systems: Elective Com Product Development: Electiv Production: Elective Compulso ems Engineering: Elective Col	e Compulsory ory	

Course L0820: Aircraft Design I (Design of Transport Aircraft)				
	Lecture			
Hrs/wk				
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) Statistical methods in overall aircraft design/data base methods Cabin design (fuselage sizing, cabin interior, loading systems) Principles of aerodynamic aircraft design (polar, geometry, 2D/3D aerodynamics) Wing Design Tail wings and landing gear Principles of engine design and integration Flight performance in cruise Take off and landing field length Loads and V-n-diagramme Operating cost calculation 			
Literature	J. Roskam: "Airplane Design" 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 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		

Hrs/wk	СР			
2	3			
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ledicine (L0338) Project Seminar 2 2 ledicine (L0336) Recitation Section (small) 1 1				
stems and	their components in			
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applications				
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manner to the other groups.				
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Navigation in Medicine
Lecture
2
3
Independent Study Time 62, Study Time in Lecture 28
Prof. Alexander Schlaefer
EN
SoSe
- 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
Troccaz: Medical Robotics, 2012
Further literature will be given in the lecture.

Course L0338: Robotics and	ourse 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			

Production"				
Module M0764: Flight	t Control Systems			
Courses				
Courses		.	H fl-	CD.
Title Flight Control Systems (L0736)		Typ Lecture	Hrs/wk 3	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 mechanics control theory			
	- Control tricory			
Educational Objectives	After taking part successfully, students have reached the following	g learning results		
Professional Competence				
Knowledge	Students are able to			
	describe the structure and the functioning of primary fligh	t control systems as well as	actuation-, avior	ic-, high lift systems
	of aircrafts in general along with corresponding properties			
	give an overview over the functioning and the structure of		ear systems	
	 explain different configurations and designs and their original 	ns		
Skills	Students are able to			
	size primary flight control actuation systems			
	perform a controller design process for the flight control actions.	tuators		
	design high-lift systems and high-lift kinematics			
	size landing gear components			
Personal Competence				
	Students are able to:			
	- Daviday isint colutions in wived tooms			
	 Develop joint solutions in mixed teams Present and explain developed solutions in front of other si 	tudents		
	Discuss developed solutions with experts	tadents		
	·			
Autonomo	Chudanta ara abla ta			
Autonomy	Students are able to:			
	derive requirements and perform appropriate yet simplifie	ed design processes for aircr	aft systems from	complex issues and
	circumstances in a self-reliant manner	16 11 1		
	apply new skills and methods in the context of exercises in	a self-reliant manner		
Workload in Hours	Independent Study Time 110, Study Time in Lecture 70			
Credit points				
Course achievement				
	Written exam			
Examination duration and scale				
	Aircraft Systems Engineering: Core Qualification: Compulsory			
Following Curricula		ation Systems: Elective Com	oulsory	
3	Aeronautics: Core Qualification: Compulsory	,	•	
	Product Development, Materials and Production: Specialisation Pr	oduct Development: Elective	Compulsory	
	Product Development, Materials and Production: Specialisation Pr			
	Product Development, Materials and Production: Specialisation M			
	Theoretical Mechanical Engineering: Specialisation Aircraft System	ns Engineering: Elective Con	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 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 	

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	
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	After the live and the second of the second of the fall to the fall to the second of t
•	After taking part successfully, students have reached the following learning results
Professional Competence Knowledge	
Knowieage	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	Select a suitable imaging system for an application.
Social Competence	none
	Students can:
	 Understand which physical effects are used in medical imaging; Decide independently for which clinical issue a measuring system can be used.
	bedde 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	90 min
scale	
Assignment for the	
Following Curricula	Biomedical Engineering: Core Qualification: 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 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. Michael Helle, Dr. Sven Prevrhal, Frank Michael Weber	
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
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 Me	chatronics (L1512)	Lecture	2	3
Fatigue & Damage Tolerance (L03	10)	Lecture	2	3
GSD - Generational Sheet-Metal D	evelopment (L3064)	Lecture	3	3
Industry 4.0 for Engineers (L2012)		Lecture	2	3
Innovation and Product Manageme	ent (L2168)	Seminar	2	3
Lightweight Design Practical Cour	e (L1258)	Project-/problem-based Learning	3	3
Mechanisms and Systems of Mate	rials Testing - from the viewpoint of product development and Failure	Lecture	2	2
Analysis (L0950)				
Microsystems Technology (L0724)		Lecture	2	4
Sustainable Industrial Production (L2863)	Lecture	2	4
Productivity Management (L0928)		Project-/problem-based Learning	2	2
Productivity Management (L0931)		Recitation Section (small)	1	1
Feedback Control in Medical Techi	nology (L0664)	Lecture	2	3
Structural Mechanics of Fibre Rein	forced Composites (L1514)	Lecture	2	3
Technical Design (L1513)		Lecture	2	3
Materials Testing - from the viewp	pint of industrial application (L0949)	Lecture	2	2
Reliability in Engineering Dynamic	s (L2994)	Lecture	2	2
Reliability in Engineering Dynamic	s (L2995)	Recitation Section (small)	1	2
Reliability of Aircraft Systems (L07	49)	Lecture	2	3
Module Responsible	Prof. Dieter Krause			
Admission Requirements	None			
Recommended Previous	None			
Knowledge				
Educational Objectives		ving learning results		
Professional Competence				
Knowledge				
Knowleage	Students are able to express their extended knowledge	and discuss the connection of di	fferent special	fields or applicati
	areas of product development, materials and production			
	Students are qualified to connect different special fields			
	The special news			
Skills				
	Students can apply specialized solution strategies and ne			
	Students are able to transfer learned skills to new and ur	nknown problems and can develo	p own solution	approaches
Personal Competence				
Social Competence	-			
•		av autonomovo alankian af		
Social Competence	-	oy autonomous election of course	S.	
Social Competence	Students are able to develop their knowledge and skills be a student of the	oy autonomous election of course	S.	
Social Competence Autonomy	Students are able to develop their knowledge and skills be Depends on choice of courses	by autonomous election of course	s.	
Social Competence Autonomy Workload in Hours	Students are able to develop their knowledge and skills to Depends on choice of courses			
Social Competence Autonomy Workload in Hours Credit points Assignment for the	Students are able to develop their knowledge and skills to Depends on choice of courses 12 Product Development, Materials and Production: Specialisation	Product Development: Elective C		
Social Competence Autonomy Workload in Hours Credit points	Students are able to develop their knowledge and skills to Depends on choice of courses 12 Product Development, Materials and Production: Specialisation	Product Development: Elective C Production: 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
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 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 L3064: GSD - Generational Sheet-Metal Development		
Тур	Lecture	
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. Dr. Nikola Bursac	
Language	DE	
Cycle	WiSe	
Content	Experience in mechanical engineering design and the fundamentals of manufacturing engineering	
	After successful completion of the course, students will be able to explain development projects using the theory of product generation engineering and explain design rules for sheet metal development.	
	After successful completion of the course, students will be able to apply the theory of product generation engineering to development tasks and develop sheet-metal products suitable for production.	
	After successful completion of the course, students will be able to develop a product in a team and to compete against other teams.	
	After successful completion of the course, students will be able to independently access knowledge required for sheet metal development.	
Literature		

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	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 a	and Systems of Materials Testing - from the viewpoint of product development and Failure Analysis
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, 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	4
Workload in Hours	Independent Study Time 92, Study Time in Lecture 28
Examination Form	
Examination duration and	
scale	
Lecturer	Dr. Simon Markus Kothe
Language	DE
Cycle	SoSe
Content	
	processes that change the form and physical properties of raw materials. Manufacturing is a central driver of economi development and has a major impact on the well-being of humanity. However, the scale of current manufacturing activities result: 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 hardl 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 th 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 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	
Lecturer	5
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.

Course L1514: Structural Me	chanics of Fibre Reinforced Composites
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 min
scale	
Lecturer	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 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

Lecturer	Prof. Werner Granzeier, Prof. Dieter Krause
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

TTOGGCCIOIT	
	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 GmbH,
	Auto & Design,
	Corso Frabcia 161, 10139 Torino, Italia
	(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 L0949: Materials Tes	ting - from the viewpoint of industrial application	
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 L2994: Reliability in 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	Dr. Eric Groß, Prof. Benedikt Kriegesmann	
Language	EN	
Cycle	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	

ourse L2995: 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		
Language	EN	
Cycle	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 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	

Production"				
Module M1156: Syste	ms Engineering			
ourses				
itle		Тур	Hrs/wk	СР
ystems Engineering (L1547)		Lecture	3	4
ystems Engineering (L1548)		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			
	Previous knowledge in:			
	Aircraft Cabin Systems			
	,			
Educational Objectives	After taking part successfully, students have reached	the following learning results		
Professional Competence				
Knowledge	Students are able to:			
	understand systems engineering process models, m		f complex System	าร
	describe innovation processes and the need for tech			
	explain the aircraft development process and the process and the process.			
	explain the system development process, including identify any irransportal conditions and test procedure.			
	 identify environmental conditions and test procedure value the methodology of requirements-based engir 		monts onginooring	~ (MRDE)
	value the methodology of requirements-based engil	eering (NBL) and model-based requirer	ments engineering	g (MDKL)
Skills	Students are able to:			
	\bullet plan the process for the development of complex \ensuremath{Sy}	stems		
	organize the development phases and development	Tasks		
	assign required business activities and technical Tas	ks		
	apply systems engineering methods and tools			
Personal Competence				
	Students are able to:			
	• understand and accept their tasks within a developm	nent team		
	• be comfortable with their role their tasks within the	overall process		
	• understand and serve their suppliers and customers	in large projects		
	• assume responsibility for people and technology in t	he development of safety-critical system	ms	
Autonomy	Students are able to:			
Autonomy	 interact and communicate in a development team w 	ith division of tasks		
	independently research and identify certification spe			
	formulate requirements on their own			
	create test plans on their own and accompany certif	ication processes		
Workload in Hours	Independent Study Time 124, Study Time in Lecture 5	6		
Credit points	6			
Course achievement	None			
Examination	Written exam			
Examination duration and	120 Minutes			
scale				
Assignment for the	Aircraft Systems Engineering: Core Qualification: Com			
Following Curricula	International Management and Engineering: Specialisa	•		
	International Management and Engineering: Specialisa	ation II. Product Development and Produ	uction: Elective Co	ompulsory
	Aeronautics: Core Qualification: Compulsory			
	Mechatronics: Core Qualification: Elective Compulsory		da a se s	
	Product Development, Materials and Production: Spec	·	-	
	Product Development, Materials and Production: Spec Product Development, Materials and Production: Spec			
	·	·	-	
	Theoretical Mechanical Engineering: Specialisation Air	crait bysterns Engineering: Elective Cor	приіѕогу	

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)		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 Transfer			
Knowledge				
Educational Objectives	After taking part successfully, students have reached the follow	ing learning results		
Professional Competence				
Knowledge	The students can			
	distinguish the physical phenomena of conversion of ene	ray		
	understand the different mathematic modelling of turbor			
	calculate and evaluate turbomachinery.	nacrimery,		
	Calculate and evaluate turboniacinnery.			
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				
Course achievement	None			
Examination	Written exam			
Examination duration and	90 min			
scale				
Assignment for the	Energy Systems: Specialisation Energy Systems: Elective Comp	ulsory		
Following Curricula		•		
	Product Development, Materials and Production: Specialisation	•	Compulsory	
	Product Development, Materials and Production: Specialisation			
	Product Development, Materials and Production: Specialisation	Materials: Elective Compulsory	,	
	Theoretical Mechanical Engineering: Specialisation Energy System	ems: Elective Compulsory		
	·			

ourse L1562: Turbomachines		
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:	
	 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)		Project-/problem-based Learning	3	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 Mechatronics (L1512)		Lecture	2	3
Fatigue & Damage Tolerance (L03		Lecture	2	3
GSD - Generational Sheet-Metal D		Lecture	3	3
ndustry 4.0 for Engineers (L2012)		Lecture	2	3
nnovation and Product Manageme	ent (L2168)	Seminar	2	3
ightweight Design Practical Cours	e (L1258)	Project-/problem-based Learning	3	3
Mechanisms and Systems of Mate	ials Testing - from the viewpoint of product development and Failure	Lecture	2	2
Analysis (L0950)				
Microsystems Technology (L0724)		Lecture	2	4
Sustainable Industrial Production (L2863)	Lecture	2	4
Productivity Management (L0928)		Project-/problem-based Learning	2	2
Productivity Management (L0931)		Recitation Section (small)	1	1
eedback Control in Medical Techr	ology (L0664)	Lecture	2	3
Structural Mechanics of Fibre Rein	forced Composites (L1514)	Lecture	2	3
Fechnical Design (L1513)		Lecture	2	3
Materials Testing - from the viewp	pint of industrial application (L0949)	Lecture	2	2
Reliability in Engineering Dynamic	s (L2994)	Lecture	2	2
Reliability in Engineering Dynamic	s (L2995)	Recitation Section (small)	1	2
Reliability of Aircraft Systems (L07	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 follow	ving loarning results		
Euucational Objectives	Arter taking part successfully, students have reached the follow	iling learning results		
Durferelevel Commetence				
Professional Competence				
Professional Competence Knowledge		and discuss the connection of di	fferent specia	l fields or applic
•	Students are able to express their extended knowledge		fferent specia	fields or applica
•	Students are able to express their extended knowledge areas of product development, materials and production		fferent specia	l fields or applica
•	Students are able to express their extended knowledge		fferent specia	l fields or applica
•	Students are able to express their extended knowledge areas of product development, materials and production Students are qualified to connect different special fields to		fferent specia	l fields or applica
Knowledge	Students are able to express their extended knowledge areas of product development, materials and production Students are qualified to connect different special fields to	with each other		fields or applica
Knowledge	Students are able to express their extended knowledge areas of product development, materials and production Students are qualified to connect different special fields to the students are qualified to connect different special fields to the students are qualified to connect different special fields to the students are qualified to connect different special fields to the students are qualified to connect different special fields to the students are qualified to connect different special fields to the students are qualified to connect different special fields to the students are qualified to connect different special fields to the students are qualified to connect different special fields to the students are qualified to connect different special fields to the students are qualified to connect different special fields to the students are qualified to the st	with each other ew scientific methods in selected	areas	
Knowledge Knowledge Skills	Students are able to express their extended knowledge areas of product development, materials and production Students are qualified to connect different special fields Students can apply specialized solution strategies and ne	with each other ew scientific methods in selected	areas	
Knowledge Skills Personal Competence	Students are able to express their extended knowledge areas of product development, materials and production Students are qualified to connect different special fields Students can apply specialized solution strategies and nees to students are able to transfer learned skills to new and ure	with each other ew scientific methods in selected	areas	
Knowledge Knowledge Skills	Students are able to express their extended knowledge areas of product development, materials and production Students are qualified to connect different special fields Students can apply specialized solution strategies and nees to students are able to transfer learned skills to new and ure	with each other ew scientific methods in selected	areas	
Knowledge Skills Personal Competence	Students are able to express their extended knowledge areas of product development, materials and production Students are qualified to connect different special fields Students can apply specialized solution strategies and ne Students are able to transfer learned skills to new and ur	with each other ew scientific methods in selected nknown problems and can develo	areas p own solutior	
Skills Personal Competence Social Competence	Students are able to express their extended knowledge areas of product development, materials and production Students are qualified to connect different special fields Students can apply specialized solution strategies and nees to students are able to transfer learned skills to new and ure	with each other ew scientific methods in selected nknown problems and can develo	areas p own solutior	
Skills Personal Competence Social Competence	Students are able to express their extended knowledge areas of product development, materials and production Students are qualified to connect different special fields of the students can apply specialized solution strategies and notes to transfer learned skills to new and ure students are able to transfer learned skills to new and ure students are able to develop their knowledge and skills be students are able to develop their knowledge and skills be students are able to develop their knowledge and skills be students.	with each other ew scientific methods in selected nknown problems and can develo	areas p own solutior	
Skills Personal Competence Social Competence Autonomy	Students are able to express their extended knowledge areas of product development, materials and production Students are qualified to connect different special fields of the students can apply specialized solution strategies and notes of students are able to transfer learned skills to new and urestudents are able to develop their knowledge and skills to Depends on choice of courses	with each other ew scientific methods in selected nknown problems and can develo	areas p own solutior	
Skills Personal Competence Social Competence Autonomy Workload in Hours Credit points	Students are able to express their extended knowledge areas of product development, materials and production Students are qualified to connect different special fields of the students can apply specialized solution strategies and notes of the students are able to transfer learned skills to new and urestudents are able to develop their knowledge and skills to Depends on choice of courses	with each other ew scientific methods in selected nknown problems and can develo by autonomous election of course	areas p own solutior s.	
Skills Personal Competence Social Competence Autonomy Workload in Hours Credit points Assignment for the	Students are able to express their extended knowledge areas of product development, materials and production Students are qualified to connect different special fields of the students can apply specialized solution strategies and notes of the students are able to transfer learned skills to new and urest of the students are able to develop their knowledge and skills to be pends on choice of courses Depends on choice of courses Product Development, Materials and Production: Specialisation	with each other ew scientific methods in selected nknown problems and can develo by autonomous election of course Product Development: Elective Co	areas p own solutior s.	
Skills Personal Competence Social Competence Autonomy Workload in Hours Credit points	Students are able to express their extended knowledge areas of product development, materials and production Students are qualified to connect different special fields of the students can apply specialized solution strategies and notes of the students are able to transfer learned skills to new and urest of the students are able to develop their knowledge and skills to be pends on choice of courses Beginning the students are able to develop their knowledge and skills to be pends on choice of courses Product Development, Materials and Production: Specialisation Product Development, Materials and Production: Specialisation Product Development, Materials and Production: Specialisation	with each other ew scientific methods in selected nknown problems and can develously autonomous election of course product Development: Elective Corpoduction: Elective Compulsory	areas p own solutior s.	
Skills Personal Competence Social Competence Autonomy Workload in Hours Credit points Assignment for the	Students are able to express their extended knowledge areas of product development, materials and production Students are qualified to connect different special fields of the students can apply specialized solution strategies and notes of the students are able to transfer learned skills to new and urest of the students are able to develop their knowledge and skills to be pends on choice of courses Depends on choice of courses Product Development, Materials and Production: Specialisation	with each other ew scientific methods in selected nknown problems and can develously autonomous election of course product Development: Elective Corpoduction: Elective Compulsory Materials: Elective Compulsory	areas p own solution s. ompulsory	

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 L2739: Advanced Tra	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 & Dar	nage 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 L3064: GSD - Generat	tional Sheet-Metal Development
Тур	Lecture
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. Dr. Nikola Bursac
Language	DE
Cycle	WiSe
Content	Experience in mechanical engineering design and the fundamentals of manufacturing engineering
	After successful completion of the course, students will be able to explain development projects using the theory of product generation engineering and explain design rules for sheet metal development.
	After successful completion of the course, students will be able to apply the theory of product generation engineering to development tasks and develop sheet-metal products suitable for production.
	After successful completion of the course, students will be able to develop a product in a team and to compete against other teams.
	After successful completion of the course, students will be able to independently access knowledge required for sheet metal development.
Literature	

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	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.

Typ	Lecture
Hrs/wk	
СР	
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 SoSe
	Application, analysis and discussion of basic and advanced testing methods to ensure correct selection of applicable testin 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, croprocess, 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 sensors; 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, parance semiconduc
	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	4
Workload in Hours	Independent Study Time 92, 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, 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 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 o 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 and 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 val
	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	
Lecturer	The state of the s
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 Me	chanics of Fibre Reinforced Composites
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 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 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

Lecturer	Prof. Werner Granzeier, Prof. Dieter Krause
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 (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 L0949: Materials Tes	ting - from the viewpoint of industrial application
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 L2994: Reliability in 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	Dr. Eric Groß, Prof. Benedikt Kriegesmann
Language	EN
Cycle	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 L2995: Reliability in I	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	Prof. Benedikt Kriegesmann, Dr. Eric Groß
Language	EN
Cycle	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 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	662)	Lecture	2	3
Module Responsible	Prof. Shan Shi			
Admission Requirements	None			
Recommended Previous	Basics in Materials Science I/II			
Knowledge				
Educational Objectives	After taking part successfully, students have reached t	he following learning results		
Professional Competence				
Knowledge	Students can explain basic principles of crystallograph	phy, statics (free body diagram	s, tractions) and therm	nodynamics (energy
	minimization, energy barriers, entropy)			
Chille	Charles to a complete of a circumstant and a classical and a circumstant and a circu			
SKIIIS	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	nd 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	6		
Credit points	6			
Course achievement	None			
Examination	Written exam			
Examination duration and	180 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	terials 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	Prof. Shan Shi
Language	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: Optin	nal and Robust Control			
Courses				
Title		Tun	Hrs/wk	СР
Optimal and Robust Control (L0658	()	Typ Lecture	2 2	3
Optimal and Robust Control (L0659		Recitation Section (small)	2	3
Module Responsible	NN			
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 f	ollowing learning results		
Professional Competence				
Knowledge				
_	Students can explain the significance of the matrix			
	They can explain the duality between optimal state			
	They can explain how the H2 and H-infinity norms a			
	 They can explain how an LQG design problem can b They can explain how model uncertainty can be rep 			
	They can explain how model uncertainty can be rep They can explain how - based on the small gain the			
	an uncertain plant.	co.c a robast cont.onc. can go	iaramee stasiiie,	and performance to
	They understand how analysis and synthesis conditions	ons on feedback loops can be repr	esented as linear	matrix inequalities.
Skills	 Students are capable of designing and tuning LQG or 	ontrollers for multivariable plant m	nodels.	
	They are capable of representing a H2 or H-infinity			and of using standard
	software tools for solving it.			
	They are capable of translating time and frequency	y domain specifications for contro	l loops into const	raints on closed-loop
	sensitivity functions, and of carrying out a mixed-se	nsitivity design.		
	 They are capable of constructing an LFT uncertain 	ty model for an uncertain system	n, and of designin	ng a mixed-objective
	robust controller.			
	They are capable of formulating analysis and synth	esis conditions as linear matrix in	equalities (LMI), a	nd of using standard
	LMI-solvers for solving them.	6		
	They can carry out all of the above using standard s	oftware tools (Matlab robust contr	ol toolbox).	
Personal Competence				
Social Competence	Students can work in small groups on specific problems to	arrive at joint solutions.		
Autonomy	Students are able to find required information in sources p	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 56			
Credit points	6			
Course achievement	None			
Examination	Oral exam			
Examination duration and	30 min			<u> </u>
scale				
Assignment for the	Electrical Engineering: Specialisation Control and Power Sy	stoms Engineering, Elective Comm	ulcony	
Following Curricula		stems Engineering. Elective Comp	uisory	
Tollowing Curricula	Aircraft Systems Engineering: Core Qualification: Elective Company	Compulsory		
	Aeronautics: Core Qualification: Elective Compulsory	sompaisory		
	Mechatronics: Core Qualification: Elective Compulsory			
	Biomedical Engineering: Specialisation Artificial Organs an	d Regenerative Medicine: Elective	Compulsory	
	Biomedical Engineering: Specialisation Implants and Endo	-		
	Biomedical Engineering: Specialisation Medical Technology		pulsory	
	Biomedical Engineering: Specialisation Management and B	•		
	Product Development, Materials and Production: Specialisa	ation Product Development: Electiv	e Compulsory	
	Product Development, Materials and Production: Specialisa	ation Production: Elective Compulse	ory	
	Product Development, Materials and Production: Specialisa	ation Materials: Elective Compulsor	У	
	Theoretical Mechanical Engineering: Core Qualification: Ele	ective 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	NN	
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	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	NN	
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 (T	Project-/problem-based Learning	2	3
Module Responsible	Prof. Bodo Fiedler			
Admission Requirements	None			
Recommended Previous	Knowledge in the basics of chemistry / physics / materials	science		
Knowledge				
Educational Objectives	After taking part successfully, students have reached the	following learning results		
Professional Competence				
Knowledge	Students are able to give a summary of the technical de	tails of the manufacturing processes co	mposites and	I illustrate respective
	relationships. They are capable of describing and comm	nunicating relevant problems and que	stions using a	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 comp	posites (FRP) and its constituents (fiber	/ matrix) and	define the necessary
	testing and analysis.	(,	,
	,			
	They can explain the complex structure-property relation:	ship and		
	the interactions of chemical structure of the polymers	s, their processing with the different	fiber types,	including to explain
	neighboring contexts (e.g. sustainability, environmental p	protection).		
Personal Competence				
Social Competence	Students are able to cooperate in small, mixed-subject g	roups in order to independently derive	solutions to g	iven problems in the
	context of civil engineering. They are able to effectively	present and explain their results alone	or in groups i	n front of a qualified
	audience. Students have the ability to develop alternativ	e approaches to an engineering proble	m independe	ntly or in groups and
	discuss advantages as well as drawbacks.			
Autonomy	Students are capable of independently solving mechani	cal engineering problems using provid	ed literature.	They are able to fill
	gaps in as well as extent their knowledge using the litera	ture and other sources provided by the	supervisor. Fu	urthermore, they can
	meaningfully extend given problems and pragmatically so	olve them by means of corresponding se	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 and Engineering: Specialisation Engineer	ering Materials: Elective Compulsory		
Following Curricula	Materials Science: Specialisation Engineering Materials: E	lective Compulsory		
	Mechanical Engineering and Management: Specialisation			
	Product Development, Materials and Production: Specialis	·	mpulsory	
	Product Development, Materials and Production: Specialis	• •		
	Product Development, Materials and Production: Specialis			
	Theoretical Mechanical Engineering: Specialisation Materi	als Science: Elective Compulsory		

Course L1895: Processing of	ourse 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	Åström: Manufacturing of Polymer Composites, Chapman and Hall

Module M1690: Aircra	aft Design II (Special Air Vehicle Desigr	1)		
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 in	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 interde	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			
	Written exam			
Examination duration and scale	180 min			
	Aircraft Systems Engineering: Core Qualification: Elective	Compulsory		
Following Curricula			oulsory	
	Aeronautics: Core Qualification: Elective Compulsory		-	
	Product Development, Materials and Production: Speciali	sation Product Development: Elective	Compulsory	
	Product Development, Materials and Production: Speciali	sation Production: Elective Compulso	ry	
	Theoretical Mechanical Engineering: Specialisation Aircra	ft Systems Engineering: Elective Con	npulsory	

Course L0844: Aircraft Desig	Course L0844: Aircraft Design 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: Struc	ture and properties of fibre-polymer-compo	osites		
Courses				
Title Structure and properties of fibre-po		Typ Lecture Project /problem based Learning	Hrs/wk 2 2	CP 3 2
Structure and properties of fibre-po		Project-/problem-based Learning Recitation Section (large)	1	1
Module Responsible				
Admission Requirements	None			
Recommended Previous				
Knowledge				
Educational Objectives	After taking part successfully, students have reached the follow	ring learning results		
Professional Competence				
Knowledge	Students can use the knowledge of fiber-reinforced composite necessary testing and analysis.	es (FRP) and its constituents to p	lay (fiber / ma	trix) and define the
	They can explain the complex relationships structure-property	relationship and		
	the interactions of chemical structure of the polymers, their neighboring contexts (e.g. sustainability, environmental protect		fiber types, i	ncluding 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 stiffness, corrosion resistance. 			
Personal Competence				
Social Competence	Students can			
	arrive at funded work results in heterogenius groups and provide appropriate feedback and handle feedback on th		ely.	
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.			
Waydaad in Harre	Indonesia and Children Time 110. Children Time in Leading 70			
Workload in Hours Credit points	Independent Study Time 110, Study Time in Lecture 70			
Course achievement				
	Written exam			
Examination duration and scale				
Assignment for the	Aircraft Systems Engineering: Core Qualification: Elective Comp	pulsory		
Following Curricula	International Management and Engineering: Specialisation II. Product Development and Production: Elective Compulsory			
	Aeronautics: Core Qualification: Elective Compulsory			
	Materials Science and Engineering: Specialisation Engineering			
	Materials Science: Specialisation Engineering Materials: Elective			
	Mechanical Engineering and Management: Core Qualification: C Product Development, Materials and Production: Specialisation		ompulsory	
	Product Development, Materials and Production: Specialisation Product Development, Materials and Production: Specialisation	•	στηραίουι γ	
	Product Development, Materials and Production: Specialisation			
	Renewable Energies: Specialisation Bioenergy Systems: Elective			
	Renewable Energies: Specialisation Wind Energy Systems: Elec	tive Compulsory		
	Renewable Energies: Specialisation Solar Energy Systems: Elec	tive Compulsory		
	Theoretical Mechanical Engineering: Specialisation Materials Sc	ience: 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	

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	The students receive the assignment in the form of a material design for test bodies made of fibre composites. Technical and normative requirements are listed in the assignment, all other required information comes from the lectures and exercises or the respective documents (electronically and in conversation). The procedure is specified in a milestone plan and enables the students to plan subtasks and thus work continuously. At the end of the project, different test specimens were tested in tensile or bending tests. In the individual project meetings, the conception (discussion of requirements and risks) is scrutinised. The calculations are analysed, the production methods are evaluated and determined. Materials are selected and the test specimens are manufactured according to standards. The quality and mechanical properties are checked and classified. At the end, a final report is prepared and the results are presented to all participants in the form of a presentation and discussed. Translated with www.DeepL.com/Translator (free version)
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 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	The contents of the lecture are repeated and deepened using practical examples.	
	Calculations are carried out together or individually, and the results are discussed critically.	
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	

Module M1878: Susta	inable energy from wind and water			
Courses				
Title Offshore Geotechnical Engineering Hydro Power Use (L0013) Wind Turbine Plants (L0011)		Typ Lecture Lecture	Hrs/wk 1 1 2	CP 1 1 3
Wind Energy Use - Focus Offshore (Lecture	1	1
_	Dr. Marvin Scherzinger			
Admission Requirements Recommended Previous	None			
Knowledge	Module: Technical Thermodynamics I, Module: Technical Thermodynamics II,			
	Module: Fundamentals of Fluid Mechanics			
Educational Objectives	After taking part successfully, students have reached	the following learning results		
Professional Competence Knowledge	1 1			
	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 ser	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 110, Study Time in Lecture 7	0		
Credit points	6			
Course achievement	None			
Examination	Written exam			
Examination duration and scale	180 min			
Assignment for the	Civil Engineering: Specialisation Structural Engineering	g: Elective Compulsory		
Following Curricula	Civil Engineering: Specialisation Geotechnical Enginee			
	Civil Engineering: Specialisation Coastal Engineering:	, ,		
	International Management and Engineering: Specialisa	**		Compulsory
	International Management and Engineering: Specialisa 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	ergy Systems: Elective Compulso	ry	
	Process Engineering: Specialisation Environmental Pro	cess Engineering: Elective Comp	ulsory	
	Water and Environmental Engineering: Specialisation Water and Environmental Engineering: Specialisation			
<u> </u>				

Course L0067: Offshore Geotechnical Engineering		
Тур	Lecture	
Hrs/wk	1	
СР	1	
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14	
Lecturer	Dr. Jan Dührkop	
Language	DE	
Cycle	SoSe	
Content	Overview and Introduction Offshore Geotechnics Introduction to Soil Mechanics Offshore soil investigation Focus on cyclical effects Geotechnical design of offshore foundations Monopiles Jackets Heavyweight foundations Geotechnical preliminary exploration for the use of lift boats and platforms	
Literature	 Randolph, M. and Gourvenec, S (2011): Offshore Geotechnical Engineering. Spon Press. Poulos H.G. (1988): Marine Geotechnics. Unwin Hyman, London BSH-Standard Baugrunderkundung für Offshore-Windenergieparks Lesny K. (2010): Foundations for Offshore Wind Turbines. VGE Verlag, Essen. EA-Pfähle (2012): Empfehlungen des Arbeitskreises Pfähle der DGGT. Ernst & Sohn, Berlin. 	

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
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

Production"					
Module M1894: Auton	nation Technology and Syste	ms			
Courses					
Title			Тур	Hrs/wk	СР
Automation Technology and System	ns (L2329)		Lecture	4	4
Automation Technology and System	ns (L2331)		Project-/problem-based Learning	1	1
Automation Technology and System	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	ve reached the followi	ng learning results		
Professional Competence					
Knowledge	Students				
3.1					
	 know the characteristic components 	of an automation sys	stems and have good understand	ling of their inte	eraction
	 know methods for a systematical an 				
	 have special competences in industrial 	rial robot based auton	nation systems		
Skills	Students are able to				
	analyze complex Automation tasks				
	develop application based concepts	and solutions			
	design subsystems and integrate integrate integrate integrate.				
	 investigate and evaluate safety of m 				
	create simple programs for robots a		ic controllers		
	 design of circuit for pneumatic appli 				
	, , , , , , , , , , , , , , , , , , ,				
Personal Competence					
Social Competence	Students are able to				
	- find solutions for automation and handlin	g tasks in groups			
	- develop solutions in a production enviror	nment with qualified p	personnel at technical level and re	epresent decisi	ions.
Autonomy	Students are able to				
Autonomy	Stadents are able to				
	 analyze automation tasks independent 	ently			
	 generate programs for robots and p 	rogrammable logic de	vices autonomously		
	 develop solutions for practice orient 		n independently		
		Section 1.			
	 assess consequences of their profes 	sional actions and res	sponsibilities		
Workload in Hours	Independent Study Time 96, Study Time in	Lecture 84			
Credit points					
	Compulsory Bonus Form	Description			
	No 20 % Subject theoretic	al andDie Studienl	eistung umfasst die Ergebnisse	e der PBL bas	sierten Anteile des
	practical work	Moduls sowie	e der Präsentation in der Gruppe.		
Examination	Written exam				
Examination duration and	120 min	<u> </u>			
scale					
Assignment for the	International Management and Engineering	g: Specialisation II. Pro	oduct Development and Production	on: Elective Co	mpulsory
_	Mechatronics: Core Qualification: Elective				, ,
	Product Development, Materials and Produ		Product Development: Elective Co	ompulsorv	
	Product Development, Materials and Produ		•	F	
	Product Development, Materials and Produ	•			
	Theoretical Mechanical Engineering: Specia		. ,	e Compulsorv	
			,	1,,	

Course L2329: Automation T	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 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 Robotics: Modelling and Control (L0168) Robotics: Modelling and Control (L1305)				Typ Integrated Lecture Project-/problem-based Learning	Hrs/wk 4 2	CP 4 2	
Module Responsible					,,,,, <u>3</u>		
Admission Requirements	None						
Recommended Previous	Fundamentals of elect	trical engine	eering				
Knowledge	Donald Incombada a second						
	Broad knowledge of m	nechanics					
	Fundamentals of cont	rol theory					
Educational Objectives	After taking part succ	essfully, stu	dents have re	ached the following	ng learning results		
Professional Competence							
					and solution approaches for mult	iple problems i	n robotics.
Skills	Students are able to o	derive and s	olve equation	s of motion for va	rious manipulators.		
	Students can generate	e trajectorie	s in various c	oordinate systems	5.		
	Students can design li	Students can design linear and partially nonlinear controllers for robotic manipulators.					
	Students can design i	inear and pe	arcially normin	car controllers for	Tobotic manipulators.		
Personal Competence							
· ·	Students are able to v						
Autonomy	Students are able to r	ecognize an	id improve kn	owledge deficits i	ndependently.		
	With instructor assists	ance, studer	nts are able to	evaluate their ov	vn knowledge level and define a	further course	of study.
Workload in Hours	Independent Study Ti	me 96, Stud	ly Time in Lec	ture 84			
Credit points	6						
Course achievement	Compulsory Bonus Yes None	Form Subject	theoretical	Description	n PBL-Einheiten sowie Erreic	shan daa Caa	and day
	res None	practical v		jeweiligen Se		illell des des	samtzieis und dei
Examination	Written exam	processor.		, c c g c . c . c			
Examination duration and	120 min						
scale							
Assignment for the	Aircraft Systems Engi	neering: Cor	re Qualificatio	n: Elective Compu	ilsory		
Following Curricula	-				duct Development and Producti		mpulsory
	-				chatronics: Elective Compulsory		
	Aeronautics: Core Qua Mechanical Engineering			-	ampulson/		
	Mechatronics: Core Q	-	-	e Quannication. Co	mpuisory		
				n: Specialisation P	roduct Development: Elective C	ompulsory	
				•	roduction: Elective Compulsory	•	
	Product Development	, Materials a	and Production	n: Specialisation M	laterials: Elective Compulsory		
		-			lopment and Production: Electiv		
	Theoretical Mechanica	al Engineerii	ng: Specialisa	tion Robotics and	Computer Science: Elective Con	npulsory	

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 M1888: Enviro	onmental protection management			
Courses				
Title		Тур	Hrs/wk	СР
Health, Safety and Environmental N	Management (L0387)	Integrated Lecture	3	3
Air Pollution Abatement (L0203)		Lecture	2	3
Module Responsible	Dr. Swantje Pietsch-Braune			
Admission Requirements	None			
Recommended Previous				
Knowledge				
Educational Objectives	After taking part successfully, students have reach	ed the following learning results		
Professional Competence				
Knowledge				
Skills				
Personal Competence				
Social Competence				
Autonomy				
Workload in Hours	Independent Study Time 110, Study Time in Lectur	re 70		
Credit points	6			
Course achievement	None			
Examination	Written exam			
Examination duration and	90 min			
scale				
Assignment for the	Civil Engineering: Specialisation Water and Traffic:	Elective Compulsory		
Following Curricula	Bioprocess Engineering: Specialisation C - Bioe	conomic Process Engineering, Focus	Management and (Controlling: Elective
	Compulsory			
	Environmental Engineering: Specialisation Energy	and Resources: Elective Compulsory		
	International Management and Engineering: Specia	alisation II. Energy and Environmental E	ngineering: Elective (Compulsory
	Product Development, Materials and Production: Sp	pecialisation Product Development: Elec	tive Compulsory	
	Product Development, Materials and Production: Sp	pecialisation Production: Elective Comp	ulsory	
	Product Development, Materials and Production: Sp	pecialisation Materials: Elective Compul	sory	
	Renewable Energies: Specialisation Bioenergy Syst	ems: Elective Compulsory		
	Process Engineering: Specialisation Environmental	Process Engineering: Elective Compulso	ory	
	Water and Environmental Engineering: Specialisati	on Environment: Compulsory		
	Water and Environmental Engineering: Specialisati	on Cities: Compulsory		

Course L0387: Health, Safety	y and Environmental Management
Тур	Integrated Lecture
Hrs/wk	3
СР	3
Workload in Hours	Independent Study Time 48, Study Time in Lecture 42
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 L0203: Air Pollution A	Abatement
Тур	Lecture
Hrs/wk	2
СР	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Dr. Swantje Pietsch-Braune, Christian Eichler
Language	EN
Cycle	WiSe
Content	In the lecture methods for the reduction of emissions from industrial plants are treated. At the beginning a short survey of the different forms of air pollutants is given. In the second part physical principals for the removal of particulate and gaseous pollutants form flue gases are treated. Industrial applications of these principles are demonstrated with examples showing the removal of specific compounds, e.g. sulfur or mercury from flue gases of incinerators.
Literature	Handbook of air pollution prevention and control, Nicholas P. Cheremisinoff Amsterdam [u.a.] : Butterworth-Heinemann, 2002 Atmospheric pollution : history, science, and regulation, Mark Zachary Jacobson Cambridge [u.a.] : Cambridge Univ. Press, 2002 Air pollution control technology handbook, Karl B. Schnelle Boca Raton [u.a.] : CRC Press, c 2002 Air pollution, Jeremy Colls 2. ed London [u.a.] : Spon, 2002

Module M1909: Syste	m Simulation			
Courses				
Title		Тур	Hrs/wk	СР
System Simulation Modul (L3150)		Lecture	2	3
System Simulation Modul (L3151)		Recitation Section (large)	2	3
Module Responsible	Prof. Arne Speerforck			
Admission Requirements	None			
Recommended Previous	Mathematics I-III, Computer Sciense, Engineering Thermodyna	mics I, II, Fluid Dynamics, Heat	Transfer, Control	Systems
Knowledge				
Educational Objectives	After taking part successfully, students have reached the follow	ving 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	Oral exam			
Examination duration and	30 min			
scale				
Assignment for the	Energy Systems: Core Qualification: Compulsory			
Following Curricula	Aircraft Systems Engineering: Core Qualification: Elective Com	pulsory		
	Aeronautics: Core Qualification: Elective Compulsory			
	Product Development, Materials and Production: Specialisation	Product Development: Elective	Compulsory	
	Product Development, Materials and Production: Specialisation	Production: Elective Compulso	ry	
	Product Development, Materials and Production: Specialisation	Materials: Elective Compulsory	′	
	Renewable Energies: Specialisation Bioenergy Systems: Electiv	e Compulsory		
	Renewable Energies: Specialisation Solar Energy Systems: Elec			
	Renewable Energies: Specialisation Wind Energy Systems: Elec	ctive Compulsory		
	Theoretical Mechanical Engineering: Specialisation Simulation	,	ry	
	Theoretical Mechanical Engineering: Specialisation Energy Syst	tems: Elective Compulsory		

Course L3150: System Simul	ation Modul
Тур	Lecture
Hrs/wk	2
СР	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Prof. Arne Speerforck, Dr. Johannes Brunnemann
Language	DE
Cycle	WiSe
Content	Lecture about equation-based, physical modelling using the modelling language Modelica and the free simulation tool OpenModelica 1.17.0. 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 3.5", Linköping, Sweden, 2021. [2] OpenModelica: OpenModelica 1.17.0, https://www.openmodelica.org (siehe Download), 2021. [3] M. Tiller: "Modelica by Example", https://book.xogeny.com, 2014. [4] M. Otter, H. Elmqvist, et al.: "Objektorientierte Modellierung Physikalischer Systeme", at- Automatisierungstechnik (german), Teil 1 - 17, Oldenbourg Verlag, 1999 - 2000. [5] P. Fritzson: "Principles of Object-Oriented Modeling and Simulation with Modelica 3.3", Wiley-IEEE Press, New York, 2015. [6] P. Fritzson: "Introduction to Modeling and Simulation of Technical and Physical Systems with Modelica", Wiley, New York, 2011.

Course L3151: System Simul	Course L3151: System Simulation Modul		
Тур	Recitation Section (large)		
Hrs/wk	2		
СР	3		
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28		
Lecturer	Prof. Arne Speerforck, Dr. Johannes Brunnemann		
Language	DE		
Cycle	WiSe		
Content	See interlocking course		
Literature	See interlocking course		

Module M0771: Flight	t Physics			
Courses				
itle		Тур	Hrs/wk	СР
erodynamics and Flight Mechanics	s I (L0727)	Lecture	3	3
light Mechanics II (L0730)		Lecture	2	2
light Mechanics II (L0731)		Recitation Section (large)	1	1
Module Responsible	Prof. Frank Thielecke			
Admission Requirements	None			
Recommended Previous	Basic knowledge in:			
Knowledge				
	Mathematics Machania			
	Mechanics			
	Thermodynamics			
	Aviation			
Educational Objectives	After taking part successfully, students have reached	the following learning results		
Professional Competence				
Knowledge	Students are able to			
	Describe the final acceptation of a continue			
	Describe the fundamental equations of aerody	namics for compressible, incompressible	e and frictional fic)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			
	Describe methods of flight simulation and airbo	orne measurement technology		
Skills	Students are able to			
Skins				
	Perform flight mechanic simulations			
	Derive flight mechanic relations from virtual ar	nd real flight test data		
Personal Competence				
	Students are able to:			
	 Perform simulations in groups and discuss result 	ılts		
	Evaluate flight test data in groups, discuss and	present the results		
Autonomy	Students are able to:			
	Process teaching content independently			
	Prepare, work out and process simulation mode			
	Apply teaching content on virtual and real fligh	it test data		
Workload in Hours	Independent Study Time 96, Study Time in Lecture 84	4		
Credit points	, , , ,			
Course achievement	None			
Examination				
Examination duration and	160 Minutes			
scale				
Assignment for the	Aircraft Systems Engineering: Core Qualification: Com	npulsory		
Following Curricula		•	pulsory	
•	Aeronautics: Core Qualification: Compulsory	-	. .	
	Product Development, Materials and Production: Spec	cialisation Product Development: Elective	e Compulsorv	
	Product Development, Materials and Production: Spec	cialisation Production: Elective Compulse	orv	
	Product Development, Materials and Production: Spec Product Development, Materials and Production: Spec	·	-	

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	ecture		
Hrs/wk			
СР			
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	ict Planning				
Courses					
Title			Тур	Hrs/wk	CP
Product Planning (L0851)			Lecture	3	3
Product Planning Seminar (L0853)			Project-/problem-based Learning	2	3
Module Responsible	Prof. Cornelius Herstatt				
Admission Requirements	None				
Recommended Previous	Good basic-knowledge of Business Administration	n			
Knowledge					
Educational Objectives	After taking part successfully, students have read	ched the following	g learning results		
Professional Competence					
Knowledge	Students will gain insights into:				
	Product Planning				
	Process				
	Methods				
	Design thinking				
	Process				
	Methods				
	User integration				
	- Oser megration				
Skills	Students will gain deep insights into:				
	Product Planning				
	Process-related aspects				
	 Organisational-related aspects 				
	Human-Ressource related aspects				
	Working-tools, methods and instrun	ments			
	0				
Davisanal Commetence					
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				
	Independent Study Time 110, Study Time in Lect	ture 70			
Credit points	6	Description			
Course achievement	Compulsory Bonus Form Yes 20 % Subject theoretical a	Description and			
	res 20 % Subject theoretical a	iliu			
Examination	'				
	90 minutes				
examination duration and scale	30 minutes				
Assignment for the	Global Innovation Management: Core Qualification	on: Compulsory			
-			ivos Managomont: Floctivo Com	nnulcor,	
Following Curricula	International Management and Engineering: Spec			npuisory	
	Mechanical Engineering and Management: Specia			mnulcom	
	Product Development, Materials and Production:	•	·	inpuisory	
	Product Development, Materials and Production:	•			
	Product Development, Materials and Production:			- Comercil	
	Theoretical Mechanical Engineering: Specialisation	on Product Develo	philietic 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.
Literature	Ulrich, K./Eppinger, S.: Product Design and Development, 2nd. Edition, McGraw-Hill 2010
	L Company of the Comp

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".	

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 i	n 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 Implants and Endoprostheses: Elective Compulsory				
	Biomedical Engineering: Specialisation Medical Technology and Control Theory: Elective Compulsory				
	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. Robert Rost			
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. Robert Rost
Language	DE
Cycle	WiSe
Content	See interlocking course
Literature	Siehe korrespondierende Vorlesung
	See interlocking course

Module M0962: Susta	inability and Risk Managemen	nt		
Courses				
Title		Тур	Hrs/wk	СР
Safety, Reliability and Risk Assessment (L1145)		Seminar	2	3
Environment and Sustainability (L0	319)	Lecture	2	3
Module Responsible	Prof. Kerstin Kuchta			
Admission Requirements	None			
Recommended Previous	none			
Knowledge				
Educational Objectives	After taking part successfully, students have	e reached the following learning results		
Professional Competence				
Knowledge	Students are able to describe single techn	•	l of safety and risk as	sessment as well as
	environmental and sustainable engineering,	in detail:		
	 basics in safety and reliability of tech 	nical facilities		
	 safety and reliability analysis method 	s		
	 risk assessment 			
	 Production and usage of bio-char 			
	 energy production and supply 			
	 sustainable product design 			
Skills	Students are able apply interdisciplinary s		•	reporting. They can
	evaluate the effort and costs for processes a	and select economically feasible treatment c	concepts.	
Personal Competence				
Social Competence				
Autonomy	Students can gain knowledge of the subject	ct area from given sources and transform i	t to new questions. Fu	rthermore, they can
	define targets for new application or resear	ch-oriented duties in for risk management a	nd sustainability conce	epts accordance with
	the potential social, economic and cultural in	mpact.		
Workload in Hours	Independent Study Time 124, Study Time in	Lecture 56		
Credit points		Lecture 50		
Course achievement				
Examination	Written elaboration			
Examination duration and		aroups)		
scale	Elaboration and presentation (15 minutes in	. g. caps,		
Assignment for the	Civil Engineering: Core Qualification: Compu	ılsorv		
Following Curricula		- Bioeconomic Process Engineering, Focu	is Management and	Controlling: Elective
•	Compulsory	3 · 3,	3	3
	International Management and Engineering:	Specialisation II. Civil Engineering: Elective	Compulsory	
	Product Development, Materials and Produc	tion: Specialisation Product Development: El	lective Compulsory	
	Product Development, Materials and Produc	tion: Specialisation Production: Elective Com	npulsory	
	Product Development, Materials and Produc	tion: Specialisation Materials: Elective Comp	oulsory	
	Water and Environmental Engineering: Core	Qualification: Compulsory		

Course L1145: Safety, Reliab	ility and Rick Assessment
	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
Content	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	Тур		Hrs/wk	СР
Aircraft Cabin Systems (L1545)	Lect	ture itation Section (large)	3 1	4
Aircraft Cabin Systems (L1546)		itation Section (large)		2
Module Responsible				
Admission Requirements				
Recommended Previous Knowledge	_			
Riomicage	Mechanics			
	• Thermodynamics			
	Electrical Engineering			
	Control Systems			
Educational Objectives	After taking part successfully, students have reached the following lea	earning recults		
Professional Competence		arriing results		
-	Students are able to:			
Momeage	describe cabin operations, equipment in the cabin and cabin System	ms		
	explain the functional and non-functional requirements for cabin System			
	elucidate the necessity of cabin operating systems and emergency	Systems		
	assess the challenges human factors integration in a cabin environn	ment		
Ckilla	Students are able to:			
SKIIIS	design a cabin layout for a given business model of an Airline			
	design a Cabin layout for a given business model of all Allillie 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				
Social Competence	Students are able to:			
	comprehend existing system solutions and explain them on the bas discuss with experts in technical language.	is of existing requirements	,	
	discuss with experts in technical language explain system functions			
	classify the criticality of functions			
	describe systems as is			
Autonomou	Chudanta ave able to			
Autonomy	Students are able to:			
	independently reflect on lecture content and expert presentations independently develop more in-depth content			
	recognize further areas of knowledge			
	recognize farance areas or knowneage			
Workload in Hours		_		
Credit points				
Course achievement				
Examination Examination duration and				
scale				
		ineering: Flective Computer	ory	
Following Curricula		meening. Elective Compuls	OI y	
	Aircraft Systems Engineering: Core Qualification: Compulsory			
		1 Systems: Elective Compu	Isory	
	International Management and Engineering: Specialisation II. Aviation	n Systems: Elective Compu	Isory	
	International Management and Engineering: Specialisation II. Aviation Aeronautics: Core Qualification: Compulsory			
9	International Management and Engineering: Specialisation II. Aviation Aeronautics: Core Qualification: Compulsory Product Development, Materials and Production: Specialisation Produc	ict Development: Elective (Compulsory	
	International Management and Engineering: Specialisation II. Aviation Aeronautics: Core Qualification: Compulsory	act Development: Elective (action: Elective Compulsory	Compulsory	

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	f Manufacturing Design and A	nalysis	
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. Jan Hendrik Dege			
Admission Requirements	None			
Recommended Previous				
Knowledge				
Educational Objectives	After taking part successfully, stude	nts have reached the following learning resul	lts	
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 Developn	nent: Elective Compulsory	
Following Curricula	Product Development, Materials and	Production: Specialisation Production: Comp	oulsory	
	Product Development, Materials and	Production: Specialisation Materials: Elective	e Compulsory	
	Theoretical Mechanical Engineering:	Specialisation Product Development and Pro	duction: 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. Jan Hendrik Dege		
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 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 scien	nce			
Knowledge					
Educational Objectives	After taking part successfully, students ha	ave reached the following learning results			
Professional Competence					
Knowledge	Students can use the knowledge of plastic	cs and define the necessary testing and analysis	is.		
	They can explain the complex relationship	os structure-property relationship and			
	the interactions of chemical structure of the polymers, including to explain neighboring contexts (e.g. sustainability, environment protection).				
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.				
	- selecting appropriate solutions for mech	nanical recycling problems and sizing example	stiffness, corrosion res	sistance.	
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				
	access their own strongths and weakness				
	- assess their own strengths and weaknesses.				
	- assess their own state of learning in specific terms and to define further work steps on this basis.				
	- assess possible consequences of their professional activity.				
Workload in Hours	Independent Study Time 124, Study Time	in Lecture 56			
Credit points	6				
Course achievement Examination	None Written over				
	Written exam				
Examination duration and	180 min				
Assignment for the	Materials Science and Engineering, Specia	alisation Engineering Materials: Elective Compu	Ilsory		
Following Curricula	Materials Science and Engineering, Special Materials Science: Specialisation Engineer	·	11301 y		
. cc.mig carricula	Biomedical Engineering: Specialisation Im	* *			
	3 3 1	tificial Organs and Regenerative Medicine: Elec	tive Compulsory		
		anagement and Business Administration: Electi			
	3 3 1	edical Technology and Control Theory: Elective			
	3 3 1	uction: Specialisation Production: Elective Com	. ,		
	•	uction: Specialisation Materials: Elective Comp			
	Product Development, Materials and Produ	uction: Specialisation Product Development: El	ective Compulsory		
	Theoretical Mechanical Engineering: Speci	ialisation 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 weilhght 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 Chara	acterization of Materials (L1580)	Lecture	2	2
Phase equilibria and transformation		Lecture	2	2
Übung zu Phänomene und Methode	n der Materialwissenschaft (L2991)	Recitation Section (large	ge) 2	2
Module Responsible	Prof. Jörg Weißmüller			
Admission Requirements	None			
Recommended Previous	Basic knowledge in Materials Science, e.g. Werks	stoffwissenschaft I/II		
Knowledge				
Educational Objectives	After taking part successfully, students have rea	ched the following learning results		
Professional Competence				
Knowledge	The students will be able to explain the properti	es of advanced materials along with	their applications in tec	hnology, in particular
	metallic, ceramic, polymeric, semiconductor, mo	dern composite materials (biomateria	ls) and nanomaterials.	
Skills	The students will be able to select material co	-		
	materials considering architectural principles f			
	modern materials science, which enables the	iem to select optimum materials	combinations depend	ing on the technical
	applications.			
Personal Competence				
Social Competence	The students are able to present solutions to specialists and to develop ideas further.			
Autonomy	The students are able to			
	assess their own strengths and weaknesse			
	 gather new necessary expertise by their or 	own.		
Workload in Hours	Independent Study Time 96, Study Time in Lectu	ire 84		
Credit points	6			
Course achievement	None			
Examination	Written exam			
Examination duration and	90 min			
scale				
Assignment for the	Chemical and Bioprocess Engineering: Specialisa	ation General Process Engineering: Ele	ctive Compulsory	
-	Chemical and Bioprocess Engineering: Specialisa	-		
	International Management and Engineering: Spe	-		Compulsory
	Materials Science: Core Qualification: Compulsor	·		-
	Product Development, Materials and Production:	Specialisation Product Development:	Elective Compulsory	
	Product Development, Materials and Production:	Specialisation Production: Elective Co	mpulsory	
	Product Development, Materials and Production:	Specialisation Materials: Compulsory		
	Theoretical Mechanical Engineering: Specialisation	on Materials Science: Elective Compul	sory	

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	nomene 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	Practice problems to practice and deepen the skills and content taught in the module.
	Exercises explore mathematical details in greater depth with the aim of familiarizing students with equations/concepts and how to apply them in practice (e.g. defining thermodynamic potentials and relationships, calculating enthalpy and entropy of a solid solution, constructing phase diagrams,).
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
	Peter Hadsen, "Physikalische Metalikunde", 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.
	William D. Callister und David G. Rethwisch, Materialwissenschaften und Werkstofftechnik, Wiley&Sons, Asia (2011).
	William D. Callister, Materials Science and Technology, Wiley& Sons, Inc. (2007).

Module M1919: Susta	inable operation of technical assets			
Courses				
Title		Тур	Hrs/wk	СР
Fundamentals of Maintenance, Rep		Lecture	3	4
Fundamentals of Maintenance, Rep		Recitation Section (large)	1	2
Module Responsible				
Admission Requirements	None			
	We recommend knowledge in the areas of general engir	-	-	
Knowledge	fields like mechanical engineering, mechatronics and processing in the second results of	production engineering will be intr	oduced into the	relevant aeronautical
	content.			
Educational Objectives	After taking part successfully, students have reached the	following learning results		
Professional Competence				
Knowledge	The students are able to describe fundamental correlatio	ns for the sustainable operation of	technical assets a	nd to identify solution
	approaches for complex optimization problems.			
Skille	The students are enabled to apply the general enginee	ring canabilities of the individual o	course towards th	o ontimization of the
Skills	sustainability in operation of technical assets. The resu	- ·		•
	production and technical operation of sustainable produc	- '		in the development,
	production and technical operation of Sustainable product	is in the module, and engineering in	riddoi reo.	
Personal Competence				
Social Competence	The students are able to work in mixed groups with	a clear focus on the approached	solutions by res	pecting the complex
	environment of multiple stakeholders.			
Autonomy	The students are enabled to find solutions for optimi	zation problems and to take req	uired decision for	r the assessment of
	determining factors independently.	,		
	Independent Study Time 124, Study Time in Lecture 56			
Credit points				
Course achievement				
Examination				
Examination duration and	30 min			
scale				
-	Aircraft Systems Engineering: Core Qualification: Elective	Compulsory		
Following Curricula		ation Floating Committee		
	Mechatronics: Specialisation Intelligent Systems and Rob			
	Mechatronics: Specialisation System Design: Elective Cor Mechatronics: Core Qualification: Elective Compulsory	ripuisory		
	Product Development, Materials and Production: Speciali	sation Product Development: Floctiv	ve Compulsory	
	Product Development, Materials and Production: Speciali	•		
	Product Development, Materials and Production: Speciali	·	-	
	Theoretical Mechanical Engineering: Specialisation Produ	·	-	,
	Theoretical Mechanical Engineering: Specialisation Aircra	·		
	Theoretical Mechanical Engineering: Specialisation Aircra	it systems Engineering: Elective Co	impuisory	

Course L3160: Fundamentals of Maintenance, Repair and Overhaul (MRO)			
Тур	ecture		
Hrs/wk	3		
СР	4		
Workload in Hours	Independent Study Time 78, Study Time in Lecture 42		
Lecturer	Prof. Gerko Wende		
Language	DE		
Cycle	WiSe		
Content	Fundamentals for the sustainable operation of technical assets by means of maintenance, repair and overhaul (MRO):		
	 Life cycle analytics Material circularity and service products Rules and regulations Processes and production methods Tools and technologies Data handling and usage Design for maintenance Self-healing technical systems 		
Literature	•		

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

Course L3161: Fundamentals of Maintenance, Repair and Overhaul (MRO)	
Тур	Recitation Section (large)
Hrs/wk	1
СР	2
Workload in Hours	Independent Study Time 46, Study Time in Lecture 14
Lecturer	Prof. Gerko Wende
Language	DE
Cycle	WiSe
Content	See interlocking course
Literature	See interlocking course

Module M1185: Technical Complementary Course for PEPMS (according to Subject Specific Regulations)		
Courses		
Title	Typ Hrs/wk CP	
Module Responsible	Prof. Dieter Krause	
Admission Requirements	None	
Recommended Previous	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.

Module M0763: Aircra	aft Energy Systems			
Courses				
Title		Tun	Hee hule	CD
Aircraft Energy Systems (L0735)		Typ Lecture	Hrs/wk 3	CP 4
Aircraft Energy Systems (L0739)		Recitation Section (large)	2	2
Module Responsible	Prof. Frank Thielecke			
Admission Requirements				
Recommended Previous	Basic knowledge in:			
Knowledge	a Mathamatica			
	Mathematics Mechanics			
	Thermodynamics			
	Electrical Engineering			
	Fluid mechanics			
Educational Objectives	After taking part suggessfully students have reached the	following loarning results		
	After taking part successfully, students have reached the	rollowing learning results		
Professional Competence	Students are able to:			
Knowiedge	Students are able to.			
	Assess challenges during the design of aircraft end			
	Describe essential components and design points		stems	
	Give an overview of the functionality of air conditi Describe different system consents for do ising	oning systems		
	 Describe different system concepts for de-icing Identify constraints for the electrification of aircraft 	t systems, and evaluate possible co	ncents and limita	tions
	Describe architectures for fuel supply systems and		neepts and minea	10115
	Explain possible approaches for the integration of		emission concept	S
2				
Skills	Students are able to:			
	Design hydraulic and electric supply systems of air	rcrafts		
	Analyze the thermodynamic behavior of air condit	oning systems		
	Design ice protection systems			
	Apply possible electrification concepts to existing	aircraft systems		
	Design fuel supply systems Derform the design of a fuel cell system			
	Perform the design of a fuel cell system			
Personal Competence				
Social Competence	Students are able to:			
	Perform system design in groups and present and	discuss results		
	Present systems engineering problems and discus			
Autonomy	Students are able to:			
,				
	Reflect on the content of lectures autonomously			
	Apply methods learned in the course of exercises Identify complex system dependencies autonomous	•	and docion proces	2505
	Identify complex system dependencies autonomo	asiy and abstract simplified models a	and design proces	sses
Workload in Hours	Independent Study Time 110, Study Time in Lecture 70			
Credit points	6			
Course achievement	None			
Examination	Written exam			
Examination duration and	165 Minutes			
scale		0 1		
	Energy Systems: Specialisation Energy Systems: Elective			
Following Curricula	Aircraft Systems Engineering: Core Qualification: Compu International Management and Engineering: Specialisation	•	nulsory	
	Aeronautics: Core Qualification: Compulsory	Aviación Systems. Liective Com	,paisory	
	Product Development, Materials and Production: Speciali	sation Product Development: Electiv	e Compulsorv	
	Product Development, Materials and Production: Speciali	·		
	Product Development, Materials and Production: Speciali	·	-	
	Theoretical Mechanical Engineering: Specialisation Aircra	ft Systems Engineering: Elective Co	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 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	ıction Planning & Control and I	Digital Enterprise		
Module Mood7: Produ	iction Flamming & Control and I	Digital Enterprise		
Courses				
Title Typ 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 teams and present them to others.			
Autonomy				
Workload in Hours	Independent Study Time 96, Study Time in L	ecture 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 Implants and Endoprostheses: Elective Compulsory			
	Biomedical Engineering: Specialisation Medical Technology and Control Theory: Elective Compulsory			
	Biomedical Engineering: Specialisation Management and Business Administration: Compulsory			
	Product Development, Materials and Production: Specialisation Product Development: Elective Compulsory			
	Product Development, Materials and Product	ion: Specialisation Production: Compulsory		
	Product Development, Materials and Product	ion: Specialisation Materials: Elective Compulsor	y	
	Theoretical Mechanical Engineering: Speciali	sation Product Development and Production: Elec	ctive Compulsory	

Course L0932: The Digital En	iterprise
Тур	Lecture
Hrs/wk	2
СР	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Dr. Robert Rost
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 Pla	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	ourse 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. Robert Rost
Language	DE
Cycle	WiSe
Content	See interlocking course
Literature	Siehe korrespondierende Vorlesung
	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. Jan Hendrik Dege				
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: Compulsory			
	Product Development, Materials and	Production: Specialisation Materials: Elective Compr	ulsory		
	Theoretical Mechanical Engineering:	Specialisation Product Development and Production	: 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 A	Analysing Production Processes
Тур	Lecture
Hrs/wk	2
СР	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Prof. Jan Hendrik Dege
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)

Troduction					
Module M1193: Cabin	Systems Engineering				
Courses					
			_		
Title	analogy in cabin electronics and avianics (L1557)		Typ	Hrs/wk	CP
	nnology in cabin electronics and avionics (L1557) nnology in cabin electronics and avionics (L1558)		Lecture Recitation Section (small)	2	2
Model-Based Systems Engineering			Project-/problem-based Learning	3	3
			Troject /problem basea Leanning	3	
Module Responsible					
Admission Requirements	None				
Knowledge	Mechanics				
	Thermodynamics				
	Electrical Engineering Control Systems				
	Control Systems				
	Previous knowledge in:				
	Systems Engineering				
Educational Objectives	After taking part successfully, students have reached	the followi	ng learning results		
Professional Competence					
Knowledge	Students are able to:				
	describe the structure and operation of computer a	rchitectures	S		
	explain the structure and operation of digital comn	nunication N	letworks		
	explain architectures of cabin electronics, integrate	ed modular	avionics (IMA) and Aircraft Data	Communicatio	on Network (ADCN)
	 understand the approach of Model-Based Systen 	ns Engineer	ing (MBSE) in the design of ha	rdware and s	oftware-based cabin
	systems				
Sville	Students are able to:				
Skills	understand, operate and maintain a Minicomputer				
	build up a network communication and communication	te with othe	er network narticinants		
				· a AFDY®-Na	twork
	 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 				
	model system functions by means of formal languages SysML/UML and generate software code from the models execute software code on a minicomputer				
	execute software code on a minicompater				
Personal Competence					
Social Competence	Students are able to:				
	form teams of two or small groups for the practical	work			
	work out partial results themselves and combine themselves.	nem with oth	ners to form an overall solution		
	represent and contribute their own solution				
	take over the guidance of the team				
	contribute in the team				
A	Charles have a see a hills ha				
AUTONOMY	Students are able to: • organize and plan their practical tasks				
	organize and plan their practical tasks further develop their own skills				
	take their own initiative				
	explore their own new ways of solving problems				
	- explore their own new ways or solving problems				
Workload in Hours	Independent Study Time 96, Study Time in Lecture 8	34			
Credit points	6				
Course achievement	None				
Examination	Written exam				
Examination duration and					
scale					
Assignment for the	Aircraft Systems Engineering: Core Qualification: Ele	ctive Comp	ılsorv		
Following Curricula			•	sorv	
. onowing curricula	Aeronautics: Core Qualification: Elective Compulsory		acion bysteins. Elective compuls	,	
	Product Development, Materials and Production: Spe		Product Development: Flective Co	nmulsory	
	Product Development, Materials and Production: Spe		•	ompuis0i y	
	Product Development, Materials and Production: Spe				
	Theoretical Mechanical Engineering: Specialisation A			llsorv	
	Theoretical Mechanical Engineering, Specialisation A	ii ci ait 3yste	and Engineering. Elective Compt	11301 y	

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

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 Des	ign)			
Courses						
Title				Тур	Hrs/wk	СР
Aircraft Design I (Design of Transpo				Lecture	3	3
Aircraft Design I (Design of Transpo				Recitation Section (large)	2	3
Module Responsible	†					
Admission Requirements	None					
Recommended Previous	Bachelor Mech	n. Eng.				
Knowledge	Bachelor Traff	ic Systems				
	Vordiplom Me	ch. Eng.				
	Module Air Tra	insport Systems				
Educational Objectives	After taking part suc	cessfully, students hav	ve reached the followi	ng learning results		
Professional Competence						
Knowledge	1 Principle unde	rstanding of integrate	d and civil aircraft do	cian		
		of the interactions ar		-		
	_	relevant design param		·		
	·	f the principle design i				
2, 111						
SKIIIS	Understanding and a	Understanding and application of design and calculation methods				
	Understanding of interdisciplinary and integrative interdependencies					
Personal Competence						
Social Competence	Working in interdisci	plinary teams				
	Communication					
	Communication					
Autonomy	Organization of work	flows and -strategies				
Workload in Hours	Independent Study T	ime 110, Study Time	in Lecture 70			
Credit points	6					
Course achievement		Form	Description			
Examination	No 10 %	Attestation	Durchtunrun	g einer Konzeptauslegung fü	r ein verkenrstlugz	zeug
Examination duration and		Written exam				
scale	100 111111					
Assignment for the	Aircraft Systems Eng	ineering: Core Qualific	cation: Compulsory			
Following Curricula		-		iation Systems: Elective Con	npulsory	
	-	ıalification: Compulsor				
	Product Developmen	t, Materials and Produ	ction: Specialisation F	Product Development: Electiv	e Compulsory	
	Product Developmen	t, Materials and Produ	iction: Specialisation F	Production: Elective Compuls	ory	
	Theoretical Mechanic	cal Engineering: Specia	alisation Aircraft Syste	ems Engineering: Elective Co	mpulsory	

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
	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.P. Raymer: "Aircraft Design - A Conceptual Approach"
	J.P. Fielding: "Introduction to Aircraft Design"
	Jenkinson, Simpkon, Rhods: "Civil Jet Aircraft Design"
	Jenkinson, Simpkon, Knous. Civil jet Alici dit Design

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

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	

Hrs/wk	СР
2	3
2	2
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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.	

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	

Production				
Module M0764: Flight	t Control Systems			
Courses				
Title		Tree	Han hade	CD.
Flight Control Systems (L0736)		Typ Lecture	Hrs/wk 3	CP 4
Flight Control Systems (L0740)		Recitation Section (large)	2	2
Module Responsible	Prof. Frank Thielecke			
Admission Requirements				
Recommended Previous				
Knowledge				
_	mathematics			
	mechanics			
	thermo dynamics electronics			
	fluid mechanics			
	control theory			
	control dicory			
Educational Objectives	After taking part successfully, students have reached the follow	ring learning results		
Professional Competence				
Knowledge	Students are able to			
	describe the structure and the functioning of primary fli	ght control systems as well as	actuation-, avior	nic high lift systems
	of aircrafts in general along with corresponding propertie			,g ,
	give an overview over the functioning and the structure		ear systems	
	 explain different configurations and designs and their or 	gins		
CL III				
Skills	Students are able to			
	size primary flight control actuation systems			
	perform a controller design process for the flight control	actuators		
	 design high-lift systems and high-lift kinematics 			
	size landing gear components			
Personal Competence				
Social Competence	Students are able to:			
	Develop joint solutions in mixed teams			
	Present and explain developed solutions in front of other	students		
	Discuss developed solutions with experts			
	·			
Autonomy	Students are able to:			
	derive requirements and perform appropriate yet simpli	fied design processes for aircr	aft systems from	complex issues and
	circumstances in a self-reliant manner	3 1	,	
	apply new skills and methods in the context of exercises	in a self-reliant manner		
M-di ii	Indianandank Chaka Tima 110 Ci. L. Ti			
	Independent Study Time 110, Study Time in Lecture 70			
Credit points				
Course achievement				
	Written exam			
Examination duration and				
scale				
-	Aircraft Systems Engineering: Core Qualification: Compulsory	vieties Cystems Flating C	alaam.	
Following Curricula		viation Systems: Elective Com	puisory	
	Aeronautics: Core Qualification: Compulsory Product Development, Materials and Production: Specialisation	Product Devolopment, Floating	- Compulsory	
	Product Development, Materials and Production: Specialisation Product Development, Materials and Production: Specialisation			
	Theoretical Mechanical Engineering: Specialisation Aircraft Sys			
	Theoretical Mechanical Engineering, Specialisation Aircfall Sys	.cma Engineering, Elective Col	привону	

Course L0736: Flight Control Systems				
Тур	Lecture			
Hrs/wk	3			
СР	4			
Workload in Hours	ependent Study Time 78, Study Time in Lecture 42			
Lecturer	f. Frank Thielecke			
Language				
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	none Students can:
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	Biomedical Engineering: Core Qualification: Compulsory
	Product Development, Materials and Production: Specialisation Product Development: Elective Compulsory
	Product Development, Materials and Production: Specialisation Production: Elective Compulsory Product Development, Materials and Production: Specialisation Materials: Elective Compulsory
	Theoretical Mechanical Engineering: Specialisation 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. Michael Helle, Dr. Sven Prevrhal, Frank Michael Weber		
Language	Language DE		
Cycle	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
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 Mechatronics (L1512)		Lecture	2	3
Fatigue & Damage Tolerance (L03	10)	Lecture	2	3
GSD - Generational Sheet-Metal D	evelopment (L3064)	Lecture	3	3
Industry 4.0 for Engineers (L2012)		Lecture	2	3
nnovation and Product Manageme	nt (L2168)	Seminar	2	3
ightweight Design Practical Cour	e (L1258)	Project-/problem-based Learning	3	3
Mechanisms and Systems of Mate	ials Testing - from the viewpoint of product development and Failure	Lecture	2	2
Analysis (L0950)				
Microsystems Technology (L0724)		Lecture	2	4
ustainable Industrial Production (_2863)	Lecture	2	4
roductivity Management (L0928)		Project-/problem-based Learning	2	2
Productivity Management (L0931)		Recitation Section (small)	1	1
eedback Control in Medical Tech	ology (L0664)	Lecture	2	3
Structural Mechanics of Fibre Rein		Lecture	2	3
Fechnical Design (L1513)	yer extension	Lecture	2	3
=	pint of industrial application (L0949)	Lecture	2	2
Reliability in Engineering Dynamic		Lecture	2	2
Reliability in Engineering Dynamic		Recitation Section (small)	1	2
Reliability of Aircraft Systems (L07		Lecture	2	3
Module Responsible		Eccture		
Admission Requirements				
<u> </u>				
Recommended Previous	None			
Knowledge				
Educational Objectives	After taking part successfully, students have reached the follow	ring learning results		
Professional Competence				
Knowledge				
	Students are able to express their extended knowledge		fferent specia	I fields or applicat
	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 ne	ew scientific methods in selected	areas	
	Students are able to transfer learned skills to new and ur			annroaches
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	Students are upic to transfer learned skins to flew and ar			
Personal Competence	Students are usite to transfer rearried skins to new und un			
Personal Competence				
Social Competence				
•	-	ny autonomous election of course	s	
Social Competence		oy autonomous election of course	s.	
Social Competence	Students are able to develop their knowledge and skills be a student of the	oy autonomous election of course	s.	
Social Competence Autonomy	Students are able to develop their knowledge and skills to Depends on choice of courses	oy autonomous election of course	s.	
Social Competence Autonomy Workload in Hours	Students are able to develop their knowledge and skills to Depends on choice of courses			
Social Competence Autonomy Workload in Hours Credit points Assignment for the	Students are able to develop their knowledge and skills to Depends on choice of courses 12 Product Development, Materials and Production: Specialisation	Product Development: Elective Co		
Social Competence Autonomy Workload in Hours Credit points	Students are able to develop their knowledge and skills to Depends on choice of courses 12 Product Development, Materials and Production: Specialisation	Product Development: Elective Co		

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
Literature	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 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
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 L3064: GSD - Generational Sheet-Metal Development	
Тур	Lecture
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. Dr. Nikola Bursac
Language	DE
Cycle	WiSe
Content	Experience in mechanical engineering design and the fundamentals of manufacturing engineering
	After successful completion of the course, students will be able to explain development projects using the theory of product generation engineering and explain design rules for sheet metal development.
	After successful completion of the course, students will be able to apply the theory of product generation engineering to development tasks and develop sheet-metal products suitable for production.
	After successful completion of the course, students will be able to develop a product in a team and to compete against other teams.
	After successful completion of the course, students will be able to independently access knowledge required for sheet metal development.
Literature	

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	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.	

Course L0950: Mechanisms a	and Systems of Materials Testing - from the viewpoint of product development and Failure Analysis
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
	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: storess stress or sensors (temperature measurement, self-generating sensors: Seebeck effect and thermopile; modulating sensors (strain based and stress based principle, capacitive readout, piezoresistivity, pressure sensor: piezoresistive, capacitive and fabrication process; accelerometer: piezoresistive, piezoelectric and capacitive; angular rate sensors: operating principle and fabrication process; accelerometer: piezoresistive, piezoelectric and capacitive; angular rate sensors: galentore and fabrication process; principle conductivity sensor; metal oxide semiconductor gas sensor, capacitive and fabrication process; principle or disoensor, clark electrode, enzyme electrode, DNA chip) Chemical and Bio Sensors (thermal gas sensors: pellistor and thermal conductivity sensor; metal oxide semiconductor gas sensor,
	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	4
Workload in Hours	Independent Study Time 92, 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, 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 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 o 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 and 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 val
	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	
Lecturer	5
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			
СР			
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		
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 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

Lecturer	Prof. Werner Granzeier, Prof. Dieter Krause
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

Production		
	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 GmbH,	
	Auto & Design,	
	Corso Frabcia 161, 10139 Torino, Italia	
	(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	
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Course L0949: Materials Tes	ting - from the viewpoint of industrial application
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 L2994: Reliability in 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	Dr. Eric Groß, Prof. Benedikt Kriegesmann	
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 L2995: Reliability in I	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	
Language	EN
Cycle	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

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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		
Literature	• CS 25.1309	
	• SAE ARP 4754	
	• SAE ARP 4761	

Production				
Module M1156: Systems Engineering				
Courses				
itle		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	Basic knowledge in:			
Knowledge	Mathematics			
	Mechanics Thermodynamics			
	Electrical Engineering			
	Control Systems			
	Previous knowledge in:			
	Aircraft Cabin Systems			
Educational Objectives	After taking part successfully, students have reached the follow	ving learning results		
Professional Competence				
Knowledge	Students are able to:			
	• understand systems engineering process models, methods a		of complex System	ns
	describe innovation processes and the need for technology N			
	explain the aircraft development process and the process of			
	 explain the system development process, including requirem identify environmental conditions and test procedures for air 			
	value the methodology of requirements-based engineering (I		ments engineerin	a (MBRE)
		,	, , , , , , , , , , , , , , , , , , ,	,
Skills	Students are able to:			
	 plan the process for the development of complex Systems organize the development phases and development Tasks 			
	assign required business activities and technical Tasks			
	apply systems engineering methods and tools			
Personal Competence				
Social Competence	Students are able to: • understand and accept their tasks within a development teal	n		
	be comfortable with their role their tasks within the overall p			
	understand and serve their suppliers and customers in large			
	assume responsibility for people and technology in the devel	opment of safety-critical syste	ms	
A				
Autonomy	Students are able to: • interact and communicate in a development team with divisi	on of tasks		
	independently research and identify certification specificatio			
	formulate requirements on their own			
	create test plans on their own and accompany certification p	rocesses		
Wankland in Harris	Indopondent Study Time 124 Study Time in Leaburg 50			
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56			
Course achievement				
Examination	Written exam			
Examination duration and				
scale	220 1			
Assignment for the	Aircraft Systems Engineering: Core Qualification: Compulsory			
Following Curricula	International Management and Engineering: Specialisation II. A	viation Systems: Elective Com	pulsory	
	International Management and Engineering: Specialisation II. F	roduct Development and Produ	uction: Elective C	ompulsory
	Aeronautics: Core Qualification: Compulsory			
	Mechatronics: Core Qualification: Elective Compulsory			
	Product Development, Materials and Production: Specialisation		-	
	Product Development, Materials and Production: Specialisation			
	Product Development, Materials and Production: Specialisation Theoretical Mechanical Engineering: Specialisation Aircraft Sys			
	meoretical mechanical Engineering, Specialisation Aircraft Sys	terns Engineering, Elective Col	iiihniani À	

Course L1547: Systems Engi	neering
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	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 Transfer			
Knowledge				
Educational Objectives	After taking part successfully, students have reached the followi	ng learning results		
Professional Competence				
Knowledge	The students can			
	distinguish the physical phenomena of conversion of ener	av		
	understand the different mathematic modelling of turbom			
	calculate and evaluate turbomachinery.	definitery,		
	Calculate and evaluate turboniachinery.			
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.			
	3			
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 Compu	llsory		
Following Curricula	Energy Systems: Specialisation Marine Engineering: Elective Cor	npulsory		
	Product Development, Materials and Production: Specialisation P	roduct Development: Elective	Compulsory	
	Product Development, Materials and Production: Specialisation P	roduction: Elective Compulso	ry	
	Product Development, Materials and Production: Specialisation N	Materials: Elective Compulsory	,	
	Theoretical Mechanical Engineering: Specialisation Energy Syste	ms: Elective Compulsory		

Course L1562: Turbomachines		
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:	
	 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 	

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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)		Project-/problem-based Learning	3	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
GSD - Generational Sheet-Metal De	evelopment (L3064)	Lecture	3	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 and Systems of Mater	ials Testing - from the viewpoint of product development and Failure	Lecture	2	2
Analysis (L0950)				
Microsystems Technology (L0724)		Lecture	2	4
Sustainable Industrial Production (I	.2863)	Lecture	2	4
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
Technical Design (L1513)		Lecture	2	3
Materials Testing - from the viewpo	oint of industrial application (L0949)	Lecture	2	2
Reliability in Engineering Dynamics	s (L2994)	Lecture	2	2
Reliability in Engineering Dynamics	s (L2995)	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 follow	ing learning results		
Professional Competence	,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,			
Knowledge	Students are able to express their extended knowledge	and discuss the connection of di	fferent special f	ields or application
	areas of product development, materials and production		•	
	Students are qualified to connect different special fields to	with each other		
	5 Students are qualified to conflect different special fields	with each other		
Skills				
	 Students can apply specialized solution strategies and ne 	w scientific methods in selected	areas	
	 Students are able to transfer learned skills to new and ur 	known problems and can develop	p own solution a	approaches
B				
Personal Competence				
Social Competence	-			
Autonomy	Chudonka are obla to dougles the Subsection of 199 1	or anthonormal and a street and a		
	Students are able to develop their knowledge and skills be a students.	y autonomous election of course	5.	
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	·	·	. ,	
i onouning curricula	Product Development, Materials and Production: Specialisation Production: Elective Compulsory Product Development, Materials and Production: Specialisation Materials: Elective Compulsory			
			o Commulas:	
	Theoretical Mechanical Engineering: Specialisation Product Dev	elopment and Production: Electiv	e compuisory	
L	ı			

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
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 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
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 L3064: GSD - General	tional Sheet-Metal Development
Тур	Lecture
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. Dr. Nikola Bursac
Language	DE
Cycle	WiSe
Content	Experience in mechanical engineering design and the fundamentals of manufacturing engineering
	After successful completion of the course, students will be able to explain development projects using the theory of product generation engineering and explain design rules for sheet metal development.
	After successful completion of the course, students will be able to apply the theory of product generation engineering to development tasks and develop sheet-metal products suitable for production.
	After successful completion of the course, students will be able to develop a product in a team and to compete against other teams.
	After successful completion of the course, students will be able to independently access knowledge required for sheet metal development.
Literature	

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	SoSe
Content	
Literature	

Course L1258: Lightweight D	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. 	

Course L0950: Mechanisms a	and Systems of Materials Testing - from the viewpoint of product development and Failure Analysis
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
	Lecture
	2
СР	4
	Independent Study Time 92, Study Time in Lecture 28
Examination Form	
Examination duration and	
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, pn junction, NTC and PTC; thermal anemometer, mass flow sensor; storain based and stress based principle, capacitive readout, piezoresistivity, pressure sensor: piezoresistive, capacitive and fabrication process) Machanical 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, clark electrode, enzyme electrode, DNA chip) <l< th=""></l<>
	M. Markey Franches and Missefeliciation CDC Dates 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

Course L2863: Sustainable In	ndustrial Production
Тур	Lecture
Hrs/wk	2
СР	4
Workload in Hours	Independent Study Time 92, Study Time in Lecture 28
Examination Form	
Examination duration and	
scale	
Lecturer	Dr. Simon Markus Kothe
Language	DE
Cycle	SoSe
Content	
	processes that change the form and physical properties of raw materials. Manufacturing is a central driver of economi development and has a major impact on the well-being of humanity. However, the scale of current manufacturing activities result: 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 hardl 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 th 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 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 N	lanagement
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	
Lecturer	The state of the s
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 N	- 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 Con	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. 	

Course L1514: Structural Me	chanics 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 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

Lecturer	Prof. Werner Granzeier, Prof. Dieter Krause
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

FIOUUCLIOII	
	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 GmbH,
	Auto & Design,
	Corso Frabcia 161, 10139 Torino, Italia
	(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

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 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 L2994: Reliability in 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		
	Dr. Eric Groß, Prof. Benedikt Kriegesmann	
Language		
Cycle		
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 L2995: Reliability in I	ngineering 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	
Language	EN
Cycle	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

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

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	662)	Lecture	2	3
Module Responsible	Prof. Shan Shi			
Admission Requirements	None			
Recommended Previous	Basics in Materials Science I/II			
Knowledge				
Educational Objectives	After taking part successfully, students have reached t	he following learning results		
Professional Competence				
Knowledge	Students can explain basic principles of crystallograph	phy, statics (free body diagram	s, tractions) and therm	nodynamics (energy
	minimization, energy barriers, entropy)			
Chille	Charles to a complete of a circumstant and a classical and a circumstant and a circu			
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 an	nd 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	6		
Credit points	6			
Course achievement	None			
Examination	Written exam			
Examination duration and	180 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	terials Science: Elective Compuls	ory	

Course L1661: Mechanical Bo	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,		
	Habara and an analysis and a second a second and a second a second and		
	Heterogeneous materials II Toughoning machanisms crack bridging fibres		
	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		
	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	
	Prof. Shan Shi	
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: 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	NN			
-	None			
Recommended Previous				
Knowledge	Classical control (frequency response, root locus	s)		
	State space methods			
	 Linear algebra, singular value decomposition 			
Educational Objectives	After taking part successfully, students have reached t	the following learning results		
Professional Competence				
Knowledge				
-	Students can explain the significance of the ma			
	They can explain the duality between optimal st			
	They can explain how the H2 and H-infinity norm They can explain how an LOC design problems.	, , ,		
	 They can explain how an LQG design problem of They can explain how model uncertainty can be 	·		
	They can explain how indeed uncertainty can be They can explain how - based on the small gai			
	an uncertain plant.	in theorem a robust controller can gu	drance stability	and performance to
	They understand how analysis and synthesis co	nditions on feedback loops can be repr	esented as linear	matrix inequalities.
	, ,	·		•
Skills	 Students are capable of designing and tuning L0 	OG controllers for multivariable plant m	odels.	
	They are capable of representing a H2 or H-infin			and of using standard
	software tools for solving it.	,		, , , , , , , , , , , , , , , , , , ,
	 They are capable of translating time and frequ 	ency domain specifications for control	loops into const	raints on closed-loop
	sensitivity functions, and of carrying out a mixe	d-sensitivity design.		
	They are capable of constructing an LFT unce	rtainty model for an uncertain system	, and of designin	ng a mixed-objective
	robust controller.			
	 They are capable of formulating analysis and sy 	ynthesis 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 standa	ard software tools (Matlab robust contro	ol toolbox).	
Personal Competence				
	Students can work in small groups on specific problem	s 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 5	6		
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 Compulso	•		
	Aircraft Systems Engineering: Core Qualification: Elect	ive Compulsory		
	Aeronautics: Core Qualification: Elective Compulsory			
	Mechatronics: Core Qualification: Elective Compulsory	s and Rogonorativo Modicino, Elective	Compulsor	
	Biomedical Engineering: Specialisation Artificial Organ: Biomedical Engineering: Specialisation Implants and E	-	Compuisory	
i	- · · · · · · · · · · · · · · · · · · ·		nulsory	
	Rinmedical Engineering, Specialication Modical Toches	nogy and control incory. Elective COM	paisory	
	Biomedical Engineering: Specialisation Medical Technological Engineering: Specialisation Management a	nd Business Administration: Flective Co	ompulsory	
	Biomedical Engineering: Specialisation Management a			
	Biomedical Engineering: Specialisation Management a Product Development, Materials and Production: Speci	alisation Product Development: Electiv	e Compulsory	
	Biomedical Engineering: Specialisation Management a	alisation Product Development: Electiv alisation Production: Elective Compulso	e Compulsory ory	

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	NN	
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	NN
Language	EN
Cycle	SoSe
Content	See interlocking course
Literature	See interlocking course

Module M1343: Struc	cure and properties of fibre-polymo	er-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	ymer-composites (L2614)	Project-/problem-based Learning	2	2
Structure and properties of fibre-po	ymer-composites (L2613)	Recitation Section (large)	1	1
Module Responsible	Prof. Bodo Fiedler			
Admission Requirements	None			
Recommended Previous	Basics: chemistry / physics / materials science			
Knowledge				
Educational Objectives	After taking part successfully, students have reach	ed the following learning results		
Professional Competence				
Knowledge	Students can use the knowledge of fiber-reinforce necessary testing and analysis.	ed composites (FRP) and its constituents to p	olay (fiber / m	atrix) and define the
	They can explain the complex relationships structu	re-property relationship and		
	the interactions of chemical structure of the po- neighboring contexts (e.g. sustainability, environm		fiber types,	including to explain
Skills	Students are capable of			
	 using standardized calculation methods in evaluate the different materials. approximate sizing using the network theory selecting appropriate solutions for mechanic 	y of the structural elements implement and ev	/aluate.	
Personal Competence				
Social Competence	Students can			
	 arrive at funded work results in heterogeniu provide appropriate feedback and handle feedback 		ely.	
Autonomy	Students are able to			
	- assess their own strengths and weaknesses.			
	- assess their own state of learning in specific term	is and to define further work steps on this bas	is.	
	- assess possible consequences of their profession	al activity.		
Workload in Hours	Independent Study Time 110, Study Time in Lectur	re 70		
Credit points				
Course achievement				
Examination	Written exam			
Examination duration and	90 min			
scale				
-	Aircraft Systems Engineering: Core Qualification: E			
Following Curricula	International Management and Engineering: Special Aeronautics: Core Qualification: Elective Compulso	·	ion: Elective C	ompulsory
	•	•		
	Materials Science and Engineering: Specialisation E Materials Science: Specialisation Engineering Mate	, ,		
	Mechanical Engineering and Management: Core Qu	• •		
	Product Development, Materials and Production: Sp	• •	ompulsory	
	Product Development, Materials and Production: Sp	•	ompulsor y	
	Product Development, Materials and Production: Sp			
	Renewable Energies: Specialisation Bioenergy Syst	• •		
	Renewable Energies: Specialisation Wind Energy S	• •		
	Renewable Energies: Specialisation Solar Energy S	• • •		
	Theoretical Mechanical Engineering: Specialisation	• • •		

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	

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	The students receive the assignment in the form of a material design for test bodies made of fibre composites. Technical and normative requirements are listed in the assignment, all other required information comes from the lectures and exercises or the respective documents (electronically and in conversation). The procedure is specified in a milestone plan and enables the students to plan subtasks and thus work continuously. At the end of the project, different test specimens were tested in tensile or bending tests. In the individual project meetings, the conception (discussion of requirements and risks) is scrutinised. The calculations are analysed, the production methods are evaluated and determined. Materials are selected and the test specimens are manufactured according to standards. The quality and mechanical properties are checked and classified. At the end, a final report is prepared and the results are presented to all participants in the form of a presentation and discussed. Translated with www.DeepL.com/Translator (free version)
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 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	The contents of the lecture are repeated and deepened using practical examples.	
	Calculations are carried out together or individually, and the results are discussed critically.	
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	

Module M1344: Processing of Fibre-Polymer-Composites					
Courses					
Title		Тур	Hrs/wk	СР	
Processing of fibre-polymer-composites (L1895)		Lecture	2	3	
From Molecule to Composites Part (Project-/problem-based Learning	2	3	
Module Responsible	Prof. Bodo Fiedler				
Admission Requirements					
	Knowledge in the basics of chemistry / physics / materials science				
Knowledge					
Educational Objectives	After taking part successfully, students have reached the	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 comm		_	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			define the necessary	
	testing and analysis.			•	
	They can explain the complex structure-property relation:	ship and			
	the interactions of chemical structure of the polymers	s, their processing with the different	fiber types,	including to explain	
	neighboring contexts (e.g. sustainability, environmental p	rotection).			
Personal Competence					
Social Competence	Students are able to cooperate in small, mixed-subject groups in order to independently derive solutions to given problems in the				
	context of civil engineering. They are able to effectively	present and explain their results alone	or in groups i	in front of a qualified	
	audience. Students have the ability to develop alternative	e approaches to an engineering proble	m independe	ntly or in groups and	
	discuss advantages as well as drawbacks.				
Autonomy	Students are capable of independently solving mechani	cal engineering problems using provid	ed literature.	They are able to fill	
	gaps in as well as extent their knowledge using the litera	•	•	-	
	meaningfully extend given problems and pragmatically so	olve them by means of corresponding so	olutions and c	oncepts.	
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56				
	6				
Course achievement	None				
Examination	Written exam				
Examination duration and	90 min				
scale					
-	Materials Science and Engineering: Specialisation Engineer	* * *			
Following Curricula	Materials Science: Specialisation Engineering Materials: E				
	Mechanical Engineering and Management: Specialisation	• •			
	Product Development, Materials and Production: Specialis	·	ompulsory		
	Product Development, Materials and Production: Specialis	• •			
	Product Development, Materials and Production: Specialis				
	Theoretical Mechanical Engineering: Specialisation Materi	als Science: Elective Compulsory			

ourse 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 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	Åström: Manufacturing of Polymer Composites, Chapman and Hall	

		_		
Module M1690: Aircra	aft Design II (Special Air Vehicle Design)		
Courses				
Title		Тур	Hrs/wk	СР
Aircraft Design II (Conceptual Design	gn of Rotorcraft, special operations aircraft, UAV) (L0844)	Lecture	3	3
Aircraft Design II (Conceptual Design	gn of Rotorcraft, special operations aircraft, UAV) (L0847)	Recitation Section (large)	2	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 pro's and con's and physical character	stics of different air systems		
	Understanding of special mission requirements and its im	pact on systems definition and conc	eptual design	
	Intensified knowledge of performance design on various a	ir systems		
Skills	Understanding and application of design and calculation i	nethods		
	Understanding of interdisciplinary and integrative interde	pendencies		
	mission oriented technical definition of air systems			
	special conceptual calculation methods for special equipr	nent 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				
Course achievement				
Examination	Written exam			
Examination duration and	180 min			
scale				
Assignment for the	, , , , , , , , , , , , , , , , , , , ,			
Following Curricula		n II. Aviation Systems: Elective Com	pulsory	
	Aeronautics: Core Qualification: Elective Compulsory	ation Books to David Co. 157 117		
	Product Development, Materials and Production: Specialis	·		
	Product Development, Materials and Production: Specialis Theoretical Mechanical Engineering: Specialisation Aircra	·	-	
ĺ	medieucai mechanicai Engineering: Specialisation Aircra	c bysterns Engineering: Elective Cor	ripuisui y	

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

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

Module M1878: Susta	inable energy from wind and water			
Courses				
Title		Тур	Hrs/wk	СР
Offshore Geotechnical Engineering	(L0067)	Lecture	1	1
Hydro Power Use (L0013)		Lecture	1	1
Wind Turbine Plants (L0011) Wind Energy Use - Focus Offshore (L0012)	Lecture Lecture	2 1	1
Module Responsible				
Admission Requirements	None			
Recommended Previous	Module: Technical Thermodynamics I,			
Knowledge	Madula, Tashnisal Thaypasdynamics II			
	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 k	nowledge of wind turbines wi	ith a particular focus of	wind energy use in
	offshore conditions and can critical comment these aspe	cts in consideration of curren	t developments. Furthe	rmore, they are able
	to describe fundamentally the use of water power to gen		reproduce and explain	the basic procedure
	in the implementation of renewable energy projects in co	untries outside Europe.		
	Through active discussions of various topics within the	seminar of the module, stud	dents improve their un	derstanding and the
	application of the theoretical background and are thus ab	le to transfer what they have	learned in practice.	
Skille	Students are able to apply the acquired theoretical fou	ndations on exemplary water	r or wind nower system	ns and evaluate and
Skills	assess technically the resulting relationships in the cont			
	compare critically the special procedure for the impleme			
	in principle applied approach in Europe and can apply thi	s procedure on exemplary the	eoretical projects.	
Borconal Compotonco				
Personal Competence Social Competence	Students can discuss scientific tasks subjet-specificly an	d multidisciplinary within a se	minar	
Social Competence	Students can discuss scientific tasks subjet-specificly and	a maidascipimary within a ser	mmar.	
Autonomy	Students can independently exploit sources in the cont		ecture material to clear	the contents of the
	lecture and to acquire the particular knowledge about the	e subject area.		
Workload in Hours	Independent Study Time 110, Study Time in Lecture 70			
Credit points	6			
Course achievement	None			
Examination	Written exam			
Examination duration and	180 min			
scale				
_	Civil Engineering: Specialisation Structural Engineering: E	lective Compulsory		
Following Curricula	Civil Engineering: Specialisation Geotechnical Engineerin			
	Civil Engineering: Specialisation Coastal Engineering: Ele			
	International Management and Engineering: Specialisation			Compulsory
	International Management and Engineering: Specialisation Product Development, Materials and Production: Specialis			
	Product Development, Materials and Production: Specials Product Development, Materials and Production: Specials			
	Product Development, Materials and Production: Specialis			
	Renewable Energies: Core Qualification: Compulsory			
	Theoretical Mechanical Engineering: Specialisation Energ	y Systems: Elective Compulso	ory	
	Process Engineering: Specialisation Environmental Proces	ss Engineering: Elective Comp	ulsory	
	Water and Environmental Engineering: Specialisation Citi			
	Water and Environmental Engineering: Specialisation Env	rironment: Compulsory		

Course L0067: Offshore Geotechnical Engineering		
Тур	Lecture	
Hrs/wk	1	
СР	1	
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14	
Lecturer	Dr. Jan Dührkop	
Language	DE	
Cycle	SoSe	
Content	Overview and Introduction Offshore Geotechnics Introduction to Soil Mechanics Offshore soil investigation Focus on cyclical effects Geotechnical design of offshore foundations Monopiles Jackets Heavyweight foundations Geotechnical preliminary exploration for the use of lift boats and platforms	
Literature	 Randolph, M. and Gourvenec, S (2011): Offshore Geotechnical Engineering. Spon Press. Poulos H.G. (1988): Marine Geotechnics. Unwin Hyman, London BSH-Standard Baugrunderkundung für Offshore-Windenergieparks Lesny K. (2010): Foundations for Offshore Wind Turbines. VGE Verlag, Essen. EA-Pfähle (2012): Empfehlungen des Arbeitskreises Pfähle der DGGT. Ernst & Sohn, Berlin. 	

Course L0013: Hydro Power	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
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.: Windkraftanlagen; Springer, Berlin, Heidelberg, 2008, 4.Auflage Heier, S.: Windkraftanlagen - Systemauslegung, Integration und Regelung; Vieweg + Teubner, Stuttgart, 2009, 5. Auflage Jarass, L.; Obermair, G.M.; Voigt, W.: Windenergie: Zuverlässige Integration in die Energieversorgung; Springer, Berlin, Heidelberg, 2009, 2. Auflage

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Module M1894: Autor	nation Technolog	y and Systems				
Courses						
Title				Тур	Hrs/wk	СР
Automation Technology and Systems (L2329)				Lecture	4	4
Automation Technology and System				Project-/problem-based Learning	1	1
Automation Technology and System	ns (L2330)			Recitation Section (small)	1	1
Module Responsible	Prof. Thorsten Schüppst	uhl				
Admission Requirements	None					
Recommended Previous	without major course as:	sessment				
Knowledge						
Educational Objectives	After taking part success	sfully, students have re	ached the following	ng learning results		
Professional Competence						
Knowledge	Students					
3						
				tems and have good understand	ling of their int	eraction
				asks and are able to use them		
	have special com	petences in industrial re	obot based autom	ation systems		
Skills	Students are able to					
	analyze complex :	Automation tasks				
		on based concepts and	solutions			
		is and integrate into on				
		valuate safety of machi				
		grams for robots and p		c controllers		
		or pneumatic application				
Personal Competence						
Social Competence	Students are able to					
	- find solutions for auton	nation and handling tas	ks in groups			
	- develop solutions in a	production environmer	nt with qualified pe	ersonnel at technical level and re	epresent decis	ions.
Autonomy	Students are able to					
	analyze automatic	on tasks independently				
	-	ns for robots and progra		vices autonomously		
		for practice oriented ta				
	-	cepts for automation a				
	assess consequer	nces of their profession	al actions and resp	oonsibilities		
		00.01.1.7				
Workload in Hours	Independent Study Time	96, Study Time in Lect	ture 84			
Credit points		orm	Docarintian			
Course achievement		orm Subject theoretical	Description and Die Studienle	eistung umfasst die Ergebnisse	e der DRI ha	sierten Anteile des
		oubject theoretical oractical work		der Präsentation in der Gruppe.		Sicited Antene des
Examination						
Examination duration and						
scale	120 11111					
Assignment for the	International Manageme	nt and Engineering: Sp	ecialisation II. Pro	duct Development and Production	on: Elective Co	mpulsory
Following Curricula	3	3 3 1				· •
-			-	roduct Development: Elective Co	ompulsory	
	Product Development, M	laterials and Production	n: Specialisation Pr	roduction: Compulsory		
	•		•	aterials: Elective Compulsory		
				lopment 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 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					Integrated Lecture	4	4
Robotics: Modelling and Control (L1					Project-/problem-based Learning	2	2
Module Responsible	Dr. Martin Gomse						
Admission Requirements	None						
Recommended Previous	Fundamentals of elect	trical engine	eering				
Knowledge	Broad knowledge of m	nechanics					
	Fundamentals of cont	rol theory					
Educational Objectives	After taking part succ	essfully, stu	idents have re	ached the followi	ng learning results		
Professional Competence							
Knowledge	Students are able to o	lescribe fun	damental pro	perties of robots a	and solution approaches for mult	iple problems	in robotics.
Skills	Students are able to o	lerive and s	olve equation	s of motion for va	rious manipulators.		
	Students can generate	e traiectorie	s in various c	oordinate system	5		
	Students can general	e trajectorie	.s III various c	oordinate system	J.		
	Students can design l	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.						
	with instructor assista	ance, studer	nts are able to	evaluate their ov	vn knowledge level and define a	turtner course	e or study.
Workload in Hours	Independent Study Ti	me 96, Stud	ly Time in Lec	ture 84			
Credit points	6						
Course achievement	Compulsory Bonus	Form		Description			
	Yes None	,	theoretical		n PBL-Einheiten sowie Erreic	hen des Ge	samtziels und der
Examination	Muithan avana	practical v	VOIK	jeweiligen Se	sssion-ziele		
	120 min						
scale	120 111111						
Assignment for the	Aircraft Systems Engi	neering: Co	re Qualificatio	n: Elective Comp	ilsory		
Following Curricula		-			oduct Development and Production	on: Elective Co	ompulsory
	International Manager	ment and Er	ngineering: Sp	ecialisation II. Me	chatronics: Elective Compulsory		
	Aeronautics: Core Qua	alification: E	lective Comp	ulsory			
	Mechanical Engineering	ng and Man	agement: Cor	e Qualification: Co	ompulsory		
	Mechatronics: Core Q						
					roduct Development: Elective Co	ompulsory	
	·				roduction: Elective Compulsory		
					Materials: Elective Compulsory	a Camanula	
					elopment and Production: Elective Computer Science: Elective Com		
	mediencal Mechanica	ai Engineeri	ng. specialisa	מינו הטטטנונג אום	computer science; Elective Con	ipuisui y	

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 M1888: Enviro	onmental protection management			
Courses				
Title		Тур	Hrs/wk	СР
Health, Safety and Environmental N	Management (L0387)	Integrated Lecture	3	3
Air Pollution Abatement (L0203)		Lecture	2	3
Module Responsible	Dr. Swantje Pietsch-Braune			
Admission Requirements	None			
Recommended Previous				
Knowledge				
Educational Objectives	After taking part successfully, students have reach	ed the following learning results		
Professional Competence				
Knowledge				
Skills				
Personal Competence				
Social Competence				
Autonomy				
Workload in Hours	Independent Study Time 110, Study Time in Lectur	re 70		
Credit points	6			
Course achievement	None			
Examination	Written exam			
Examination duration and	90 min			
scale				
Assignment for the	Civil Engineering: Specialisation Water and Traffic:	Elective Compulsory		
Following Curricula	Bioprocess Engineering: Specialisation C - Bioe	conomic Process Engineering, Focus	Management and 0	Controlling: Elective
	Compulsory			
	Environmental Engineering: Specialisation Energy	and Resources: Elective Compulsory		
	International Management and Engineering: Specia	lisation II. Energy and Environmental E	ngineering: Elective (Compulsory
	Product Development, Materials and Production: Sp	pecialisation Product Development: Elec	ctive Compulsory	
	Product Development, Materials and Production: Sp	pecialisation Production: Elective Comp	ulsory	
	Product Development, Materials and Production: Sp	pecialisation Materials: Elective Compul	sory	
	Renewable Energies: Specialisation Bioenergy Syst	ems: Elective Compulsory		
	Process Engineering: Specialisation Environmental	Process Engineering: Elective Compulse	ory	
	Water and Environmental Engineering: Specialisati	on Environment: Compulsory		
	Water and Environmental Engineering: Specialisati	on Cities: Compulsory		

Course L0387: Health, Safety	and Environmental Management
Тур	Integrated Lecture
Hrs/wk	3
СР	3
Workload in Hours	Independent Study Time 48, Study Time in Lecture 42
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 L0203: Air Pollution A	Abatement
Тур	Lecture
Hrs/wk	2
СР	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Dr. Swantje Pietsch-Braune, Christian Eichler
Language	EN
Cycle	WiSe
Content	In the lecture methods for the reduction of emissions from industrial plants are treated. At the beginning a short survey of the different forms of air pollutants is given. In the second part physical principals for the removal of particulate and gaseous pollutants form flue gases are treated. Industrial applications of these principles are demonstrated with examples showing the removal of specific compounds, e.g. sulfur or mercury from flue gases of incinerators.
Literature	Handbook of air pollution prevention and control, Nicholas P. Cheremisinoff Amsterdam [u.a.] : Butterworth-Heinemann, 2002 Atmospheric pollution : history, science, and regulation, Mark Zachary Jacobson Cambridge [u.a.] : Cambridge Univ. Press, 2002 Air pollution control technology handbook, Karl B. Schnelle Boca Raton [u.a.] : CRC Press, c 2002 Air pollution, Jeremy Colls 2. ed London [u.a.] : Spon, 2002

Module M1909: Syste	m Simulation			
Courses				
Title		Тур	Hrs/wk	СР
System Simulation Modul (L3150)		Lecture	2	3
System Simulation Modul (L3151)		Recitation Section (large)	2	3
Module Responsible	Prof. Arne Speerforck			
Admission Requirements	None			
Recommended Previous	Mathematics I-III, Computer Sciense, Engineering Thermodyna	mics I, II, Fluid Dynamics, Heat	Transfer, Control	Systems
Knowledge				
Educational Objectives	After taking part successfully, students have reached the follow	ving 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	Oral exam			
Examination duration and	30 min			
scale				
Assignment for the	Energy Systems: Core Qualification: Compulsory			
Following Curricula	Aircraft Systems Engineering: Core Qualification: Elective Com	oulsory		
	Aeronautics: Core Qualification: Elective Compulsory			
	Product Development, Materials and Production: Specialisation	Product Development: Elective	Compulsory	
	Product Development, Materials and Production: Specialisation	Production: Elective Compulso	ry	
	Product Development, Materials and Production: Specialisation	Materials: Elective Compulsory		
	Renewable Energies: Specialisation Bioenergy Systems: Electiv	re Compulsory		
	Renewable Energies: Specialisation Solar Energy Systems: Elec			
	Renewable Energies: Specialisation Wind Energy Systems: Elec			
	Theoretical Mechanical Engineering: Specialisation Simulation	,	ry	
	Theoretical Mechanical Engineering: Specialisation Energy Sys	ems: Elective Compulsory		

Course L3150: System Simul	ation Modul
Тур	Lecture
Hrs/wk	2
СР	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Prof. Arne Speerforck, Dr. Johannes Brunnemann
Language	DE
Cycle	WiSe
Content	Lecture about equation-based, physical modelling using the modelling language Modelica and the free simulation tool OpenModelica 1.17.0. 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 3.5", Linköping, Sweden, 2021. [2] OpenModelica: OpenModelica 1.17.0, https://www.openmodelica.org (siehe Download), 2021. [3] M. Tiller: "Modelica by Example", https://book.xogeny.com, 2014. [4] M. Otter, H. Elmqvist, et al.: "Objektorientierte Modellierung Physikalischer Systeme", at- Automatisierungstechnik (german), Teil 1 - 17, Oldenbourg Verlag, 1999 - 2000. [5] P. Fritzson: "Principles of Object-Oriented Modeling and Simulation with Modelica 3.3", Wiley-IEEE Press, New York, 2015. [6] P. Fritzson: "Introduction to Modeling and Simulation of Technical and Physical Systems with Modelica", Wiley, New York, 2011.

Course L3151: System Simulation Modul		
Тур	Recitation Section (large)	
Hrs/wk	2	
СР	3	
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28	
Lecturer	Prof. Arne Speerforck, Dr. Johannes Brunnemann	
Language	DE	
Cycle	WiSe	
Content	See interlocking course	
Literature	See interlocking course	

Module M0771: Flight	t Physics			
Courses				
Title		Тур	Hrs/wk	СР
Aerodynamics and Flight Mechanic	ss 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				
Recommended Previous	Basic knowledge in:			
Knowledge				
3	Mathematics			
	Mechanics			
	Thermodynamics			
	Aviation			
Educational Objectives	After taking part successfully, students have reached the	following learning results		
Professional Competence		. ronowing rearring results		
-	Students are able to			
	Describe the fundamental equations of aerodynan	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 	ral motion		
	Describe methods of flight simulation and airborne	e measurement technology		
Skille	Students are able to			
Skins	Students are able to			
	 Perform flight mechanic simulations 			
	Derive flight mechanic relations from virtual and relations.	eal flight test data		
Personal Competence				
-	Students are able to:			
30Clai Competence	Students are able to.			
	Perform simulations in groups and discuss results			
	Evaluate flight test data in groups, discuss and pre	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 teaching.			
	,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,			
Workload in Hours	·			
Credit points Course achievement				
Examination				
Examination duration and				
examination duration and scale				
	Aircraft Systems Engineering: Core Qualification: Compul	sorv		
Following Curricula		•	nulsorv	
i onowing curricula	Aeronautics: Core Qualification: Compulsory	an in Aviation Systems. Liective Com	pai301 y	
		eation Braduct Davidson ant. Electiv	Compular	
	Product Development, Materials and Production: Speciali	·		
	Product Development, Materials and Production: Speciali	•	-	
	Product Development, Materials and Production: Speciali			
	Theoretical Mechanical Engineering: Specialisation Aircra	itt 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	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 Mechan	ourse L0731: Flight Mechanics II		
Тур	Recitation Section (large)		
Hrs/wk	1		
СР			
Workload in Hours	ndependent Study Time 16, Study Time in Lecture 14		
Lecturer	rof. Frank Thielecke		
Language	E		
Cycle	SoSe		
Content	See interlocking course		
Literature	See interlocking course		

Module M0815: Produ	uct Planning					
Module Moo15. I Touc						
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	ı				
Knowledge						
Educational Objectives	After taking part successfully, students have read	ched 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 instrun	conts				
	o	ients				
Personal Competence						
Social Competence						
Social Competence	Interact within a team					
	 Raise awareness for globabl issues 					
Autonomy						
ratoriomy	 Gain access to knowledge sources 					
	 Interpret complex cases 					
	 Develop presentation skills 					
Workload in Hours	Independent Study Time 110, Study Time in Lect	ure 70				
Credit points	6					
Course achievement	Compulsory Bonus Form	Description				
	Yes 20 % Subject theoretical a	nd				
	practical work					
Examination	Thesis					
Examination duration and	90 minutes					
scale						
Assignment for the	Global Innovation Management: Core Qualificatio	n: Compulsory				
Following Curricula	International Management and Engineering: Spec	cialisation I. Electives Management: Elective Cor	npulsory			
3	Mechanical Engineering and Management: Specia		. ,			
	Product Development, Materials and Production:	-	nmnulsory			
	Product Development, Materials and Production: Product Development, Materials and Production:	·	лиривогу			
	•					
	Product Development, Materials and Production:		o Compulsor:			
	Theoretical Mechanical Engineering: Specialisation	on Froduct Development and Production: Elective	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		
Literature	unich, 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	dependent Study Time 62, Study Time in Lecture 28		
Lecturer	of. Cornelius Herstatt		
Language	N		
Cycle	ViSe		
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".		

Module M0962: Susta	inability and Risk Manageme	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	ı, 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
,		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				
Course achievement	None			
Examination	Written elaboration			
	Elaboration and presentation (45 minutes in	n groups)		
scale				
Assignment for the	Civil Engineering: Core Qualification: Comp	•		
Following Curricula		- Bioeconomic Process Engineering, Focus	Management and	Controlling: Elective
	Compulsory	Coordination II Civil Engineering 5'	Samanulaan:	
		: Specialisation II. Civil Engineering: Elective (
	·	ction: Specialisation Product Development: Elective Com		
	·	ction: Specialisation Production: Elective Comp ction: Specialisation Materials: Elective Compu	-	
	Water and Environmental Engineering: Core		11301 y	
	water and Environmental Engineering. Core	e Quaimeadon. Compuisory		

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.	

Module M1024: Metho	ods of Product Development			
Courses				
Title		Тур	Hrs/wk	СР
Methods of Product Development (L1254)	Lecture	3	3
Methods of Product Development (L1255)	Project-/problem-based Learning	2	3
Module Responsible	Prof. Dieter Krause			
Admission Requirements	None			
Recommended Previous	Basic knowledge of Integrated product development and	d applying CAE systems		
Knowledge				
Educational Objectives	After taking part successfully, students have reached th	e 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 managements of construction managements are the construction managements.	-		
	describe current problems and the current state in the current stat	or research of integrated product develop	ment.	
Skills	After passing the module students are able to:			
	select and apply proper construction methods for the select and apply proper construction methods. - The select are select and apply proper construction methods are selected as a select and apply proper construction methods. - The select are selected as a selected and apply proper construction methods are selected as a selected and apply proper construction methods. - The select are selected as a selected and apply proper construction methods are selected as a selected and apply proper construction methods. - The selected are selected as a selected as a selected as a selected and a selected and a selected are selected as a selected	or non-standardized solutions of problem	is as well as a	adapt new bounda
	conditions,			
	solve product development problems with the as:			
	 choose and execute appropriate moderation tech 	iniques.		
Personal Competence				
Social Competence	After passing the module students are able to:			
	prepare and lead team meetings and moderation	processes,		
	work in teams on complex tasks,			
	 represent problems and solutions and advance ic 	leas.		
Autonomy	After passing the module students are able to:			
	give a structured feedback and accept a critical f	eedback,		
	 implement the accepted feedback autonomous. 			
Workload in Hours	Independent Study Time 110, Study Time in Lecture 70			
Credit points	6			
Course achievement				
Examination				
Examination duration and	30 Minuten			
scale	50 Pillacell			
Assignment for the	Aircraft Systems Engineering: Core Qualification: Electiv	o Compulsory		
Following Curricula	International Management and Engineering: Specialisati		nn: Flective Co	omnulsory
i onowing curricula	Aeronautics: Core Qualification: Elective Compulsory	on it. Froduct Development and Froduction	JII. LICCUVE CO	inpuisor y
	Mechatronics: Specialisation System Design: Elective Compusory	ompulsory		
	Mechatronics: Specialisation System Design: Elective Co			
	Product Development, Materials and Production: Specia	lisation Product Development: Compulsor	·v	
	Product Development, Materials and Production: Specia	·	J	
	Product Development, Materials and Production: Specia			
	Theoretical Mechanical Engineering: Specialisation Prod		e Compulsory	
		Leaphine and Froduction. Electiv	_ 50pai501 y	

Production"	Production"				
Course L1254: Methods of Pr	ourse L1254: Methods of Product Development				
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, Tachnical Supply Chair Management				
	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. A Market State of the Control				
	Ashby, M. F.: Materials Selection in Mechanical Design, München, Spektrum 2007. Parkmann H. Gunde Chair Management Parkin Carinean 2004. Research Chair Management Parkin Carinean 2004.				
	Beckmann, H.: Supply Chain Management, Berlin, Springer 2004. Hartmann, M., Biograf, M., Flink, R., Bath, Lt., Zielegrichtet, mederiaran, Fin, Handbuch, für, Führungskräfte, Berater, und				
	Hartmann, M., Rieger, M., Funk, R., Rath, U.: Zielgerichtet moderieren. Ein Handbuch für Führungskräfte, Berater und Trainer Weinheim Beltz 2007.				
	Trainer, Weinheim, Beltz 2007. Pahl, G., Beitz, W.: Konstruktionslehre, Berlin, Springer 2006.				
	Roth, K.H.: Konstruktionslerire, Berlin, Springer 2000. 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, 				
İ	, , , , , , , , , , , , , , , , , , ,				

Course L1255: Methods of Pr	ourse L1255: Methods of Product Development		
Тур	Project-/problem-based Learning		
Hrs/wk	2		
СР	3		
Workload in Hours	ndependent Study Time 62, Study Time in Lecture 28		
Lecturer	rof. Dieter Krause		
Language	E		
Cycle	riSe		
Content	See interlocking course		
Literature	See interlocking course		

Springer 2013.

Module M1025: Fluidi	cs					
Courses						
Title Fluidics (L1256) Fluidics (L1371) Fluidics (L1257)				Typ Lecture Project-/problem-based Learning Recitation Section (large)	Hrs/wk 2 1	CP 3 2 1
Module Responsible	Prof. Dieter Krause					_
Admission Requirements	None					
Recommended Previous Knowledge	Good knowledge of med engineering design	chanics (stereo stati	cs, elastostatics,	hydrostatics, kinematics and	kinetics), flu	uid mechanics, and
Educational Objectives	After taking part successful	ully, students have rea	ached the followin	ng learning results		
Professional Competence Knowledge	explain the interactexplain open and cl	and functionalities of h tion of hydraulic comp losed loop control of h g and applications of l	onents in hydraul ydraulic systems,			as 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 • discuss and presen • organise teamwork	t functional context in	groups,			
Autonomy	After passing the module students are able to • obtain necessary knowledge for the simulation.					
Workload in Hours	Independent Study Time 1	124, Study Time in Lec	ture 56			
Credit points	6					
Course achievement	CompulsoryBonusForYesNoneAtt	m testation	Description Simulation hy	drostatischer Systeme		
Examination	Written exam		<u> </u>			
Examination duration and scale Assignment for the Following Curricula	International Managemen International Managemen Product Development, Ma	t and Engineering: Spe terials and Production	ecialisation II. Pro : Specialisation Pr	chatronics: Elective Compulsory duct Development and Production roduct Development: Compulsory roduction: Elective Compulsory	on: Elective Co	ompulsory
	Product Development, Ma	terials and Production	: Specialisation M	aterials: Elective Compulsory opment and Production: Elective	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			
Lecturer	Prof. Dieter Krause			
Language	DE			
Cycle	NiSe			
Content				
	Hydrostatics			
	physical fundamentals			
	hydraulic fluids			
	hydrostatic machines			
	• valves			
	• components			
	hydrostatic transmissions			
	examples from industry			
	Pneumatics			
	. The state of the			
	generation of compressed air			
	pneumatic motors			
	Examples of use			
	Hydrodynamics			
	.,,			
	physical fundamentals			
	hydraulic continous-flow machines			
	hydrodynamic transmissions			
	interoperation of motor and transmission			
	cercise			
	Hydrostatics			
	reading and design of hydraulic diagrams			
	dimensioning of hydrostatic traction and working drives			
	performance calculation			
	Hydrodynamics			
	Tydrodynamics			
	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			
	 variation of simulation parameters using simulations for system dimensioning and optimisation 			
	using sinulations for system differsioning and optimisation (partly) self-organised teamwork			
	(p=1-1), ==1. 34m304 Calmon			
Literature	Bücher			
	Muyanhaff II. Cumulagan day Fhidhashaile Tail 1. Hudgaidh Chalan Vadan Aashan 2011			
	Murrenhoff, H.: Grundlagen der Fluidtechnik - Teil 1: Hydraulik, Shaker Verlag, Aachen, 2011 Murrenhoff, H.: Grundlagen der Fluidtechnik - Teil 2: Programmtik, Shaker Verlag, Aachen, 2006			
	Murrenhoff, H.: Grundlagen der Fluidtechnik - Teil 2: Pneumatik, Shaker Verlag, Aachen, 2006 Matthies, H.I. Benius, K.Th.: Finführung in die Ölbudraulik, Toubers Verlag, 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 			
	ع ما			
	Skript zur Vorlesung			

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	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 following	ng learning results		
Professional Competence	,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,	· · · · · · · · · · · · · · · · · · ·		
-	Students are able to:			
2	describe cabin operations, equipment in the cabin and cabin Sy	rstems		
	explain the functional and non-functional requirements for cabi			
	• elucidate the necessity of cabin operating systems and emerge			
	assess the challenges human factors integration in a cabin env	ironment		
Civilla	Chudanta ara abla ta			
SKIIIS	Students are able to: • design a cabin layout for a given business model of an Airline			
	design a cabin layout for a given business model of an Allillie design cabin systems for safe operations			
	design emergency systems for safe man-machine interaction			
	solve comfort needs and entertainment requirements in the ca	bin		
Personal Competence				
Social Competence	Students are able to:			
	comprehend existing system solutions and explain them on the	basis of existing requiremen	its	
	discuss with experts in technical language			
	explain system functions classify the criticality of functions			
	classify the criticality of functions describe systems as is			
	describe systems as is			
Autonomy	Students are able to:			
	independently reflect on lecture content and expert presentation	ons		
	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	6			
Course achievement	None			
Examination	Written exam			
Examination duration and	120 Minutes			
scale				
Assignment for the	Electrical Engineering: Specialisation Control and Power Systems	Engineering: Elective Compu	Isory	
Following Curricula				
	International Management and Engineering: Specialisation II. Avi	ation Systems: Elective Comp	ulsory	
	Aeronautics: Core Qualification: Compulsory			
	Product Development, Materials and Production: Specialisation P			
	Product Development, Materials and Production: Specialisation P			
	Product Development, Materials and Production: Specialisation M			
	Theoretical Mechanical Engineering: Specialisation Aircraft Syste	ms Engineering: Elective Com	npulsory	

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	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	ners			
Courses				
Γitle		Тур	Hrs/wk	СР
Structure and Properties of Polyme	rs (L0389)	Lecture	2	3
Processing and design with polyme	ers (L1892)	Lecture	2	3
Module Responsible	Dr. Hans Wittich			
Admission Requirements	None			
Recommended Previous	Basics: chemistry / physics / material science	ce		
Knowledge				
Educational Objectives	After taking part successfully, students have	e reached the following learning results		
Professional Competence				
Knowledge	Students can use the knowledge of plastics	and define the necessary testing and analyst	sis.	
	They can explain the complex relationships	structure property relationship and		
	They can explain the complex relationships	structure-property relationship and		
	the interactions of chemical structure of the	polymers, including to explain neighboring	contexts (e.g. sustaina	bility, environmental
	protection).			
Skills	Students are capable of			
S.i.i.s	ordadino di e capable di			
		in a given context to mechanical proper	rties (modulus, strengt	th) to calculate and
	evaluate the different materials.			
	- selecting appropriate solutions for mecha	nical recycling problems and sizing example	stiffness, corrosion res	sistance.
	3 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1	5 - 1 - 1 - 1 - 1 - 1 - 1 - 1 - 1 - 1 -		
Personal Competence				
Social Competence	Students can			
	- arrive at funded work results in heterogen	ius groups and document them.		
	- provide appropriate feedback and handle	feedback on their own performance constru	ctively.	
Autonomy	Students are able to			
	- assess their own strengths and weaknesse	25.		
	their company of leaves in a second	C - k	alite hands	
	- assess their own state of learning in specif	fic terms and to define further work steps or	I LITIS DASIS.	
	- assess possible consequences of their prof	fessional activity.		
Workload in Hours	Independent Study Time 124, Study Time ir	Lecture 56		
		i Lecture 30		
Credit points Course achievement				
Examination				
Examination duration and scale	180 min			
Assignment for the	Materials Science and Engineering: Specialis	sation Engineering Materials: Flective Comp	ulsory	
Following Curricula		· ·	a1501 y	
. cc.mig carricula	Biomedical Engineering: Specialisation Impl			
	Biomedical Engineering: Specialisation Artif		ctive Compulsory	
	Biomedical Engineering: Specialisation Man			
	Biomedical Engineering: Specialisation Med	-		
	Product Development, Materials and Product	•		
	Product Development, Materials and Produc	tion: Specialisation Materials: Elective Comp	oulsory	
	Product Development, Materials and Produc	tion: Specialisation Product Development: E	lective Compulsory	
	Theoretical Mechanical Engineering: Specia	lisation Materials Science: Elective Compulse	ory	

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	nd 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		Lecture	2	2
Phase equilibria and transformation		Lecture	2	2
	en der Materialwissenschaft (L2991)	Recitation Section (large)	2	2
Module Responsible	None			
Admission Requirements				
Recommended Previous Knowledge	Basic knowledge in Materials Science, e.g. Werk	STOTTWISSENSCHAFT I/II		
Knowledge				
Educational Objectives	After to Line nout acceptable, at adopte house	asked the following learning requite		
	After taking part successfully, students have re-	acried the following learning results		
Professional Competence	The students will be able to evaluin the preparati	tion of advanced materials along with their	annlications in too	handanı in nartisular
Knowieage	The students will be able to explain the properties of advanced materials along with their applications in technology, in particular metallic, ceramic, polymeric, semiconductor, modern composite materials (biomaterials) and nanomaterials.		nnology, in particular	
Skills	The students will be able to select material of	configurations according to the technical	needs and, if neces	ssary, to design new
	materials considering architectural principles	from the micro- to the macroscale. The	students will also	gain an overview on
	modern materials science, which enables t	hem to select optimum materials con	nbinations dependi	ng on the technical
	applications.			
Personal Competence	The short one of the beautiful and the same			
Social Competence	The students are able to present solutions to sp	ecialists and to develop ideas further.		
Autonomy	The students are able to			
	assess their own strengths and weakness	ses.		
	gather new necessary expertise by their	own.		
	Independent Study Time 96, Study Time in Lect	ure 84		
Credit points	6			
Course achievement				
Examination	Written exam			
Examination duration and	90 min			
scale				
Assignment for the	Chemical and Bioprocess Engineering: Specialis			
Following Curricula	Chemical and Bioprocess Engineering: Specialis			
	International Management and Engineering: Spo	•	pauction: Elective C	ompulsory
	Materials Science: Core Qualification: Compulso		tivo Compulsoru	
	Product Development, Materials and Production	·		
	Product Development, Materials and Production Product Development, Materials and Production	·	iisui y	
	Theoretical Mechanical Engineering: Specialisat			
	medical Mechanical Engineering. Specialisat	ion materials ocience. Liective compulsory		

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 equilib	ria 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	nomene 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	Practice problems to practice and deepen the skills and content taught in the module.
	Exercises explore mathematical details in greater depth with the aim of familiarizing students with equations/concepts and how to
	apply them in practice (e.g. defining thermodynamic potentials and relationships, calculating enthalpy and entropy of a solid
	solution, constructing phase diagrams,).
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.
	William D. Callister und David G. Rethwisch, Materialwissenschaften und Werkstofftechnik, Wiley&Sons, Asia (2011).
	William D. Callister, Materials Science and Technology, Wiley& Sons, Inc. (2007).

Module M1919: Susta	inable operation of technical assets			
Courses				
Title		Тур	Hrs/wk	СР
Fundamentals of Maintenance, Rep Fundamentals of Maintenance, Rep		Lecture Recitation Section (large)	3 1	4 2
Module Responsible		Recitation Section (large)	1	2
Admission Requirements	None			
	We recommend knowledge in the areas of general engir	neering sciences, aeronautics and a	aircraft systems ei	ngineering Technical
	fields like mechanical engineering, mechatronics and properties.	-	-	-
Educational Objectives	After taking part successfully, students have reached the	following learning results		
Professional Competence				
Knowledge	The students are able to describe fundamental correlatio approaches for complex optimization problems.	ns for the sustainable operation of t	echnical assets a	nd to identify solution
Skills	The students are enabled to apply the general enginee sustainability in operation of technical assets. The resu production and technical operation of sustainable produc	lting competencies will open an en	try into positions	•
Personal Competence				
Social Competence	The students are able to work in mixed groups with environment of multiple stakeholders.	a clear focus on the approached	solutions by resp	pecting the complex
Autonomy	The students are enabled to find solutions for optimi determining factors independently.	zation problems and to take req	uired decision for	r the assessment of
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56			
Credit points	6			
Course achievement	None			
Examination	Oral exam			
Examination duration and	30 min			
scale				
-		e Compulsory		
Following Curricula		ation Floating Committee		
	Mechatronics: Specialisation Intelligent Systems and Rob Mechatronics: Specialisation System Design: Elective Cor			
	Mechatronics: Specialisation System Design: Elective Col	Tipuisor y		
	Product Development, Materials and Production: Specialis	sation Product Development: Electiv	ve Compulsory	
	Product Development, Materials and Production: Specialis	•		
	Product Development, Materials and Production: Specialis	·	•	
	Theoretical Mechanical Engineering: Specialisation Produ	ct Development and Production: Ele	ective Compulsory	,
	Theoretical Mechanical Engineering: Specialisation Aircra	ft Systems Engineering: Elective Co	mpulsory	

Course L3160: Fundamentals	s of Maintenance, Repair and Overhaul (MRO)
Тур	Lecture
Hrs/wk	3
СР	4
Workload in Hours	Independent Study Time 78, Study Time in Lecture 42
Lecturer	Prof. Gerko Wende
Language	DE
Cycle	WiSe
Content	Fundamentals for the sustainable operation of technical assets by means of maintenance, repair and overhaul (MRO):
	 Life cycle analytics Material circularity and service products Rules and regulations Processes and production methods Tools and technologies Data handling and usage Design for maintenance Self-healing technical systems
Literature	•

Course L3161: Fundamentals	s of Maintenance, Repair and Overhaul (MRO)
Тур	Recitation Section (large)
Hrs/wk	1
СР	2
Workload in Hours	Independent Study Time 46, Study Time in Lecture 14
Lecturer	Prof. Gerko Wende
Language	DE
Cycle	WiSe
Content	See interlocking course
Literature	See interlocking course

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

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: Aircra	aft Energy Systems			
Courses				
Title		Тур	Hrs/wk	CP
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	Makhamakia			
	Mathematics Mechanics			
	Thermodynamics Electrical Engineering			
	Fluid mechanics			
	• Fluid mechanics			
Educational Objectives	After taking part successfully, students have reached th	e following learning results		
Professional Competence				
Knowledge	Students are able to:			
	Assess challenges during the design of aircraft en			
	 Describe essential components and design points 		stems	
	Give an overview of the functionality of air condit	ioning systems		
	Describe different system concepts for de-icing			
	Identify constraints for the electrification of aircra	•	ncepts and limita	tions
	Describe architectures for fuel supply systems an			
	 Explain possible approaches for the integration of 	fuel cell systems and evaluate zero-	emission concept	:S
Skills	Students are able to:			
	 Design hydraulic and electric supply systems of a 	ircrafts		
	Analyze the thermodynamic behavior of air condi-	tioning systems		
	Design ice protection systems			
	 Apply possible electrification concepts to existing 	aircraft systems		
	Design fuel supply systems			
	Perform the design of a fuel cell system			
Personal Competence				
•	Students are able to:			
	 Perform system design in groups and present and 	l discuss results		
	 Present systems engineering problems and discuss 	ss solutions with experts		
Autonomy	Students are able to:			
Autonomy	Stagenes are able to.			
	Reflect on the content of lectures autonomously			
	 Apply methods learned in the course of exercises 	to more advanced problems		
	 Identify complex system dependencies autonomo 	usly and abstract simplified models a	and design proces	sses
Workland in House	Independent Study Time 110, Study Time in Lecture 70			
	Independent Study Time 110, Study Time in Lecture 70			
Credit points				
Course achievement				
Examination	Written exam			
Examination duration and	165 Minutes			
scale				
Assignment for the	Energy Systems: Specialisation Energy Systems: Elective	e Compulsory		
Following Curricula	Aircraft Systems Engineering: Core Qualification: Compu	llsory		
	International Management and Engineering: Specialisati	on II. Aviation Systems: Elective Com	pulsory	
	Aeronautics: Core Qualification: Compulsory			
	Product Development, Materials and Production: Special	isation Product Development: Electiv	e Compulsory	
	Product Development, Materials and Production: Special	isation Production: Elective Compulso	ory	
	Product Development, Materials and Production: Special	isation Materials: Elective Compulsor	у	
	Theoretical Mechanical Engineering: Specialisation Aircr	aft 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	y 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)

itle		Тур	Hrs/wk	СР
applied Automation (L1592)		Project-/problem-based Learning	3	3
dvanced Training Course SE-ZEI	T (L2739)	Project-/problem-based Learning	2	3
lements of Integrated Production		Project-/problem-based Learning	2	3
Development Management for Mo	chatronics (L1512)	Lecture	2	3
atigue & Damage Tolerance (L0		Lecture	2	3
GSD - Generational Sheet-Metal Development (L3064)		Lecture	3	3
ndustry 4.0 for Engineers (L2012	•	Lecture	2	3
nnovation and Product Management (L2168)		Seminar	2	3
Lightweight Design Practical Course (L1258)		Project-/problem-based Learning	3	3
Mechanisms and Systems of Materials Testing - from the viewpoint of product development and Failure		Lecture	2	2
nalysis (L0950)	, , , , , , , , , , , , , , , , , , ,			
icrosystems Technology (L0724		Lecture	2	4
ustainable Industrial Production		Lecture	2	4
roductivity Management (L0928		Project-/problem-based Learning	2	2
roductivity Management (L0931		Recitation Section (small)	1	1
eedback Control in Medical Tech		Lecture	2	3
Structural Mechanics of Fibre Rei		Lecture	2	3
echnical Design (L1513)	cca composited (E1014)	Lecture	2	3
	oint of industrial application (L0949)	Lecture	2	2
leliability in Engineering Dynami		Lecture	2	2
teliability in Engineering Dynami		Recitation Section (small)	1	2
Reliability of Aircraft Systems (L0		Lecture (Small)	2	3
		Lecture	۷	3
Module Responsible				
Admission Requirement	None			
Recommended Previou	None			
Knowledge				
	1			
Educational Objective	After taking part successfully, students have reached the follow	ring learning results		
Educational Objective Professional Competence	After taking part successfully, students have reached the follow	ring learning results		
	After taking part successfully, students have reached the follow			
Professional Competence	After taking part successfully, students have reached the follow		fferent specia	l fields or applica
Professional Competence	After taking part successfully, students have reached the follow	and discuss the connection of di	fferent specia	l fields or applica
Professional Competence	After taking part successfully, students have reached the follow	and discuss the connection of di	fferent specia	l fields or applica
Professional Competence Knowledg	After taking part successfully, students have reached the follow Students are able to express their extended knowledge areas of product development, materials and production Students are qualified to connect different special fields	and discuss the connection of di	fferent specia	l fields or applica
Professional Competence	After taking part successfully, students have reached the follow Students are able to express their extended knowledge areas of product development, materials and production Students are qualified to connect different special fields	and discuss the connection of di		l fields or applica
Professional Competence Knowledg	After taking part successfully, students have reached the follow Students are able to express their extended knowledge areas of product development, materials and production Students are qualified to connect different special fields Students can apply specialized solution strategies and ne	and discuss the connection of diswith each other	areas	
Professional Competence Knowledg	After taking part successfully, students have reached the follow Students are able to express their extended knowledge areas of product development, materials and production Students are qualified to connect different special fields	and discuss the connection of diswith each other	areas	
Professional Competence Knowledg	After taking part successfully, students have reached the follow Students are able to express their extended knowledge areas of product development, materials and production Students are qualified to connect different special fields Students can apply specialized solution strategies and ne Students are able to transfer learned skills to new and ur	and discuss the connection of diswith each other	areas	
Professional Competence Knowledg Skill Personal Competence	After taking part successfully, students have reached the follow Students are able to express their extended knowledge areas of product development, materials and production Students are qualified to connect different special fields Students can apply specialized solution strategies and ne Students are able to transfer learned skills to new and ur	and discuss the connection of diswith each other	areas	
Professional Competence Knowledge Skille Personal Competence Social Competence	After taking part successfully, students have reached the follow Students are able to express their extended knowledge areas of product development, materials and production Students are qualified to connect different special fields Students can apply specialized solution strategies and ne Students are able to transfer learned skills to new and ur	and discuss the connection of diswith each other	areas	
Professional Competence Knowledge Skille Personal Competence	After taking part successfully, students have reached the follow Students are able to express their extended knowledge areas of product development, materials and production Students are qualified to connect different special fields Students can apply specialized solution strategies and not students are able to transfer learned skills to new and ure	and discuss the connection of diswith each other ew scientific methods in selected or name of the selected of	areas o own solution	
Professional Competence Knowledge Skille Personal Competence Social Competence	After taking part successfully, students have reached the follow Students are able to express their extended knowledge areas of product development, materials and production Students are qualified to connect different special fields Students can apply specialized solution strategies and ne Students are able to transfer learned skills to new and ur	and discuss the connection of diswith each other ew scientific methods in selected or name of the selected of	areas o own solution	
Professional Competence Knowledge Skille Personal Competence Social Competence	After taking part successfully, students have reached the follow Students are able to express their extended knowledge areas of product development, materials and production Students are qualified to connect different special fields Students can apply specialized solution strategies and neels of the students are able to transfer learned skills to new and under the students are able to develop their knowledge and skills to develop their knowle	and discuss the connection of diswith each other ew scientific methods in selected or name of the selected of	areas o own solution	
Professional Competence Knowledg Skill Personal Competence Social Competence Autonom	After taking part successfully, students have reached the follow Students are able to express their extended knowledge areas of product development, materials and production Students are qualified to connect different special fields Students can apply specialized solution strategies and nees to students are able to transfer learned skills to new and under the students are able to develop their knowledge and skills to be peends on choice of courses	and discuss the connection of diswith each other ew scientific methods in selected or name of the selected of	areas o own solution	
Professional Competence Knowledg Skill Personal Competence Social Competence Autonom Workload in Hour	After taking part successfully, students have reached the follow Students are able to express their extended knowledge areas of product development, materials and production Students are qualified to connect different special fields Students can apply specialized solution strategies and nees to students are able to transfer learned skills to new and ure Students are able to develop their knowledge and skills to be peends on choice of courses	and discuss the connection of diswith each other ew scientific methods in selected nknown problems and can develop by autonomous election of course	areas p own solution s.	
Professional Competence Knowledg Skill Personal Competence Social Competence Autonom Workload in Hour Credit point Assignment for the	After taking part successfully, students have reached the follow Students are able to express their extended knowledge areas of product development, materials and production Students are qualified to connect different special fields Students can apply specialized solution strategies and nees to students are able to transfer learned skills to new and under the students are able to develop their knowledge and skills to be peends on choice of courses Depends on choice of courses 12	and discuss the connection of diswith each other ew scientific methods in selected inknown problems and can develop by autonomous election of course Product Development: Elective Co	areas p own solution s.	
Professional Competence Knowledg Skill Personal Competence Social Competence Autonom Workload in Hour Credit point	After taking part successfully, students have reached the follow Students are able to express their extended knowledge areas of product development, materials and production Students are qualified to connect different special fields Students can apply specialized solution strategies and nees to students are able to transfer learned skills to new and ure Students are able to develop their knowledge and skills to be peends on choice of courses Depends on choice of courses Product Development, Materials and Production: Specialisation	and discuss the connection of diswith each other ew scientific methods in selected inknown problems and can develop by autonomous election of course Product Development: Elective Corpoduction: Elective Compulsory	areas p own solution s.	

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
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 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 L3064: GSD - Generational Sheet-Metal Development	
Тур	Lecture
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. Dr. Nikola Bursac
Language	DE
Cycle	WiSe
Content	Experience in mechanical engineering design and the fundamentals of manufacturing engineering
	After successful completion of the course, students will be able to explain development projects using the theory of product generation engineering and explain design rules for sheet metal development.
	After successful completion of the course, students will be able to apply the theory of product generation engineering to development tasks and develop sheet-metal products suitable for production.
	After successful completion of the course, students will be able to develop a product in a team and to compete against other teams.
	After successful completion of the course, students will be able to independently access knowledge required for sheet metal development.
Literature	

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	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 	
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, 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. 	

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 SoSe
	Application, analysis and discussion of basic and advanced testing methods to ensure correct selection of applicable testin 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, 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
	G. Gerlach; W. Dötzel: Introduction to microsystem technology, Wiley, 2008

Course L2863: Sustainable Industrial Production		
Тур	Lecture	
Hrs/wk	2	
СР	4	
Workload in Hours	Independent Study Time 92, Study Time in Lecture 28	
Examination Form		
Examination duration and		
scale		
Lecturer	Dr. Simon Markus Kothe	
Language	DE	
Cycle	SoSe	
Content		
	processes that change the form and physical properties of raw materials. Manufacturing is a central driver of economi development and has a major impact on the well-being of humanity. However, the scale of current manufacturing activities result: 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 hardl 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 th 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 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				
Lecturer				
Language				
Cycle				
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	ndependent 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	ndependent 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 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	

Lecturer	Prof. Werner Granzeier, Prof. Dieter Krause
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

Production"	
	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 GmbH,
	Auto & Design,
	Corso Frabcia 161, 10139 Torino, Italia
	(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 L0949: Materials Testing - from the viewpoint of industrial application			
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 L2994: Reliability in Engineering Dynamics				
Тур	Lecture			
Hrs/wk	2			
СР	2			
Workload in Hours	dependent Study Time 32, Study Time in Lecture 28			
Examination Form	Klausur			
Examination duration and	90 min			
scale				
Lecturer	Dr. Eric Groß, Prof. Benedikt Kriegesmann			
Language	EN			
Cycle	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 L2995: 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			
Language	EN		
Cycle	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		

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

Course L0749: Reliability of Aircraft Systems			
Тур	Lecture		
Hrs/wk			
СР			
Workload in Hours	ndependent 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 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	
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	chatronics (L1512)	Lecture	2	3	
Fatigue & Damage Tolerance (L031	10)	Lecture	2	3	
GSD - Generational Sheet-Metal De	evelopment (L3064)	Lecture	3	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 and Systems of Mater	ials Testing - from the viewpoint of product development and Failure	Lecture	2	2	
Analysis (L0950)					
Microsystems Technology (L0724)		Lecture	2	4	
Sustainable Industrial Production (I	.2863)	Lecture	2	4	
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	
Technical Design (L1513)		Lecture	2	3	
Materials Testing - from the viewpo	pint of industrial application (L0949)	Lecture	2	2	
Reliability in Engineering Dynamics		Lecture	2	2	
Reliability in Engineering Dynamics		Recitation Section (small)	1	2	
Reliability of Aircraft Systems (L074	49)	Lecture	2	3	
Module Responsible	Prof Dieter Krause				
Admission Requirements	None				
Recommended Previous					
Knowledge	None				
	After teling part appearing the students have reached the follow	ing looping require			
Educational Objectives Professional Competence	After taking part successfully, students have reached the follow	ing learning results			
•					
Knowledge	Knowledge • 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 to	with each other			
Skills					
Skiiis	 Students can apply specialized solution strategies and ne 	ew scientific methods in selected	areas		
	 Students are able to transfer learned skills to new and ur 	known problems and can develop	p own solution a	pproaches	
Personal Competence					
Social Competence	-				
Autonomy					
	Students are able to develop their knowledge and skills by autonomous election of courses.				
Workload in Hours	Depends on choice of courses				
Credit points	6				
Assianment for the	Product Development, Materials and Production: Specialisation	Product Development: Elective Co	ompulsorv		
Following Curricula	·	·			
i onowing curricula					
	Product Development, Materials and Production: Specialisation Materials: Elective Compulsory				
	Theoretical Mechanical Engineering: Specialisation Product Development and Production: Elective Compulsory				
	<u> </u>				

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
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 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
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 L3064: GSD - Generational Sheet-Metal Development		
Тур	Lecture	
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. Dr. Nikola Bursac	
Language	DE	
Cycle	WiSe	
Content	Experience in mechanical engineering design and the fundamentals of manufacturing engineering	
	After successful completion of the course, students will be able to explain development projects using the theory of product generation engineering and explain design rules for sheet metal development.	
	After successful completion of the course, students will be able to apply the theory of product generation engineering to development tasks and develop sheet-metal products suitable for production.	
	After successful completion of the course, students will be able to develop a product in a team and to compete against other teams.	
	After successful completion of the course, students will be able to independently access knowledge required for sheet metal development.	
Literature		

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	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 	
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, 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 and Systems of Materials Testing - from the viewpoint of product development and Failure Analysis Typ Lecture Hrs/wk 2 CP 2 Workload in Hours Independent Study Time 32, Study Time in Lecture 28 Examination Form Klausur Examination duration and scale 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 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	
Hrs/wk 2 CP 2 Workload in Hours Independent Study Time 32, Study Time in Lecture 28 Examination Form Klausur Examination duration and 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 procedure for investigation of part/materials deficiencies Stress-strain relationships Strain gauge application Visko elastic behavior Tensile test (strain hardening, necking, strain rate)	
Workload in Hours Independent Study Time 32, Study Time in Lecture 28 Examination Form Klausur Examination duration and 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 procedure for investigation of part/materials deficiencies Stress-strain relationships Strain gauge application Visko elastic behavior Tensile test (strain hardening, necking, strain rate)	
Workload in Hours Examination Form Klausur Examination duration and 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 procedure for investigation of part/materials deficiencies Stress-strain relationships Strain gauge application Visko elastic behavior Tensile test (strain hardening, necking, strain rate)	
Examination Form Klausur Examination duration and 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 procedure for investigation of part/materials deficiencies Stress-strain relationships Strain gauge application Visko elastic behavior Tensile test (strain hardening, necking, strain rate)	
Examination duration and 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 procedure for investigation of part/materials deficiencies • Stress-strain relationships • Strain gauge application • Visko elastic behavior • Tensile test (strain hardening, necking, strain rate)	
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 procedure for investigation of part/materials deficiencies Stress-strain relationships Strain gauge application Visko elastic behavior Tensile test (strain hardening, necking, strain rate)	
Language DE Cycle SoSe Content Application, analysis and discussion of basic and advanced testing methods to ensure correct selection of applicable procedure for investigation of part/materials deficiencies • Stress-strain relationships • Strain gauge application • Visko elastic behavior • Tensile test (strain hardening, necking, strain rate)	
Cycle SoSe Content Application, analysis and discussion of basic and advanced testing methods to ensure correct selection of applicable procedure for investigation of part/materials deficiencies • Stress-strain relationships • Strain gauge application • Visko elastic behavior • Tensile test (strain hardening, necking, strain rate)	
Content Application, analysis and discussion of basic and advanced testing methods to ensure correct selection of applicable procedure for investigation of part/materials deficiencies • Stress-strain relationships • Strain gauge application • Visko elastic behavior • Tensile test (strain hardening, necking, strain rate)	
procedure for investigation of part/materials deficiencies • Stress-strain relationships • Strain gauge application • Visko elastic behavior • Tensile test (strain hardening, necking, strain rate)	
 Stress-strain relationships Strain gauge application Visko elastic behavior Tensile test (strain hardening, necking, strain rate) 	testing
 Strain gauge application Visko elastic behavior Tensile test (strain hardening, necking, strain rate) 	
 Strain gauge application Visko elastic behavior Tensile test (strain hardening, necking, strain rate) 	
Visko elastic behavior Tensile test (strain hardening, necking, strain rate)	
Tensile test (strain hardening, necking, strain rate)	
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
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; accelerometer: piezoresistive, piezoelectric and capacitive; angular rate 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, clark electrode, enzyme electrode, DNA chip) Micro Actua
	and silicon fusion bonding; micro electroplating, 3D-MID)
110.	M. Madau Fundamentals of Missofabrication CRC Press 2002
Literature	M. Madou: Fundamentals of Microfabrication, CRC Press, 2002 N. Schwesinger: Lehrbuch Mikrosystemtechnik, Oldenbourg Verlag, 2009 T. M. Adama, R. A. Leitzer, Market, MEMS, Carinear, 2010
	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	4
Workload in Hours	Independent Study Time 92, 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 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 and 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 life cycle assessment.
Litouatura	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 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			
Lecturer	5		
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, Fina 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	ndependent 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			
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 editio. 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 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	

şcale	Prof. Werner Granzeier, Prof. Dieter Krause
Language	DE
Cycle	
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

Production"	
	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 GmbH,
	Auto & Design,
	Corso Frabcia 161, 10139 Torino, Italia
	(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 L0949: Materials Testing - from the viewpoint of industrial application				
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 L2994: Reliability in Engineering Dynamics				
Тур	Lecture			
Hrs/wk	2			
СР				
Workload in Hours	ndependent Study Time 32, Study Time in Lecture 28			
Examination Form	Klausur			
Examination duration and	90 min			
scale				
Lecturer	Dr. Eric Groß, Prof. Benedikt Kriegesmann			
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. ISS 0943-9412			

Course L2995: Reliability in Engineering Dynamics				
Тур	Recitation Section (small)			
Hrs/wk	ık 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	Prof. Benedikt Kriegesmann, Dr. Eric Groß			
Language	EN			
Cycle	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. ISS 0943-9412			

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

Course L0749: Reliability of Aircraft Systems				
Тур	ecture			
Hrs/wk				
СР				
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			
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			

Production					
Module M1193: Cabin	Systems Engineering				
Courses					
Title		Тур	Hrs/wk	СР	
	nnology in cabin electronics and avionics (L1557)	Lecture	2	2	
	nnology in cabin electronics and avionics (L1558)	Recitation Section (small)	1	1	
Model-Based Systems Engineering		Project-/problem-based Lear		3	
Module Responsible		.,,,		-	
-	None				
Admission Requirements					
Recommended Previous	1				
Knowledge					
	• Mechanics				
	• Thermodynamics				
	Electrical Engineering				
	Control Systems				
	Previous knowledge in:				
	Systems Engineering				
Educational Objectives	After taking part successfully, students have reached t	he following learning results			
Professional Competence	*				
-	Students are able to:				
Knowledge		hitocturos			
	describe the structure and operation of computer arc avalage the structure and operation of digital computers.				
	explain the structure and operation of digital commu		Data Camanauniaati	an Naturali (ADCN)	
	explain architectures of cabin electronics, integrated				
	understand the approach of Model-Based Systems .	Engineering (MBSE) in the design	of hardware and s	software-based cabin	
	systems				
Skills	Students are able to:				
S.i.i.s	understand, operate and maintain a Minicomputer				
	build up a network communication and communicate	with other network participants			
	connect a minicomputer with a cabin management si		e over a ΔFDX®-Ne	twork	
	 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					
Social Competence	Students are able to:				
	form teams of two or small groups for the practical w	vork			
	work out partial results themselves and combine themselves.		tion		
	represent and contribute their own solution				
take over the guidance of the team					
	contribute in the team				
	contribute in the team				
Autonomy	Students are able to:				
	organize and plan their practical tasks				
	further develop their own skills				
	take their own initiative				
	explore their own new ways of solving problems				
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: Core Qualification: Electi	ve Compulsory			
Following Curricula			mnulsory		
	Aeronautics: Core Qualification: Elective Compulsory	alication Product Davidson ant. Flat	ivo Compulsari		
	Product Development, Materials and Production: Specia	•			
	Product Development, Materials and Production: Specia	·	-		
	Product Development, Materials and Production: Specia	•	•		
	Theoretical Mechanical Engineering: Specialisation Airc	craft Systems Engineering: Elective C	ompulsory		

Course L1557: Computer and	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

Course L1558: Computer and	communication technology in cabin electronics and avionics
Тур	Recitation Section (small)
Hrs/wk	1
СР	1
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 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 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

Hrs/wk 3 CP 3	dependent Study Time 48, Study Time in Lecture 42
CP 3	
Workload in Hours Inde	
	of. Ralf God
Lecturer Prof	
Language DE	
Cycle SoS	Se
Content Obj	ojectives of the problem-oriented course are the acquisition of knowledge on system design using the formal languages
Sys	sML/UML, learning about tools for modeling and finally the implementation of a project with methods and tools of Model-Based
Sys	stems Engineering (MBSE) on a realistic hardware platform (e.g. Arduino®, Raspberry Pi®):
• W	What is a model?
• W	What is Systems Engineering?
• St	Survey of MBSE methodologies
• Th	The modelling languages SysML /UML
• To	Tools for MBSE
• Be	Best practices for MBSE
• Re	Requirements specification, functional architecture, specification of a solution
• Fr	From model to software code
• Va	Validation and verification: XiL methods
• Ad	Accompanying MBSE project
Literature - Sk	skript zur Vorlesung
- W	Veilkiens, T.: Systems Engineering mit SysML/UML: Modellierung, Analyse, Design. 2. Auflage, dpunkt.Verlag, 2008
- Ho	Holt, J., Perry, S.A., Brownsword, M.: Model-Based Requirements Engineering. Institution Engineering & Tech, 2011

Module MU630: Robo	tics and Navigation in Medic	cine		
Courses				
Title		Тур	Hrs/wk	СР
Robotics and Navigation in Medicin	e (L0335)	Lecture	2	3
Robotics and Navigation in Medicin		Project Seminar	2	2
Robotics and Navigation in Medicin		Recitation Section (small)	1	1
Module Responsible	Prof. Alexander Schlaefer			
Admission Requirements	None			
Recommended Previous	 principles of math (algebra, analyst 	sis/calculus)		
Knowledge	 principles of math (argesta, unary) principles of programming, e.g., ir 			
	solid R or Matlab skills	.,		
Educational Objectives	After taking part successfully students h	any a reached the following learning results		
Educational Objectives Professional Competence	After taking part successiumy, students i	nave reached the following learning results		
•	The students can explain kinematics a	nd tracking systems in clinical contexts and illus	strate systems and	their components
	· ·	respect to collision detection and safety and r		
	systems regarding design and limitation		-5	, ,,,
Skills	The students are able to design and eval	luate navigation systems and robotic systems for	medical application	S.
Personal Competence				
Social Competence	The students are able to grasp practical	al tasks in groups, develop solution strategies in	dependently, define	e work processes ar
	work on them collaboratively.			
	The students are able to collaboratively	y organize their work processes and software so	utions using virtua	I communication a
	software management tools.			
		the results of other groups, make constructive	suggestions for im	provement, and al
	incorporate them into their own work.			
Autonomy		knowledge and independently control their lear		
		critically evaluate the results achieved and preser	it them in an appro	priate argumentati
	manner to the other groups.			
Workload in Hours	Independent Study Time 110, Study Tim	e in Lecture 70		
Credit points	6 Compulsory Bonus Form	Description		
Course achievement	Yes 10 % Presentation	2000 peton		
	Yes 10 % Written elaboration	on		
Examination	Written exam			
Examination duration and	90 minutes			
scale				
Assignment for the	Computer Science: Specialisation II: Intel	lligence Engineering: Elective Compulsory		
Following Curricula	Data Science: Specialisation III. Applicati	ons: Elective Compulsory		
	Data Science: Specialisation IV. Special F	Focus Area: Elective Compulsory		
	Electrical Engineering: Specialisation Me	dical Technology: Elective Compulsory		
	Computer Science in Engineering: Specia	alisation II. Engineering Science: Elective Compuls	ory	
		ing: Specialisation II. Electrical Engineering: Electi		
		ing: Specialisation II. Process Engineering and Biol	echnology: Elective	e Compulsory
	Mechatronics: Core Qualification: Elective	' '		
		artificial Organs and Regenerative Medicine: Electiv		
		mplants and Endoprostheses: Elective Compulsory		
		Medical Technology and Control Theory: Elective Co		
		Management and Business Administration: Elective		
	,	duction: Specialisation Product Development: Elec		
	,	duction: Specialisation Production: Elective Compu	-	
	'	duction: Specialisation Materials: Elective Compuls	-	
		cialisation Bio- and Medical Technology: Elective (

Course L0335: Robotics and Navigation in Medicine		
Lecture		
2		
3		
Independent Study Time 62, Study Time in Lecture 28		
Prof. Alexander Schlaefer		
EN		
SoSe		
- 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		
Troccaz: Medical Robotics, 2012		
Further literature will be given in the lecture.		

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	

Production				
Module M0764: Flight	t Control Systems			
Courses				
		Time	Hee feels	CD
Title Flight Control Systems (L0736)		Typ Lecture	Hrs/wk 3	CP 4
Flight Control Systems (L0740)		Recitation Section (large)	2	2
Module Responsible	Prof. Frank Thielecke			
Admission Requirements				
Recommended Previous				
Knowledge				
	mathematics			
	mechanics thermo dynamics			
	electronics			
	fluid mechanics			
	control theory			
	After taking part successfully, students have reached the following	ng learning results		
Professional Competence				
Knowledge	Students are able to			
	describe the structure and the functioning of primary flight	nt control systems as well as	actuation-, avior	nic-, high lift systems
	of aircrafts in general along with corresponding properties	and applications.		
	give an overview over the functioning and the structure of	landing gears and landing g	ear systems	
	explain different configurations and designs and their orig	ins		
Skills	Students are able to			
	size primary flight control actuation systems			
	perform a controller design process for the flight control a	ctuators		
	design high-lift systems and high-lift kinematics			
	size landing gear components			
Personal Competence				
	Students are able to:			
	Develop joint solutions in mixed teams			
	Present and explain developed solutions in front of other s Discuss developed solutions with expects.	tudents		
	Discuss developed solutions with experts			
Autonomy	Students are able to:			
	derive requirements and perform appropriate yet simplifications.	ed design processes for aircr	aft systems from	complex issues and
	circumstances in a self-reliant manner	ed design processes for direct	are systems from	complex issues und
	apply new skills and methods in the context of exercises in	n a self-reliant manner		
	Independent Study Time 110, Study Time in Lecture 70			
Credit points				
Course achievement				
	Written exam			
Examination duration and				
Scale				
Assignment for the Following Curricula	Aircraft Systems Engineering: Core Qualification: Compulsory International Management and Engineering: Specialisation II. Avi	ation Systems: Floctive Com	ulcory	
ronowing curricula	Aeronautics: Core Qualification: Compulsory	ation bystems. Elective Comp	rui301 y	
	Product Development, Materials and Production: Specialisation P	roduct Development: Elective	Compulsorv	
	Product Development, Materials and Production: Specialisation P			
	Product Development, Materials and Production: Specialisation M			
	Theoretical Mechanical Engineering: Specialisation Aircraft Syste			
			· · · · · · · · · · · · · · · · · · ·	

Course L0736: Flight Control	Systems	
Тур	Lecture	
Hrs/wk	3	
СР		
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	urse 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	cal 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 require
	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	
Credit points	
Course achievement	
Examination	
Examination duration and	90 min
scale	Floridad Fording of the Constitution Medical Technology Florida Constitution
	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 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. Michael Helle, Dr. Sven Prevrhal, Frank Michael Weber	
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.	

Production				
Module M1156: Systems Engineering				
Courses				
itle		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	Basic knowledge in:			
Knowledge				
	Mechanics They made up a paid.			
	Thermodynamics Electrical Engineering			
	Control Systems			
	Previous knowledge in:			
	Aircraft Cabin Systems			
Educational Objectives	After taking part successfully, students have reached the following	ig learning results		
Professional Competence				
Knowledge	Students are able to:			
	understand systems engineering process models, methods and		f complex Systen	ns
	describe innovation processes and the need for technology Mar			
	explain the aircraft development process and the process of type			
	explain the system development process, including requirement identify any ironmental conditions and test procedures for airbo			
	identify environmental conditions and test procedures for airbo value the methodology of requirements-based engineering (RB)		ments engineering	n (MRRE)
	value the methodology of requirements based engineering (NE)	E) and model based requirer	ricins engineering	g (I-IDIKE)
Skills	Students are able to:			
	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 angineering methods and tools.			
	apply systems engineering methods and tools			
Personal Competence				
Social Competence	Students are able to:			
	understand and accept their tasks within a development team			
	be comfortable with their role their tasks within the overall productions and approximately and approximately and approximately approxima			
	 understand and serve their suppliers and customers in large pre- assume responsibility for people and technology in the develop 		me	
	assume responsibility for people and technology in the develop	illelit of safety-critical system	1115	
Autonomy	Students are able to:			
	• interact and communicate in a development team with division	of tasks.		
	independently research and identify certification specifications			
	formulate requirements on their own create test plans on their own and accompany certification produces.	205505		
	- create test plans on their own and accompany certification proc	.======================================		
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 Minutes			
scale	Aircraft Cychona Fraincering, Core Cycliff a blog Core			
Assignment for the Following Curricula		ation Systems: Floative Com	nulsony	
Following Curricula	International Management and Engineering: Specialisation II. Avid International Management and Engineering: Specialisation II. Prod			ompulsorv
	Aeronautics: Core Qualification: Compulsory	adet Development and Plout	accion. Liective Ci	ompuisory
	Mechatronics: Core Qualification: Elective Compulsory			
	Product Development, Materials and Production: Specialisation Pr	oduct Development: Compu	Isory	
	Product Development, Materials and Production: Specialisation Pr	·	-	
	Product Development, Materials and Production: Specialisation M			
	Theoretical Mechanical Engineering: Specialisation Aircraft System	ms Engineering: Elective Cor	mpulsory	

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: Turbomachinery				
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			
	Technical Thermodynamics I, II, Fluid Dynamics, Heat Transfer			
Knowledge				
Educational Objectives	After taking part successfully, students have reached the	following learning results		
Professional Competence				
Knowledge	The students can			
	 distinguish the physical phenomena of conversion 	of energy,		
	 understand the different mathematic modelling of 			
	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	Compulsory		
Following Curricula	Energy Systems: Specialisation Marine Engineering: Elec	tive Compulsory		
	Product Development, Materials and Production: Speciali	sation Product Development: Elective	Compulsory	
	Product Development, Materials and Production: Speciali	sation Production: Elective Compulso	ry	
	Product Development, Materials and Production: Speciali	sation Materials: Elective Compulsory		
	Theoretical Mechanical Engineering: Specialisation Energ	y Systems: Elective Compulsory		

ourse L1562: Turbomachines		
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 M1226: Mech	anical Properties			
Courses				
Title		Тур	Hrs/wk	СР
Mechanical Behaviour of Brittle Mat		Lecture	2	3
Dislocation Theory of Plasticity (L16	662)	Lecture	2	3
Module Responsible	Prof. Shan Shi			
Admission Requirements	None			
Recommended Previous	Basics in Materials Science I/II			
Knowledge				
Educational Objectives	After taking part successfully, students have reached t	he following learning results		
Professional Competence				
Knowledge	Students can explain basic principles of crystallograph	phy, statics (free body diagram	s, tractions) and therm	nodynamics (energy
	minimization, energy barriers, entropy)			
Chille				
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 an	nd to define further work steps or	n this basis guided by te	achers.
	- 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	6		
Credit points	6			
Course achievement	None			
Examination	Written exam			
Examination duration and	180 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	terials 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			
	Heterogeneous materials I			
	Internal stresses, micro cracks, weight function,			
	Heterogeneous materials II			
	oughening mechanisms: crack bridging, fibres			
	eterogeneous materials III			
	oughening mechanisms. Process zone			
	Festing 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
	Prof. Shan Shi
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: 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	NN			
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	ne following learning results		
Professional Competence				
Knowledge				
_	 Students can explain the significance of the mat 			
	They can explain the duality between optimal state			
	They can explain how the H2 and H-infinity norm			
	 They can explain how an LQG design problem ca They can explain how model uncertainty can be 			
	They can explain how model uncertainty can be They can explain how - based on the small gain			
	an uncertain plant.	a robuse controller can gu	arantee stability	and performance to
	They understand how analysis and synthesis con	nditions on feedback loops can be repr	esented as linear	matrix inequalities.
		·		•
Skills	 Students are capable of designing and tuning LQ 	G controllers for multivariable plant m	odels.	
	They are capable of representing a H2 or H-infin			and of using standard
	software tools for solving it.	,		
	 They are capable of translating time and frequency 	ency domain specifications for control	loops into const	raints on closed-loo
	sensitivity functions, and of carrying out a mixed-sensitivity design.			
	They are capable of constructing an LFT uncer	tainty model for an uncertain system	, and of designing	ng a mixed-objective
	robust controller.			
	 They are capable of formulating analysis and sy 	nthesis conditions as linear matrix ine	qualities (LMI), a	nd of using standard
	LMI-solvers for solving them.			
	They can carry out all of the above using standar	rd software tools (Matlab robust contro	ol toolbox).	
Personal Competence				
	Students can work in small groups on specific problems	s to arrive at joint solutions.		
Autonomy	Students are able to find required information in source		oftware docume	ntation) and use it to
	solve given problems.			
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56	5		
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 Compulsor	•		
	Aircraft Systems Engineering: Core Qualification: Elective	ve Compulsory		
	Aeronautics: Core Qualification: Elective Compulsory Mechatronics: Core Qualification: Elective Compulsory			
	Biomedical Engineering: Specialisation Artificial Organs	and Regenerative Medicine: Flortivo	Compulsory	
	Biomedical Engineering: Specialisation Implants and En	-	comparsor y	
	Biomedical Engineering: Specialisation Implants and En		pulsory	
	Biomedical Engineering: Specialisation Medical Technology Biomedical Engineering: Specialisation Management an	**		
		The state of the s		
	Product Development, Materials and Production: Specia	alisation Product Development: Elective	e Compulsorv	
	Product Development, Materials and Production: Special Product Development, Materials and Production: Special Production: Special Production: Special Production: Special Production: Special Production: Special Production			
		alisation Production: Elective Compulso	ory	

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	NN
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 Robust Control		
Тур	Recitation Section (small)	
Hrs/wk	2	
СР	3	
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28	
Lecturer	NN	
Language	EN	
Cycle	SoSe	
Content	See interlocking course	
Literature	See interlocking course	

Module M1343: Struc	ure and properties of fibre-polyme	er-composites			
Courses					
Title		Тур	Hrs/wk	СР	
Structure and properties of fibre-po	ymer-composites (L1894)	Lecture	2	3	
Structure and properties of fibre-po	ymer-composites (L2614)	Project-/problem-based Learning	2	2	
Structure and properties of fibre-po	ymer-composites (L2613)	Recitation Section (large)	1	1	
Module Responsible	Prof. Bodo Fiedler				
Admission Requirements	None				
Recommended Previous	Basics: chemistry / physics / materials science				
Knowledge					
Educational Objectives	After taking part successfully, students have reache	ed the following learning results			
Professional Competence					
Knowledge	Students can use the knowledge of fiber-reinforce necessary testing and analysis.	d composites (FRP) and its constituents to p	olay (fiber / m	atrix) and define the	
	They can explain the complex relationships structur	re-property relationship and			
	the interactions of chemical structure of the pol neighboring contexts (e.g. sustainability, environme		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 a 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	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	s and to define further work steps on this bas	is.		
	- assess possible consequences of their professiona	l activity.			
Workload in Hours	Independent Study Time 110, Study Time in Lecture	e 70			
Credit points					
Course achievement					
Examination	Written exam				
Examination duration and	90 min				
scale					
-	Aircraft Systems Engineering: Core Qualification: Ele				
Following Curricula	International Management and Engineering: Special	·	on: Elective C	ompuisory	
	Aeronautics: Core Qualification: Elective Compulsor Materials Science and Engineering: Specialisation E	•			
	3 3 ,	, ,			
	Materials Science: Specialisation Engineering Mater Mechanical Engineering and Management: Core Qu				
	Mechanical Engineering and Management: Core Qui Product Development, Materials and Production: Sp	• •	omnuleory		
	Product Development, Materials and Production: Sp Product Development, Materials and Production: Sp	·	ompuisol y		
	Product Development, Materials and Production: Sp				
	Renewable Energies: Specialisation Bioenergy Syste	, ,			
	Renewable Energies: Specialisation Wind Energy Systems: Elective Compulsory				
	Renewable Energies: Specialisation Solar Energy Sy	· ·			
	Theoretical Mechanical Engineering: Specialisation				
	3 3				

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	

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	The students receive the assignment in the form of a material design for test bodies made of fibre composites. Technical and normative requirements are listed in the assignment, all other required information comes from the lectures and exercises or the respective documents (electronically and in conversation). The procedure is specified in a milestone plan and enables the students to plan subtasks and thus work continuously. At the end of the project, different test specimens were tested in tensile or bending tests. In the individual project meetings, the conception (discussion of requirements and risks) is scrutinised. The calculations are analysed, the production methods are evaluated and determined. Materials are selected and the test specimens are manufactured according to standards. The quality and mechanical properties are checked and classified. At the end, a final report is prepared and the results are presented to all participants in the form of a presentation and discussed. Translated with www.DeepL.com/Translator (free version)
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 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	The contents of the lecture are repeated and deepened using practical examples.
	Calculations are carried out together or individually, and the results are discussed critically.
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

Module M1344: Proce	ssing of Fibre-Polymer-Compo	sites		
Courses				
Title		Тур	Hrs/wk	СР
Processing of fibre-polymer-composites (L1895)		Lecture	2	3
From Molecule to Composites Part (L1516)	Project-/problem-based Learnin	, 2	3
Module Responsible	Prof. Bodo Fiedler			
Admission Requirements	None			
Recommended Previous	Knowledge in the basics of chemistry / physic	s / materials science		
Knowledge				
Educational Objectives	After taking part successfully, students have	reached the following learning results		
Professional Competence				
Knowledge	Students are able to give a summary of the	technical details of the manufacturing processes	composites an	nd illustrate respective
	relationships. They are capable of describin	g and communicating relevant problems and qu	estions using	$appropriate\ technical$
	language. They can explain the typical proce	ss of solving practical problems and present relate	ed results.	
Skills	Students can use the knowledge of fiber-rein	forced composites (FRP) and its constituents (fibe	r / matrix) and	d define the necessary
Skins	testing and analysis.	composites (i.i., and its constituents (ii.s.	, macini, and	a define the necessary
	3			
	They can explain the complex structure-prop	erty relationship and		
	the interactions of chemical structure of t	he polymers, their processing with the differen	it fiber types.	including to explain
	neighboring contexts (e.g. sustainability, env		7,,	,
Personal Competence				
Social Competence	Students are able to cooperate in small, mix	ed-subject groups in order to independently deriv	e solutions to	given problems in the
•	context of civil engineering. They are able to	effectively present and explain their results alor	e or in groups	in front of a qualified
	audience. Students have the ability to devel	op alternative approaches to an engineering prob	lem independ	ently or in groups and
	discuss advantages as well as drawbacks.			
Autonomy	Students are capable of independently solving mechanical engineering problems using provided literature. They are able to fill gaps in as well as extent their knowledge using the literature and other sources provided by the supervisor. Furthermore, they can			
	meaningfully extend given problems and pra	gmatically solve them by means of corresponding	solutions and	concepts.
Workload in Hours	Independent Study Time 124, Study Time in	Lecture 56		
Credit points	6			
Course achievement	None			
Examination	Written exam			
Examination duration and	90 min			
scale				
Assignment for the	Materials Science and Engineering: Specialisa	ation Engineering Materials: Elective Compulsory	· · · · · · · · · · · · · · · · · · ·	
Following Curricula	Materials Science: Specialisation Engineering	Materials: Elective Compulsory		
	Mechanical Engineering and Management: Sp	pecialisation Materials: Elective Compulsory		
	Product Development, Materials and Product	on: Specialisation Product Development: Elective	Compulsory	
	•	on: Specialisation Production: Elective Compulsor	<i>y</i>	
	•	on: Specialisation Materials: Elective Compulsory		
	Theoretical Mechanical Engineering: Specialis	sation Materials Science: Elective Compulsory		

Course L1895: Processing of	Course L1895: Processing of fibre-polymer-composites				
Тур	Lecture				
Hrs/wk	2				
СР	3				
Workload in Hours	ependent Study Time 62, Study Time in Lecture 28				
Lecturer	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 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	Åström: Manufacturing of Polymer Composites, Chapman and Hall				

Module M1878: Susta	inable energy from wind and water						
Courses							
Title		Тур	Hrs/wk	СР			
Offshore Geotechnical Engineering	(L0067)	Lecture	1	1			
Hydro Power Use (L0013)		Lecture	1	1			
Wind Turbine Plants (L0011) Wind Energy Use - Focus Offshore (L0012)	Lecture Lecture	2 1	1			
Module Responsible							
Admission Requirements	None						
Recommended Previous	Module: Technical Thermodynamics I,						
Knowledge	Madula, Tashnisal Thaypasdynamics II						
	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 k	nowledge of wind turbines wi	ith a particular focus of	wind energy use in			
	offshore conditions and can critical comment these aspe	cts in consideration of curren	t developments. Furthe	rmore, they are able			
	to describe fundamentally the use of water power to gen		reproduce and explain	the basic procedure			
	in the implementation of renewable energy projects in co	untries outside Europe.					
	Through active discussions of various topics within the	seminar of the module, stud	dents improve their un	derstanding and the			
	application of the theoretical background and are thus ab	le to transfer what they have	learned in practice.				
Skille	Students are able to apply the acquired theoretical fou	ndations on exemplary water	r or wind nower system	ns and evaluate and			
Skills	assess technically the resulting relationships in the cont						
	compare critically the special procedure for the impleme						
	in principle applied approach in Europe and can apply thi	s procedure on exemplary the	eoretical projects.				
Borconal Compotonco							
Personal Competence Social Competence	Students can discuss scientific tasks subjet-specificly an	d multidisciplinary within a se	minar				
Social Competence	Students can discuss scientific tasks subjet-specificly and	a maidascipimary within a ser	mmar.				
Autonomy	Students can independently exploit sources in the cont		ecture material to clear	the contents of the			
	lecture and to acquire the particular knowledge about the	e subject area.					
Workload in Hours	Independent Study Time 110, Study Time in Lecture 70						
Credit points	6						
Course achievement	None						
Examination	Written exam						
Examination duration and	180 min						
scale							
_	Civil Engineering: Specialisation Structural Engineering: E	lective Compulsory					
Following Curricula	Civil Engineering: Specialisation Geotechnical Engineerin						
	Civil Engineering: Specialisation Coastal Engineering: Ele						
	International Management and Engineering: Specialisation			Compulsory			
	International Management and Engineering: Specialisation Product Development, Materials and Production: Specialis						
	Product Development, Materials and Production: Specials Product Development, Materials and Production: Specials						
	Product Development, Materials and Production: Specialis						
	Renewable Energies: Core Qualification: Compulsory						
	Theoretical Mechanical Engineering: Specialisation Energ	y Systems: Elective Compulso	ory				
	Process Engineering: Specialisation Environmental Proces	ss Engineering: Elective Comp	ulsory				
	Water and Environmental Engineering: Specialisation Citi						
	Water and Environmental Engineering: Specialisation Environment: Compulsory						

Course L0067: Offshore Geotechnical Engineering						
Тур	Lecture					
Hrs/wk	1					
СР	1					
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14					
Lecturer	Dr. Jan Dührkop					
Language	DE					
Cycle	SoSe					
Content	Overview and Introduction Offshore Geotechnics Introduction to Soil Mechanics Offshore soil investigation Focus on cyclical effects Geotechnical design of offshore foundations Monopiles Jackets Heavyweight foundations Geotechnical preliminary exploration for the use of lift boats and platforms					
Literature	 Randolph, M. and Gourvenec, S (2011): Offshore Geotechnical Engineering. Spon Press. Poulos H.G. (1988): Marine Geotechnics. Unwin Hyman, London BSH-Standard Baugrunderkundung für Offshore-Windenergieparks Lesny K. (2010): Foundations for Offshore Wind Turbines. VGE Verlag, Essen. EA-Pfähle (2012): Empfehlungen des Arbeitskreises Pfähle der DGGT. Ernst & Sohn, Berlin. 					

Course L0013: Hydro Power	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
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.: Windkraftanlagen; Springer, Berlin, Heidelberg, 2008, 4.Auflage Heier, S.: Windkraftanlagen - Systemauslegung, Integration und Regelung; Vieweg + Teubner, Stuttgart, 2009, 5. Auflage Jarass, L.; Obermair, G.M.; Voigt, W.: Windenergie: Zuverlässige Integration in die Energieversorgung; Springer, Berlin, Heidelberg, 2009, 2. Auflage

FIOUUCLIOII								
Module M1894: Autor	mation Technolo	gy and Systems						
Courses								
Title				Тур	Hrs/wk	СР		
Automation Technology and System	ms (L2329)		Lecture	4	4			
Automation Technology and Systems (L2331)				Project-/problem-based Learning	1	1		
Automation Technology and System	ns (L2330)			Recitation Section (small)	1	1		
Module Responsible	Prof. Thorsten Schüpps	tuhl						
Admission Requirements	None							
Recommended Previous	without major course a:	ssessment						
Knowledge								
Educational Objectives	After taking part succes	ssfully, students have re	ached the following	ig learning results				
Professional Competence								
Knowledge	Students							
				ems and have good understand	ling of their in	eraction		
		or a systematical analys npetences in industrial r		asks and are able to use them ation systems				
Skills	Students are able to							
	 analyze complex 	Automation tasks						
	 develop applicat 	ion based concepts and	solutions					
	 design subsyster 	ms and integrate into or	ne system					
	investigate and a	evaluate safety of mach	inery					
		ograms for robots and p		controllers				
	design of circuit	for pneumatic application	ons					
Personal Competence								
Social Competence	Students are able to							
•								
	- find solutions for auto	find solutions for automation and handling tasks in groups						
	- develop solutions in a	a production environmen	nt with qualified pe	ersonnel at technical level and re	epresent decis	sions.		
Autonomy	Students are able to							
	analyze automat	ion tasks independently	'					
		ms for robots and progra						
		s for practice oriented to		independently				
		ncepts for automation a						
	assess conseque	ences of their profession	al actions and resp	oonsibilities				
Workload in Hours	Independent Study Tim	e 96, Study Time in Lec	ture 84					
Credit points								
Course achievement		Form	Description					
		Subject theoretical practical work		eistung umfasst die Ergebnisse der Präsentation in der Gruppe.		sierten Anteile des		
Examination	Written exam	-		- 17.17				
Examination duration and								
scale	120							
Assignment for the		ent and Engineering: Sp	ecialisation II. Pro	duct Development and Production	on: Elective Co	ompulsory		
Following Curricula	1							
	Product Development,	Materials and Production	n: Specialisation Pr	oduct Development: Elective Co	ompulsory			
	Product Development,	Materials and Production	n: Specialisation Pi	oduction: Compulsory				
	Product Development, Materials and Production: Specialisation Materials: Elective Compulsory							
	Theoretical Mechanical	Engineering: Specialisa	tion Product Devel	opment and Production: Elective	e Compulsory			

Course L2329: Automation Technology and Systems				
Тур	Lecture			
Hrs/wk	4			
СР	4			
Workload in Hours	endent 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	ependent Study Time 16, Study Time in Lecture 14			
Lecturer	f. Thorsten Schüppstuhl			
Language				
Cycle	oSe .			
Content	e interlocking course			
Literature	See interlocking course			

Course L2330: Automation Technology and Systems				
Тур	Recitation Section (small)			
Hrs/wk	1			
СР	1			
Workload in Hours	lependent Study Time 16, Study Time in Lecture 14			
Lecturer	f. 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 (L0168)					Integrated Lecture		4	4	
Robotics: Modelling and Control (L1					Project-/problem-based Lea	arning	2	2	
Module Responsible	Dr. Martin Gomse	r. Martin Gomse							
Admission Requirements	None								
Recommended Previous	Fundamentals of elec	trical engine	eering						
Knowledge									
	Broad knowledge of r	nechanics							
	Fundamentals of cont	rol theory							
Educational Objectives	After taking part succ	essfully, stu	dents have r	eached the followi	ng learning results				
Professional Competence									
Knowledge	Students are able to	describe fun	damental pro	operties of robots a	and solution approaches fo	or multi	ple problems	in robotics.	
Skills	Students are able to	derive and s	olve equation	ns of motion for va	rious manipulators.				
	Students can generat	e traiectorie	s in various	coordinate system	s				
	Stadents can general	e trajectorie	.5 III various	coordinate system	J.				
	Students can design l	inear and pa	artially nonlir	near controllers for	robotic manipulators.				
Personal Competence									
Social Competence	Students are able to	work goal-or	iented in sm	all mixed groups.					
Autonomy	Students are able to	ecognize an	nd improve kı	nowledge deficits i	ndependently.				
	With instructor assist	ance, studer	nts are able t	o evaluate their o	wn knowledge level and de	efine a	further course	e of study.	
Workload in Hours	Independent Study Ti	me 96, Stud	ly Time in Le	cture 84					
Credit points	6								
Course achievement	Compulsory Bonus	Form		Description					
	Yes None	•	theoretical		an PBL-Einheiten sowie	Erreicl	hen des Ge	samtziels und de	
		practical w	vork	jeweiligen Se	ession-Ziele				
Examination	Written exam								
Examination duration and scale	120 min								
Assignment for the	Aircraft Systems Engi	nooring: Cor	ro Qualificatio	an, Flactive Comp	ulcon/				
Following Curricula		-			oduct Development and Pr	oductio	n: Flective Co	mnulsory	
1 onowing curricula	_		-		echatronics: Elective Comp		on. Elective co	лприізої у	
	Aeronautics: Core Qu		-		enda omes. Elective comp	, a.50. j			
	Mechanical Engineeri			-	ompulsory				
	Mechatronics: Core Q	ualification:	Compulsory						
	Product Development	, Materials a	and Production	n: Specialisation F	Product Development: Elec	tive Co	mpulsory		
	Product Development	, Materials a	and Production	n: Specialisation F	Production: Elective Compu	ulsory			
	Product Development	, Materials a	and Production	n: Specialisation N	Materials: Elective Compul	sory			
		-			elopment and Production: I				
	Theoretical Mechanic	al Engineerii	ng: Specialis	ation Robotics and	Computer Science: Electiv	ve Com	pulsory		

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 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	

Module M1888: Enviro	onmental protection management			
Courses				
Title		Тур	Hrs/wk	СР
Health, Safety and Environmental N	Management (L0387)	Integrated Lecture	3	3
Air Pollution Abatement (L0203)		Lecture	2	3
Module Responsible	Dr. Swantje Pietsch-Braune			
Admission Requirements	None			
Recommended Previous				
Knowledge				
Educational Objectives	After taking part successfully, students have reach	ed the following learning results		
Professional Competence				
Knowledge				
Skills				
Personal Competence				
Social Competence				
Autonomy				
Workload in Hours	Independent Study Time 110, Study Time in Lectur	re 70		
Credit points	6			
Course achievement	None			
Examination	Written exam			
Examination duration and	90 min			
scale				
Assignment for the	Civil Engineering: Specialisation Water and Traffic:	Elective Compulsory		
Following Curricula	Bioprocess Engineering: Specialisation C - Bioe	conomic Process Engineering, Focus	Management and 0	Controlling: Elective
	Compulsory			
	Environmental Engineering: Specialisation Energy	and Resources: Elective Compulsory		
	International Management and Engineering: Specia	lisation II. Energy and Environmental E	ngineering: Elective (Compulsory
	Product Development, Materials and Production: Sp	pecialisation Product Development: Elec	ctive Compulsory	
	Product Development, Materials and Production: Sp	pecialisation Production: Elective Comp	ulsory	
	Product Development, Materials and Production: Sp	pecialisation Materials: Elective Compul	sory	
	Renewable Energies: Specialisation Bioenergy Syst	ems: Elective Compulsory		
	Process Engineering: Specialisation Environmental	Process Engineering: Elective Compulse	ory	
	Water and Environmental Engineering: Specialisati	on Environment: Compulsory		
	Water and Environmental Engineering: Specialisati	on Cities: Compulsory		

Course L0387: Health, Safety	y and Environmental Management
Тур	Integrated Lecture
Hrs/wk	3
СР	3
Workload in Hours	Independent Study Time 48, Study Time in Lecture 42
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 L0203: Air Pollution A	ourse L0203: Air Pollution Abatement	
Тур	Lecture	
Hrs/wk	2	
СР	3	
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28	
Lecturer	Dr. Swantje Pietsch-Braune, Christian Eichler	
Language	EN	
Cycle	WiSe	
Content	In the lecture methods for the reduction of emissions from industrial plants are treated. At the beginning a short survey of the different forms of air pollutants is given. In the second part physical principals for the removal of particulate and gaseous pollutants form flue gases are treated. Industrial applications of these principles are demonstrated with examples showing the removal of specific compounds, e.g. sulfur or mercury from flue gases of incinerators.	
Literature	Handbook of air pollution prevention and control, Nicholas P. Cheremisinoff Amsterdam [u.a.] : Butterworth-Heinemann, 2002 Atmospheric pollution : history, science, and regulation, Mark Zachary Jacobson Cambridge [u.a.] : Cambridge Univ. Press, 2002 Air pollution control technology handbook, Karl B. Schnelle Boca Raton [u.a.] : CRC Press, c 2002 Air pollution, Jeremy Colls 2. ed London [u.a.] : Spon, 2002	

Module M1909: Syste	m Simulation			
Courses				
Title		Тур	Hrs/wk	СР
System Simulation Modul (L3150)		Lecture	2	3
System Simulation Modul (L3151)		Recitation Section (large)	2	3
Module Responsible	Prof. Arne Speerforck			
Admission Requirements	None			
Recommended Previous	Mathematics I-III, Computer Sciense, Engineering Thermodyna	mics I, II, Fluid Dynamics, Heat	Transfer, Control	Systems
Knowledge				
Educational Objectives	After taking part successfully, students have reached the follow	ving 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	Oral exam			
Examination duration and	30 min			
scale				
Assignment for the	Energy Systems: Core Qualification: Compulsory			
Following Curricula	Aircraft Systems Engineering: Core Qualification: Elective Com	pulsory		
	Aeronautics: Core Qualification: Elective Compulsory			
	Product Development, Materials and Production: Specialisation	Product Development: Elective	Compulsory	
	Product Development, Materials and Production: Specialisation	Production: Elective Compulso	ry	
	Product Development, Materials and Production: Specialisation	Materials: Elective Compulsory	′	
	Renewable Energies: Specialisation Bioenergy Systems: Electiv	e Compulsory		
	Renewable Energies: Specialisation Solar Energy Systems: Elec			
	Renewable Energies: Specialisation Wind Energy Systems: Elec	ctive Compulsory		
	Theoretical Mechanical Engineering: Specialisation Simulation	3,	ry	
	Theoretical Mechanical Engineering: Specialisation Energy Syst	tems: Elective Compulsory		

Course L3150: System Simul	ation Modul
Тур	Lecture
Hrs/wk	2
СР	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Prof. Arne Speerforck, Dr. Johannes Brunnemann
Language	DE
Cycle	WiSe
Content	Lecture about equation-based, physical modelling using the modelling language Modelica and the free simulation tool OpenModelica 1.17.0. 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 3.5", Linköping, Sweden, 2021. [2] OpenModelica: OpenModelica 1.17.0, https://www.openmodelica.org (siehe Download), 2021. [3] M. Tiller: "Modelica by Example", https://book.xogeny.com, 2014. [4] M. Otter, H. Elmqvist, et al.: "Objektorientierte Modellierung Physikalischer Systeme", at- Automatisierungstechnik (german), Teil 1 - 17, Oldenbourg Verlag, 1999 - 2000. [5] P. Fritzson: "Principles of Object-Oriented Modeling and Simulation with Modelica 3.3", Wiley-IEEE Press, New York, 2015. [6] P. Fritzson: "Introduction to Modeling and Simulation of Technical and Physical Systems with Modelica", Wiley, New York, 2011.

Course L3151: System Simulation Modul	
Тур	Recitation Section (large)
Hrs/wk	2
СР	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Prof. Arne Speerforck, Dr. Johannes Brunnemann
Language	DE
Cycle	WiSe
Content	See interlocking course
Literature	See interlocking course

rioduction				
Module M0771: Flight Physics				
Courses				
Title		Тур	Hrs/wk	СР
Aerodynamics and Flight Mechanics I (L0727)		Lecture	3	3
Flight Mechanics II (L0730)		Lecture	2	2
Flight Mechanics II (L0731)		Recitation Section (large)	1	1
Module Responsible	Prof. Frank Thielecke			
Admission Requirements	None			
Recommended Previous	Basic knowledge in:			
Knowledge				
-	Mathematics			
	Mechanics			
	Thermodynamics			
	Aviation			
Educational Objectives	After teling part greenefully attribute here years had the	following loopsing vocults		
	After taking part successfully, students have reached the	following learning results		
Professional Competence				
Knowledge	Students are able to			
	Describe the fundamental equations of aerodynam	ics 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 later	al motion		
	Describe methods of flight simulation and airborne			
	Describe methods of hight simulation and amborne	measurement technology		
Skills	Students are able to			
	Deufe was flight was also air signalations			
	Perform flight mechanic simulations	10: 1		
	Derive flight mechanic relations from virtual and re	al flight test data		
Personal Competence				
	Students are able to:			
, , , , , , , , , , , , , , , , , , , ,				
	 Perform simulations in groups and discuss results 			
	 Evaluate flight test data in groups, discuss and pre 	sent the results		
Autonomy	Students are able to:			
	Process toaching content index and arthur			
	Process teaching content independently	adaman dan bir		
	Prepare, work out and process simulation models in			
	Apply teaching content on virtual and real flight tes	et data		
Workload in House	Independent Study Time 06 Study Time in Lecture 94			
Workload in Hours Credit points	, ,			
Course achievement	None			
Examination	Written exam			
Examination duration and				
scale	255			
Assignment for the	Aircraft Systems Engineering: Core Qualification: Compuls	sory		
Following Curricula		•	pulsory	
	Aeronautics: Core Qualification: Compulsory	3,2222. 2.000	,	
	Product Development, Materials and Production: Specialis	ation Product Development: Flective	e Compulsory	
	Product Development, Materials and Production: Specialis Product Development, Materials and Production: Specialis	·		
	Product Development, Materials and Production: Specialis Product Development, Materials and Production: Specialis	·	-	
		·		
	Theoretical Mechanical Engineering: Specialisation Aircraft	t systems Engineering: Elective Cor	приіѕогу	

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 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	DE
Cycle	SoSe 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	ict i idillilig				
Courses					
Title		Тур		Hrs/wk	СР
Product Planning (L0851)		Lecture		3	3
Product Planning Seminar (L0853)		Project-/p	roblem-based Learning	2	3
Module Responsible	Prof. Cornelius Herstatt				
Admission Requirements	None				
Recommended Previous	Good basic-knowledge of Business Administration	n			
Knowledge					
Educational Objectives	After taking part successfully, students have rea	ched the following learnin	g 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 instruction 	ments			
Personal Competence					
•					
Social Competence	Interact within a team				
	Raise awareness for globabl issues				
	raise awareness for globablissaes				
Autonomy					
	 Gain access to knowledge sources 				
	 Interpret complex cases 				
	Develop presentation skills				
Workload in Hours	Independent Study Time 110, Study Time in Lec	ture 70			
Credit points	6				
Course achievement	Compulsory Bonus Form	Description			
	Yes 20 % Subject theoretical	and			
	practical work				
Examination	Thesis				
Examination duration and	90 minutes				
scale					
Assignment for the	Global Innovation Management: Core Qualification	on: Compulsory			
Following Curricula	International Management and Engineering: Spe	cialisation I. Electives Mar	nagement: Elective Cor	mpulsory	
-	Mechanical Engineering and Management: Spec			-	
	Product Development, Materials and Production:			ompulsory	
	· ·		•	pui50i y	
	Product Development, Materials and Production:	•			
	Product Development, Materials and Production:	•			
	Theoretical Mechanical Engineering: Specialisati	on Product Development a	and Production: Electiv	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.
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 independantly.	
Literature	See lecture information "Product Planning".	

Madula MOSCZ, Buada	etion Diamina S Control and	Digital Enterprise		
Module MU867: Produ	iction Planning & Control and	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	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 Mar	nagement		
Knowledge				
Educational Objectives	After taking part successfully, students have	e 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 applyi	ing models and methods from the module to indu	strial problems.	
Personal Competence				
Social Competence	Students can develop joint solutions in mixe	d teams and present them to others.		
Autonomy	-			
Workload in Hours	Independent Study Time 96, Study Time in L	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	ıction: Elective C	ompulsory
Following Curricula	Logistics, Infrastructure and Mobility: Specia	lisation Production and Logistics: Elective Compu	lsory	
	Biomedical Engineering: Specialisation Artifi	cial Organs and Regenerative Medicine: Elective (Compulsory	
	Biomedical Engineering: Specialisation Implants and Endoprostheses: Elective Compulsory			
	Biomedical Engineering: Specialisation Medi	cal Technology and Control Theory: Elective Com	pulsory	
	Biomedical Engineering: Specialisation Mana	agement and Business Administration: Compulsor	у	
	Product Development, Materials and Product	tion: Specialisation Product Development: Elective	e Compulsory	
	Product Development, Materials and Product	tion: Specialisation Production: Compulsory		
	Product Development, Materials and Product	tion: Specialisation Materials: Elective Compulsor	/	
	Theoretical Mechanical Engineering: Special	isation Product Development and Production: Elec	ctive Compulsory	

Course L0932: The Digital En	iterprise
Тур	Lecture
Hrs/wk	2
СР	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Dr. Robert Rost
Language	DE
Cycle	WiSe
	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)
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 Pla	ourse 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. Robert Rost
Language	DE
Cycle	WiSe
Content	See interlocking course
Literature	Siehe korrespondierende Vorlesung
	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 assessme	nt 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
riatoriomy		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 Com	•	
		ction: Specialisation Materials: Elective Compu	ilsory	
	Water and Environmental Engineering: Core	e Qualification: Compulsory		

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.

Courses				
Title		Тур	Hrs/wk	СР
Methods of Product Development (Lecture	3	3
Methods of Product Development (Project-/problem-based Learning	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 methodol 	loav.		
	describe essential elements of construction	**		
		state of research of integrated product develo	pment.	
Skills	After passing the module students are able to:			
S.M.S				
		nods for non-standardized solutions of proble	ms as well as	adapt new bounda
	conditions,			
		the assistance of a workshop based approach,		
	 choose and execute appropriate moderation 	on techniques.		
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 adva 	ance ideas.		
Autonomy	After passing the module students are able to:			
	give a structured feedback and accept a cr			
	 implement the accepted feedback autonon 	nous.		
Workload in Hours	Independent Study Time 110, Study Time in Lectu	ure 70		
Credit points	6			
Course achievement	None			
Examination	Oral exam			
Examination duration and				
scale				
Assignment for the	Aircraft Systems Engineering: Core Qualification:	Elective Compulsory		
Following Curricula	International Management and Engineering: Spec		ion: Elective C	ompulsory
3	Aeronautics: Core Qualification: Elective Compulsi			. ,
	Mechatronics: Specialisation System Design: Elect			
	Mechatronics: Core Qualification: Elective Compul	• •		
	Product Development, Materials and Production: S	-	ory	
	Product Development, Materials and Production: 5	Specialisation Production: Elective Compulsory		
	Product Development, Materials and Production: 5	Specialisation Materials: Elective Compulsory		
	Theoretical Mechanical Engineering: Specialisation	n Product Development and Production: Electi	ve Compulsory	

Production"	
Course L1254: Methods of Pr	oduct Development
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
	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, Project management (cost, time, quality) and escalation principles,
	Development management for mechatronics, Technical Supply Chain Management.
	• 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 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,

ourse L1255: Methods of Product Development		
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)	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), flui	d 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, present of the interaction 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 compone • design and dimension hydraulic systems for mechanic • perform numerical simulations of hydraulic systems ba • select and adapt pump characteristic curves for hydra • dimension hydrodynamic torque converters and brake	al applications, ased on abstract problem definitions ulic systems		
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 n 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 Product Development: Compulsor	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
Lecturer	Prof. Dieter Krause
Language	DE
Cycle	
Content	
	Hydrostatics
	physical fundamentals
	hydraulic fluids
	hydrostatic machines
	valves
	components
	hydrostatic transmissions
	examples from industry
	Pneumatics
	generation of compressed air
	pneumatic motors
	Examples of use
	Illuding during mailing
	Hydrodynamics
	physical fundamentals
	hydraulic continous-flow machines
	hydrodynamic transmissions
	interoperation of motor and transmission
	Exercise
	Exercise
	Hydrostatics
	reading and design of hydraulic diagrams
	dimensioning of hydrostatic traction and working drives
	performance calculation
	personnel acceptation
	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	Rücher
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
	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	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		

TitleTypHrs/wkCPcircraft Cabin Systems (L1545)Lecture34	Production"				
Tree in the properties in 1546) Module Responsible Performance Perf	Module M1155: Aircra	aft Cabin Systems			
Tree in the properties in 1546) Module Responsible Performance Perf					
interest (1.548b) Section (1.549c) Rectation Section (Garge) 1 2 Module Responsible Module Responsible Module (Responsible Module (Responsible (Res	Courses				
Modular Reposable no. TAIT God Admission Requirements No. TAIT God Admission Requirements Sack knowledge Modernations Moderna	Title		Тур	Hrs/wk	СР
Module Responsibile Admission Requirements Recommended Pravious Bisch knowledge in: Knowledge Pravious Sisch Recommended Pravious Sisch Recommended Pravious Sisch Recommended Pravious Sisch Sischerical Fedineering - Control Systems - Recommended Pravious Sischerical Fedineering - Control Systems - Recommended Recommender - Annowledge - Control Systems - Septial Competence - Annowledge - Social Competence	Aircraft Cabin Systems (L1545)				
Admission Requirements Recommended Previous Sack Introviledge in: Knowledge Allocations of Security	Aircraft Cabin Systems (L1546)		Recitation Section (large)	1	2
Recommended Previous asia: knowledge in: Knowledge Mechanics	Module Responsible	Prof. Ralf God			
Knowledge - Mathematics - Thermodynamics - Electrical Engineering - Control Systems	Admission Requirements	None			
# Mechanics - Themodynamics - Electrical Engineering - Control Systems - Control Systems - Students are able to: - describe cabin operations, equipment in the cabin and cabin Systems - describe cabin operations, equipment in the cabin and cabin Systems - describe cabin operations, equipment in the cabin and cabin Systems - describe cabin operations, equipment in the cabin and cabin Systems - describe cabin operations, equipment in the cabin and cabin Systems - design cabin Systems - describe cabin operations, equipment in the cabin and cabin Systems - design cabin Systems of cabin operation systems and emergency Systems - design cabin Systems and emergency Systems - design cabin Systems on the cabin systems of a sign cabin systems of cabin operations - design cabin systems for safe operations - design cabin systems for safe operations - design emergency systems for safe operations - design cabin systems for safe operations - describe systems as able to: - compensed consisting system solutions and explain them on the basis of existing requirements - describe systems as is - Autonomy - Students are able to: - independently reflect on lecture content and expert presentations - independently reflect on lecture content and expert presentations - independently reflect on lecture content and expert presentations - describe systems as is - Workload in Hours - independently reflect on lecture content and expert presentations - independently reflect on lecture content and expert presentations - describe systems are able to: - independently reflect on lecture content and expert presentations - describe systems are able to: - independently reflect on lecture content and expert presentations - describe systems are able to: - independently reflect on lecture	Recommended Previous	Basic knowledge in:			
Educational Objective Professional Competence Removing a After taking part successfully, students have reached the following learning results Educational Objective Removing a After taking part successfully, students have reached the following learning results After taking part successfully, students have reached the following learning results Advantage - describe cobin operations, equipment in the cabin and cabin Systems - explain the functional and non-functional requirements for cabin Systems - explain the functional and non-functional requirements for cabin Systems - elucidate the necessity of cabin operations, systems and emergency Systems - elucidate the necessity of cabin operations or a stable newtronment Sitis Students are able to: - design a cabin layout for a given business model of an Alfrice - 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 Social Competence Social Competence - Social Competenc	Knowledge	Mathematics			
Educational Objectives After taking part successfully, students have reached the following learning results Professional Competence Anonineties Authority of the cabin operations, equipment in the cabin and cabin Systems - explain the functional and non-functional requirements for cabin Systems - explain the functional and non-functional requirements for cabin Systems - explain the functional and non-functional requirements for cabin Systems - explain the functional and non-functional requirements for cabin Systems - explain the functional and non-functional requirements for cabin Systems - explain the functional and non-functional requirements for cabin Systems - explain as cabin leto: - explain cabin systems for safe operations - design cabin systems for safe operations - design emergency systems for safe operations - design cabin system for safe operations - design cabin system for safe operations - design competence - Social socia		Mechanics			
Educational Objectives After taking part successfully, students have reached the following learning results Professional Competence Knowledge **Country Systems** **Learning the functional and non-functional requirements for cabin Systems **Learning the functional and non-functional requirements for cabin Systems **Learning the functional and non-functional requirements for cabin Systems **Learning the functional and non-functional requirements for cabin Systems **Learning the functional and non-functional requirements for cabin Systems **Learning the functional and non-functional requirements for cabin Systems **Learning the functional and non-functional requirements for cabin Systems **Learning the functional and systems for safe operations **Learning cost in Systems for a given business model of an Airline **Learning cost in Systems for a given business model of an Airline **Learning cost in Systems for a given business model of an Airline **Learning cost in Systems for a given business model of an Airline **Learning cost in Systems for a given business model of an Airline **Learning cost in Systems for a given business model of an Airline **Learning cost in Systems for a given business model of an Airline **Learning cost in Systems for a given business model of an Airline **Learning cost in Systems for a given business model of an Airline **Learning cost in Systems for given business model of an Airline **Learning cost in Systems and Exercisements in the cabin **Learning competence** **Learning					
Educational Objectives After taking part successfully, students have reached the following learning results					
Professional Competence Knowledge Students are able to: 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 operations ystems an emergency Systems assess the challenges human factors integration in a cabin environment Sistilis Students are able to: design acid systems for safe operations design acid systems for safe operations elucidate the recessity of safe operations design acid systems for safe operations design emergency systems for safe operations design acid systems for safe operations design acid systems for safe operations design acid systems for safe operations design emergency systems for safe operations design acid 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 describe systems as is Autonomy Students are able to: Independently reflect on lecture content and expert presentations independently reflect on lecture content and expert presentations describe systems as is Workload in Hours Independently reflect on lecture content and expert presentations describe systems as is Workload in Hours Independently reflect on lecture content and expert presentations describe systems are able to: Course achievement None Examination Murater example of the presentation of the presentations of the presentation of		Control Systems			
Autonomy	Educational Objectives	After taking part successfully, students have reached the foll	owing learning results		
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 Still Students are able to:	Professional Competence				
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 Still Students are able to:	Knowledge	Students are able to:			
elucidate the necessity of cabin operating systems and emergency Systems	-		in Systems		
- assess the challenges human factors integration in a cabin environment Skills Students are able to: - design cabin systems for safe operations - design energency systems for safe operations - design emergency systems for safe man-machine interaction - solve comfort needs and entertainment requirements in the cabin Personal Competence Social Competence Social Competence Social 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 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 - Credit points - Course achievement - None Examination - Examination - Written exam Examination duration and - Scale Assignment for the - Following Curricula - Alcraft Systems Engineering: Specialisation Control and Power Systems Engineering: Elective Compulsory - Aeronautics: 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 Production: Elective Compulsory - Product Development, Materials and Production: Specialisation Production: Elective Compulsory - Product Development, Materials and Production: Specialisation Production: Elective Compulsory		• explain the functional and non-functional requirements for	cabin Systems		
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 Social Competence Social Competence Social Competence - 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 Autonomy Students are able to: - independently reflect on lecture content and expert presentations - 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 None Examination Written exam Examination Written exam Examination duration and Scale Assignment for the Electrical Engineering: Specialisation Control and Power Systems Engineering: Elective Compulsory Aeronautics: Core Qualification: 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 Concellography		• elucidate the necessity of cabin operating systems and em	ergency Systems		
design a cabin layout for a given business model of an Airline design acabin systems for safe operations design energroup systems for safe operations design energroup systems for safe man-machine interaction solve comfort needs and entertainment requirements in the cabin Personal Competence Social Competence Social 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 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 independently develop more in-depth content recognize further areas of knowledge Workload in Hours independently territory independently territory independently develop more in-depth content recognize further areas of knowledge Workload in Hours independently develop more in-depth content recognize further areas of knowledge Workload in Hours independently develop more in-depth content recognize further areas of knowledge Vortical to the production of the product Development, Waterials 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		assess the challenges human factors integration in a cabin	environment		
design a cabin layout for a given business model of an Airline design acabin systems for safe operations design energroup systems for safe operations design energroup systems for safe man-machine interaction solve comfort needs and entertainment requirements in the cabin Personal Competence Social Competence Social 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 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 independently develop more in-depth content recognize further areas of knowledge Workload in Hours independently territory independently territory independently develop more in-depth content recognize further areas of knowledge Workload in Hours independently develop more in-depth content recognize further areas of knowledge Workload in Hours independently develop more in-depth content recognize further areas of knowledge Vortical to the production of the product Development, Waterials 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	Clilla	Chudanka aya abla ka			
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Theoretical Mechanical Engineering: Specialisation Aircraft Systems Engineering: Elective Compulsory					

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 Des	ign and Ana	lysis	
Courses					
Title			Тур	Hrs/wk	СР
Laser Systems and Process Techno		1	Lecture	2	3
Methods for Analysing Production F	Processes (L0876)		Lecture	2	3
Module Responsible	Prof. Jan Hendrik Dege				
Admission Requirements	None				
Recommended Previous					
Knowledge					
Educational Objectives	After taking part successfully, studen	ts have reached the following	g 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 Production	oduct Developmer	nt: Elective Compulsory	
Following Curricula	Product Development, Materials and	Production: Specialisation Pro	oduction: Compuls	sory	
	Product Development, Materials and	Production: Specialisation Ma	aterials: Elective C	ompulsory	
	Theoretical Mechanical Engineering:	Specialisation Product Develo	pment and Produ	ction: 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 A	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. Jan Hendrik Dege		
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	rs (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	e		
Knowledge				
Educational Objectives	After taking part successfully, students have	e reached the following learning results		
Professional Competence				
Knowledge	Students can use the knowledge of plastics	and define the necessary testing and analys	sis.	
	They can explain the complex relationships	abusahura nyanashir sadahir and		
	They can explain the complex relationships	structure-property relationship and		
	the interactions of chemical structure of the	polymers, including to explain neighboring	contexts (e.g. sustaina	ability, environment
	protection).			
Ckilla	Students are capable of			
SKIIIS	Students are capable of			
	- using standardized calculation methods	in a given context to mechanical proper	rties (modulus, streng	th) to calculate ar
	evaluate the different materials.			
	- selecting appropriate solutions for mechai	nical recycling problems and sizing example	stiffnoss corrosion ro	cistanco
	- selecting appropriate solutions for mechan	nical recycling problems and sizing example	stillless, corrosion re	sistance.
Personal Competence				
Social Competence	Students can			
	aveire at final ad most, requite in betaveres	ive average and decreases there		
	- arrive at funded work results in heterogeni	ius groups and document them.		
	- provide appropriate feedback and handle f	eedback on their own performance construc	ctively.	
Autonomy	Students are able to			
	access their own strongths and weaknesse			
	- assess their own strengths and weaknesse	25.		
	- assess their own state of learning in specif	ic terms and to define further work steps on	this basis.	
	- assess possible consequences of their prof	inscional activity		
	- assess possible consequences of their prof	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 and Engineering: Specialis	sation Engineering Materials: Elective Comp	ulsory	
Following Curricula	Materials Science: Specialisation Engineerin			
	Biomedical Engineering: Specialisation Impla	ants and Endoprostheses: Compulsory		
	Biomedical Engineering: Specialisation Artifi	icial Organs and Regenerative Medicine: Ele	ctive Compulsory	
	Biomedical Engineering: Specialisation Mana	agement and Business Administration: Elect	ive Compulsory	
	Biomedical Engineering: Specialisation Medi	cal Technology and Control Theory: Elective	e Compulsory	
	Product Development, Materials and Produc	tion: Specialisation Production: Elective Con	npulsory	
	Product Development, Materials and Produc	tion: Specialisation Materials: Elective Comp	oulsory	
	Product Development, Materials and Produc			
	Theoretical Mechanical Engineering: Special	isation Materials Science: Elective Compulso	ory	

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 Materials	Science		
Module M1170. Filelio	mena and Methods III Materials	Science		
Courses				
Title		Тур	Hrs/wk	СР
Experimental Methods for the Chara	acterization of Materials (L1580)	Lecture	2	2
Phase equilibria and transformation		Lecture	2	2
_	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. Werk	stoffwissenschaft I/II		
Knowledge				
Educational Objectives	After taking part successfully, students have re-	ached the following learning results		
Professional Competence				
Knowledge	The students will be able to explain the proper			hnology, in particular
	metallic, ceramic, polymeric, semiconductor, m	odern composite materials (biomaterials) a	nd nanomaterials.	
Skills	The students will be able to select material of	configurations according to the technical i	needs and, if nece	ssary, to design new
	materials considering architectural principles			
	modern materials science, which enables t	hem to select optimum materials com	nbinations depend	ng on the technical
	applications.			
Barranal Commistance				
Personal Competence	The students are able to present colutions to see	acialista and to dayalan ideas from		
Social Competence	The students are able to present solutions to sp	ecialists and to develop ideas further.		
Autonomy	The students are able to			
Autonomy	The students are able to			
	 assess their own strengths and weakness 	ses.		
	gather new necessary expertise by their	own.		
Workload in Hours	Independent Study Time 96, Study Time in Lect	ure 84		
Credit points	6			
Course achievement	None			
Examination	Written exam			
Examination duration and	90 min			
scale				
Assignment for the	Chemical and Bioprocess Engineering: Specialis	ation General Process Engineering: Elective	Compulsory	
Following Curricula	Chemical and Bioprocess Engineering: Specialis	ation Chemical Process Engineering: Electi	ve Compulsory	
	International Management and Engineering: Spe	ecialisation II. Product Development and Pr	oduction: Elective C	compulsory
	Materials Science: Core Qualification: Compulso	ry		
	Product Development, Materials and Production	: Specialisation Product Development: Elec	tive Compulsory	
	Product Development, Materials and Production	·	llsory	
	Product Development, Materials and Production			
	Theoretical Mechanical Engineering: Specialisat	ion Materials Science: Elective Compulsory		

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	nomene 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	Practice problems to practice and deepen the skills and content taught in the module.
	Exercises explore mathematical details in greater depth with the aim of familiarizing students with equations/concepts and how to apply them in practice (e.g. defining thermodynamic potentials and relationships, calculating enthalpy and entropy of a solid solution, constructing phase diagrams,).
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. William D. Callister und David G. Rethwisch, Materialwissenschaften und Werkstofftechnik, Wiley&Sons, Asia (2011). William D. Callister, Materials Science and Technology, Wiley& Sons, Inc. (2007).

Module M1919: Susta	inable operation of technical assets	5		
Courses				
Title		Тур	Hrs/wk	СР
Fundamentals of Maintenance, Rep		Lecture	3	4
Fundamentals of Maintenance, Rep	T	Recitation Section (large)	1	2
Module Responsible	Prof. Gerko Wende			
Admission Requirements	None			
Recommended Previous	We recommend knowledge in the areas of general	3	,	3
Knowledge	fields like mechanical engineering, mechatronics a content.	and production engineering will be intro	duced into the i	relevant aeronautical
Educational Objectives	After taking part successfully, students have reache	d the following learning results		
Professional Competence				
Knowledge	The students are able to describe fundamental correapproaches for complex optimization problems.	elations for the sustainable operation of to	echnical assets ar	nd to identify solution
Skills	The students are enabled to apply the general engineering capabilities of the individual course towards the optimization of the sustainability in operation of technical assets. The resulting competencies will open an entry into positions in the development, production and technical operation of sustainable products in the mobility and engineering industries.			
Personal Competence				
Social Competence	The students are able to work in mixed groups environment of multiple stakeholders.	with a clear focus on the approached	solutions by resp	pecting the complex
Autonomy	The students are enabled to find solutions for o determining factors independently.	ptimization problems and to take requ	iired decision for	the assessment of
Workload in Hours	Independent Study Time 124, Study Time in Lecture	56		
Credit points	6			
Course achievement	None			
Examination	Oral exam			
Examination duration and	30 min			
scale				
Assignment for the	Aircraft Systems Engineering: Core Qualification: Ele	ective Compulsory		
Following Curricula	Aeronautics: Core Qualification: Elective Compulsory	/		
	Mechatronics: Specialisation Intelligent Systems and	Robotics: Elective Compulsory		
	Mechatronics: Specialisation System Design: Electiv	e Compulsory		
	Mechatronics: Core Qualification: Elective Compulso			
	Product Development, Materials and Production: Spe			
	Product Development, Materials and Production: Spe	•	-	
	Product Development, Materials and Production: Spe			
	Theoretical Mechanical Engineering: Specialisation F			'
	Theoretical Mechanical Engineering: Specialisation A	Anciait Systems Engineering: Elective Cor	привогу	

Course L3160: Fundamentals	s of Maintenance, Repair and Overhaul (MRO)
Тур	Lecture
Hrs/wk	3
СР	4
Workload in Hours	Independent Study Time 78, Study Time in Lecture 42
Lecturer	Prof. Gerko Wende
Language	DE
Cycle	WiSe
Content	Fundamentals for the sustainable operation of technical assets by means of maintenance, repair and overhaul (MRO):
	 Life cycle analytics Material circularity and service products Rules and regulations Processes and production methods Tools and technologies Data handling and usage Design for maintenance Self-healing technical systems
Literature	-

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Course L3161: Fundamentals of Maintenance, Repair and Overhaul (MRO)	
Тур	Recitation Section (large)
Hrs/wk	1
СР	2
Workload in Hours	Independent Study Time 46, Study Time in Lecture 14
Lecturer	Prof. Gerko Wende
Language	DE
Cycle	WiSe
Content	See interlocking course
Literature	See interlocking course

Supplement Modules Core Studies

Module M0599: Digita	l Product Development and Lightweight	: Design		
Courses				
Title		Тур	Hrs/wk	СР
CAE-Team Project (L0271)		Project-/problem-based Learning	2	2
Digital Product Development (L026		Lecture	2	2
Development of Lightweight Design		Lecture	2	2
Module Responsible	Prof. Dieter Krause			
Admission Requirements	None			
Recommended Previous	Advanced Knowledge about engineering design:			
Knowledge	Fundamentals of Mechanical Engineering Design			
	Mechanical Engineering: Design			
	Advanced Mechanical Engineering Design			
Educational Objectives	After taking part successfully, students have reached the fo	ollowing learning results		
Professional Competence				
Knowledge	After completing the module, students are capable of:			
	ovalaining the functional principle of 3D CAD System	os PDM and EEM Systems		
	 explaining the functional principle of 3D-CAD-Systen describing the interaction of the different CAE-Syste 		c	
	describing the interaction of the unferent CAL-System	ins in the product development proces	55	
Skills				
	After completing the module, students are able to:			
	Arter completing the module, students are able to:			
	 evaluate different CAD- and PDM-Systems with rec 	aards to the desired requirements su	ich as classific	cation schemes and
	product structuring	,		
	 design an exemplary product using CAD-,PDM- and/o 	or FEM-Systems with shared workload		
Personal Competence				
Social Competence	After completing the module, students are able to:			
	To develop a majork also and allocate made and a second		. 6	!
	To develop a project plan and allocate work appropr Present project results as a team for instance in a pro-		or group aiscu	issions
	 Present project results as a team for instance in a pr 	esentation		
Autonomy	Students are capable of:			
	 independently adapt to a CAE-Tool and complete a g 	iivon practical tack with it		
	Time permentity adapt to a CAL-1001 and complete a g	iven practical task with it		
Workload in Hours	Independent Study Time 96, Study Time in Lecture 84			
Credit points	6			
Course achievement	Compulsory Bonus Form Descripti	on		
	-	amprojekt inkl. Vortrag und Ausarbeitu	ıng	
	practical work			
Examination	Written exam			
Examination duration and	90			
scale				
Assignment for the	General Engineering Science (German program, 7 seme	ester): Specialisation Mechanical Eng	ineering, Foci	us Aircraft Systems
Following Curricula	Engineering: Compulsory			
	General Engineering Science (German program, 7 semest	er): Specialisation Mechanical Engine	ering, Focus Pi	rouuct Development
	and Production: Compulsory	r. Floctive Compulsor		
	Engineering Science: Specialisation Mechanical Engineering General Engineering Science (English program, 7 semester		na: Elective C	ompulsory
	Mechanical Engineering: Specialisation Product Developme		ilg. Elective Co	ompuisory
	Mechanical Engineering: Specialisation Product Developme Mechanical Engineering: Specialisation Aircraft Systems En	• •		
	Product Development, Materials and Production: Technical		Elective Comr	pulsory
		prementary course core studies.	ccave comp	,

Course L0271: CAE-Team Pro	ject
Тур	Project-/problem-based Learning
Hrs/wk	2
СР	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Prof. Dieter Krause
Language	DE
Cycle	SoSe
Content	 Practical Introduction in the used software systems (Creo, Windchill, Hyperworks) Team formation, allocation of tasks and generation of a project plan Collective creation of one product out of CAD models supported by FEM calculations and PDM system Manufacturing of selected parts using 3D printer Presentation of results Description Part of the module is a project based team orientated practical course using the PBL method. In this course, students learn the handling of modern CAD, PDM and FEM systems (Creo, Windchill and Hyperworks). After a short introduction in the applied software systems, students work in teams on a task during the semester. The aim is the development of one product out of several CAD parts models using a PDM system including FEM calculations of selected parts and 3D printing of parts. The developed product must be presented in a joint presentation.
Literature	-

Course L0269: Digital Product Development		
Тур	Lecture	
Hrs/wk	2	
СР	2	
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28	
Lecturer	Prof. Dieter Krause	
Language	DE	
Cycle	SoSe	
Content	 Introduction to Integrated Product Development 3D CAD -Systems and CAD interfaces Administration of part lists / PDM systems PDM in different industries Selection of CAD-/PDM Systems Simulation Construction methods Design for X 	
Literature	 Ehrlenspiel, K.: Integrierte Produktentwicklung, München, Carl Hanser Verlag Lee, K.: Principles of CAD / CAM / CAE Systems, Addison Wesles Schichtel, M.: Produktdatenmodellierung in der Praxis, München, Carl Hanser Verlag Anderl, R.: CAD Schnittstellen, München, Carl Hanser Verlag Spur, G., Krause, F.: Das virtuelle Produkt, München, Carl Hanser Verlag 	

Course I 0270: Dovelenment	of Lightweight Design Products
·	
	Lecture
Hrs/wk	2
СР	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Prof. Dieter Krause, Prof. Benedikt Kriegesmann
Language	DE
Cycle	SoSe
Content	Lightweight design materials Product development process for lightweight structures Dimensioning of lightweight structures
Literature	 Schürmann, H., "Konstruieren mit Faser-Kunststoff-Verbunden", Springer, Berlin, 2005. Klein, B., "Leichtbau-Konstruktion", Vieweg & Sohn, Braunschweig, 1989. 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. Wiedemann, J., "Leichtbau Band 1: Elemente", Springer, Berlin, Heidelberg, 1986.

Module M1901: Mater	rials Science Laboratory			
Courses				
Title		Тур	Hrs/wk	СР
Companion Lecture for Materials So	cience Laboratory (L1088)	Lecture	2	2
Material Science Laboratory (L1235	i)	Practical Course	4	4
Module Responsible	Prof. Kaline Pagnan Furlan			
Admission Requirements	None			
Recommended Previous	none			
Knowledge				
Educational Objectives	After taking part successfully, students have reache	ed the following learning results		
Professional Competence				
Knowledge	Students are able to give a summary of the tech	nnical details of experiments in the	area of materials so	ciences and illustrate
	respective relationships. They are capable of desc	ribing and communicating relevant រុ	roblems and questic	ons using appropriate
	technical language. They can explain the typical pro	ocess of solving practical problems an	d present related res	sults.
Chille	The short set of the second se	ladas sa saskadal asisasas ka kha sa		-ti1 Th
SKIIIS	The students can transfer their fundamental know	-		
	identify and overcome typical problems during the	realization of experiments in the cont	ext of material scienc	.es.
Personal Competence				
Social Competence	Students are able to cooperate in small groups in o	rder to conduct experiments in the co	ntext of materials sc	iences. They are able
	to effectively present and explain their results alone	e or in groups in front of a qualified au	dience.	
Autonomy	Students are capable of solving problems in the co	ntoyt of materials sciences, using pro	vided literature. The	v are able to fill gans
Autonomy	in as well as extent their knowledge using the litera	- ·		y are able to fill gaps
	in as well as extent their knowledge asing the intera	tare and other sources provided by a	ie supervisor.	
Workload in Hours	Independent Study Time 96, Study Time in Lecture	84		
Credit points	6			
Course achievement	None			
Examination	Subject theoretical and practical work			
Examination duration and	Reports on each one of the experiments and online	learning modules with integrated che	cking	
scale				
Assignment for the	General Engineering Science (German program, 7	semester): Specialisation Mechanical	Engineering, Focus I	Product Development
Following Curricula	and Production: Elective Compulsory			
	General Engineering Science (German program, 7 s	emester): Specialisation Advanced Ma	aterials: Compulsory	
	Engineering Science: Specialisation Advanced Mate	rials: Compulsory		
	Engineering Science: Specialisation Advanced Mate	rials: Compulsory		
	Engineering Science: Specialisation Mechanical Eng	ineering: Elective Compulsory		
	Mechanical Engineering: Specialisation Product Dev	elopment and Production: Compulsor	У	
	Mechanical Engineering: Specialisation Materials in	Engineering Sciences: Compulsory		
	Product Development, Materials and Production: Te	chnical Complementary Course Core	Studies: Elective Com	npulsory

Course L1088: Companion Le	ecture for Materials Science Laboratory
Тур	Lecture
Hrs/wk	2
СР	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Prof. Kaline Pagnan Furlan
Language	DE/EN
Cycle	WiSe
Content	 Introduction to the Materials Science Laboratory practical course and learning modules; Collection of data: source of errors and sample distribution; Error calculation; Report writing and presentation of results; Graph plotting using software(s).
Literature	1) W.D. Callister, Materials science and engineering: an introduction, Wiley 2000 https://katalog.tub.tuhh.de/Record/270018409 or https://katalog.tub.tuhh.de/Record/1696922097 (online link at 'Exemplare') 2) John R. Taylor, Fehleranalyse: eine Einführung in die Untersuchung von Unsicherheiten in physikalischen Messungen, 1. Aufl., VCH Verlag, 1988 https://katalog.tub.tuhh.de/Record/027422038 // An Introduction to Error Analysis: The Study of Uncertainties in Physical Measurements, 2d Edition, University Science Books, 1997 https://katalog.tub.tuhh.de/Record/024511676

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Course L1235: Material Science Laboratory		
Тур	Practical Course	
Hrs/wk	4	
СР	4	
Workload in Hours	Independent Study Time 64, Study Time in Lecture 56	
Lecturer	Prof. Kaline Pagnan Furlan, Prof. Bodo Fiedler, Prof. Gerold Schneider, Prof. Jörg Weißmüller, Prof. Patrick Huber	
Language	DE/EN	
Cycle	WiSe	
Content	5 laboratory experiments:	
	- Metals: Tensile test	
	- Plastics: Scanning electron microscopy on fracture surfaces of fiber reinforced plastics	
	- Plastics: Bending test - bending properties of carbon fiber reinforced plastics	
	- Ceramics: Ceramic synthesis - From raw material up to sintered product	
	- Ceramics: Mechanical testing - hardness and fracture toughness of ceramic materials	
Literature	1) Vorlesungsunterlagen Grundlagen der Werkstoffwissenschaft I & II	
	2) W.D. Callister, Materials science and engineering: an introduction, Wiley 2000 https://katalog.tub.tuhh.de/Record/270018409 or https://katalog.tub.tuhh.de/Record/1696922097 (online link at 'Exemplare')	

Modulo M0726: Brodi	ection Tochnology				
Module M0726: Produ	iction reciniology				
Courses					
Title		1	Тур	Hrs/wk	СР
Fundamentals of Machine Tools (LC	0689)	L	ecture	2	2
Fundamentals of Machine Tools (L1	.992)	F	Recitation Section (large)	1	1
Forming and Cutting Technology (L			ecture	2	2
Forming and Cutting Technology (L		F	Recitation Section (large)	1	1
	Prof. Jan Hendrik Dege				
Admission Requirements					
	without major course assessment				
Knowledge	internship recommended				
	Previous knowledge in mathematics, mecha	anics and electrical eng	ineering		
Educational Objectives	After taking part successfully, students have	e reached the following	learning results		
Professional Competence	Arter taking part successionly, students have	e reactied the following	rearring results		
•	Students are able to				
Knowledge	Students are able to				
	 explain the basics of chip formation a 	and mechanisms and m	odels of machining.		
	 explain methods and parameters for 	design and analysis of	metal forming, machining	processes and too	ols.
	 explain technical concepts of machin 	ne tool building and give	e an overview on trends in	the machine tool	industry.
	 explain types, constructions and fund 	ctions of CNC-machines	and give an overview on r	nulti-machine sys	tems.
	 explain equipment components. 				
Skills	Students are able to				
	 select tool geometry, cutting materia 	als, process parameter	s and appropriate measur	ina technique in	accordance with th
	requirements.	, p			
	estimate occurring forces and tempe	ratures during chip for	mation.		
	select appropriate machine tools for its select appropriate machine tools for its select appropriate machine tools.			d milling	
	assess the quality of a machine tools			g.	
Personal Competence					
Social Competence	Students are able to				
,					
	 develop solutions in a production env 	vironment with qualified	d personnel at technical lev	el and represent	decisions.
Autonomy	Students are able to				
ratonomy	Students are able to				
	 interpret independently cutting proce 	esses.			
	 create independently NC programs. 				
	select independently machine tools b		iate requirements.		
	assess own strengths and weaknesse	-			
	 assess their learning progress and de 	efine gaps to be improv	ed.		
	assess possible consequences of thei	ir actions.			
Workload in Hours	Independent Study Time 96, Study Time in	Lecture 84			
Credit points	6				
Course achievement	None				
Examination	Written exam				
Examination duration and scale	180 min				
	General Engineering Science (German prog	gram, 7 semester): Sne	cialisation Mechanical End	ineering, Focus P	roduct Developme
-	and Production: Compulsory	, , semester, spe		,zeg, 1 ocus 1	
. Jiloming Curricula	Mechanical Engineering: Specialisation Prod	fuct Development and	Production: Compulsory		
	Mechatronics: Specialisation Robot- and Ma	•			
	Product Development, Materials and Product	•		ias: Flactive Com	nulsory
	Troduct Development, Materials and Floud	caon. recrimear comple	mentary course core stud	ics. Liective Colli	paisory

Course L0689: Fundamentals	s of Machine Tools	
	Lecture	
Hrs/wk		
CP		
	Independent Study Time 32, Study Time in Lecture 28	
	Prof. Thorsten Schüppstuhl	
Language		
Cycle		
Content	Terminology and trends in machine tool building	
	CNC controls	
	NC programming and NC programming systems	
	Types, construction and function of CNC machines	
	Multi-machinesystems	
	Equipmentcomponents for machine tools	
	Assessment of machine tools	
Literature	Conrad, K.J	
	Taschenbuch der Werkzeugmaschinen	
	9783446406414	
	Fachbuchverlag 2006	
	Perović, Božina	
	Spanende Werkzeugmaschinen - Ausführungsformen und Vergleichstabellen	
	ISBN: 3540899529	
	Berlin [u.a.]: Springer, 2009	
	Weck, Manfred	
	Werkzeugmaschinen 1 - Maschinenarten und Anwendungsbereiche	
	ISBN: 9783540225041	
	Berlin [u.a.]: Springer, 2005	
	Weck, Manfred; Brecher, Christian	
	Werkzeugmaschinen 4 - Automatisierung von Maschinen und Anlagen	
	ISBN: 3540225072	
	Berlin [u.a.]: Springer, 2006	
	Weck, Manfred; Brecher, Christian	
	Werkzeugmaschinen 5 - Messtechnische Untersuchung und Beurteilung, dynamische Stabilität	
	ISBN: 3540225056	
	Berlin [u.a.]: Springer, 2006	

Course L1992: Fundamentals of Machine Tools	
Тур	Recitation Section (large)
Hrs/wk	1
СР	1
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14
Lecturer	Prof. Thorsten Schüppstuhl
Language	DE
Cycle	WiSe
Content	See interlocking course
Literature	See interlocking course

Course L0613: Forming and Cutting Technology		
Тур	Lecture	
Hrs/wk		
СР	2	
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28	
Lecturer	Prof. Jan Hendrik Dege	
Language	DE	
Cycle	WiSe	
Content	 Thermomechanical Principles and Models of Machining Chip Formation, Forces, Temperature and Tribology process Wear mechanisms and wear patterns Machinability by Cutting and Forming, Specific Problems of Light Weight Structures Cutting Material and Coatings Methods and Parameters for Analysis and Configuration of Forming and Cutting Processes and Tools 	
Literature	Lange, K.; Umformtechnik Grundlagen, 2. Auflage, Springer (2002) Tönshoff, H.; Spanen Grundlagen, 2. Auflage, Springer Verlag (2004) König, W., Klocke, F.; Fertigungsverfahren Bd. 4 <i>Massivumformung</i> , 4. Auflage, VDI-Verlag (1996) König, W., Klocke, F.; Fertigungsverfahren Bd. 5 <i>Blechbearbeitung</i> , 3. Auflage, VDI-Verlag (1995) Klocke, F., König, W.; Fertigungsverfahren <i>Schleifen, Honen, Läppen</i> , 4. Auflage, Springer Verlag (2005) König, W., Klocke, F.: Fertigungsverfahren <i>Drehen, Fräsen, Bohren</i> , 7. Auflage, Springer Verlag (2002)	

Course L0614: Forming and Cutting Technology	
Тур	Recitation Section (large)
Hrs/wk	1
СР	1
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14
Lecturer	Prof. Jan Hendrik Dege
Language	DE
Cycle	WiSe
Content	See interlocking course
Literature	See interlocking course

Thesis

Module M-002: Master 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 specialize	
	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 question	
	• To apply knowledge they have acquired and methods they have learnt in the course of their studies to complex and/o	
	incompletely defined problems in a solution-oriented way.	
	To develop new scientific findings in their subject area and subject them to a critical assessment.	
Parsonal Compatons		
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:	
raconomy	Stadents are able.	
	To structure a project of their own in work packages and to work them off accordingly.	
	To work their way in depth into a largely unknown subject and to access the information required for them to do so.	
	To apply the techniques of scientific work comprehensively in research of their own.	
Workload in Hours	Independent Study Time 900, Study Time in Lecture 0	
Credit points	30	
Course achievement	None	
Examination	Thesis	
Examination duration and	According to General Regulations	
scale		
Assignment for the	Civil Engineering: Thesis: Compulsory	
Following Curricula		
	Chemical and Bioprocess Engineering: Thesis: Compulsory	
	Computer Science: Thesis: Compulsory	
	Data 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	
	Aeronautics: Thesis: Compulsory Materials Science and Engineering: Thesis: Compulsory	
	Materials Science: Thesis: Compulsory	
	Mechanical Engineering and Management: Thesis: Compulsory	
	Mechatronics: Thesis: Compulsory	
	Biomedical Engineering: Thesis: Compulsory	

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

Production"	
	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