

Module Manual

Master of Science (M.Sc.)

Product Development, Materials and Production

Cohort: Winter Term 2022

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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)

	 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		Тур	Hrs/wk	СР
Nonlinear Structural Analysis (L027	77)	Lecture	3	4
Nonlinear Structural Analysis (L027	79)	Recitation Section (small)	1	2
Module Responsible	Prof. Alexander Düster			
Admission Requirements	None			
Recommended Previous	Knowledge of partial differential equations is re	ecommended.		
Knowledge				
Educational Objectives	After taking part successfully, students have re	eached the following learning results		
Professional Competence				
Knowledge	Students are able to			
	+ give an overview of the different nonlinear p	henomena in structural mechanics.		
	+ explain the mechanical background of nonlin	near phenomena in structural mechanics.		
	+ to specify problems of nonlinear structural	analysis, to identify them in a given situation	and to explain the	eir mathematical and
	mechanical background.			
Skills	Students are able to			
Skills	+ model nonlinear structural problems.			
	+ select for a given nonlinear structural proble	em a suitable computational procedure.		
	+ apply finite element procedures for nonlinear			
	+ critically verify and judge results of nonlinea	•		
	+ to transfer their knowledge of nonlinear solu			
Personal Competence				
Social Competence	Students are able to			
	+ solve problems in heterogeneous groups.	Al- are		
	+ present and discuss their results in front of o			
	+ give and accept professional constructive cr	iucism.		
Δutonomy	Students are able to			
Autonomy	+ assess their knowledge by means of exercis	es and F-I earning		
	+ acquaint themselves with the necessary kno			
	+ to transform the acquired knowledge to sim			
	·	·		
Workload in Hours	Independent Study Time 124, Study Time in Le	ecture 56		
Credit points				
Course achievement				
Examination	Written exam			
Examination duration and				
scale				
Assignment for the	Civil Engineering: Specialisation Structural Eng	gineering: Elective Compulsory		
Following Curricula		• •	npulsory	
	Materials Science: Specialisation Modeling: Ele		,,	
	Mechatronics: Specialisation System Design: E	•		
	Product Development, Materials and Productio			
	Naval Architecture and Ocean Engineering: Co	• •		
	Ship and Offshore Technology: Core Qualificati			
	Theoretical Mechanical Engineering: Specialisa		sory	

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, Prof. Gerhard Schmitz	
Language	DE	
Cycle	WiSe	
Content	1. Introduction	
	 Fundamentals of Thermal Engineering 2.1 Heat Conduction 2.2 Convection 2.3 Radiation 2.4 Heat transition 2.5 Combustion parameters 2.6 Electrical heating 2.7 Water vapor transport Heating Systems 3.1 Warm water heating systems 3.2 Warm water supply 3.3 piping calculation 3.4 boilers, heat pumps, solar collectors 3.5 Air heating systems 3.6 radiative heating systems Thermal traetment systems 4.1 Industrial furnaces 4.2 Melting furnaces 4.3 Drying plants 4.4 Emission control 4.5 Chimney calculation 4.6 Energy measuring Laws and standards 5.1 Buildings 5.2 Industrial plants 	
Literature	 Schmitz, G.: Klimaanlagen, Skript zur Vorlesung VDI Wärmeatlas, 11. Auflage, Springer Verlag, Düsseldorf 2013 Herwig, H.; Moschallski, A.: Wärmeübertragung, Vieweg+Teubner Verlag, Wiesbaden 2009 Recknagel, H.; Sprenger, E.; Schrammek, ER.: Taschenbuch für Heizung- und Klimatechnik 2013/2014, 76. Auflage, Deutscher Industrieverlag, 2013 	

Course L0024: Thermal Engergy Systems	
Тур	Recitation Section (large)
Hrs/wk	1
СР	1
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14
Lecturer	Prof. Arne Speerforck
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 Theory	
Тур	Integrated Lecture
Hrs/wk	4
СР	6
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56
Lecturer	Prof. Norbert Hoffmann
Language	DE/EN
Cycle	WiSe
Content	Linear and Nonlinear Single and Multiple Degree of Freedom 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	e Elements Methods	
Courses		
	To the first of th	
Title Finite Element Methods (L0291)	Typ Hrs/wk CP Lecture 2 3	
Finite Element Methods (L0804)	Recitation Section (large) 2 3	
Module Responsible		
Admission Requirements		
Recommended Previous		
Knowledge		
Kilowieuge	Platienades 1, 11, 111 (iii particular differential equations)	
Educational Objectives	s After taking part successfully, students have reached the following learning results	
Professional Competence	e e	
Knowledge	e 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.	
Skille	(s) The students are capable to handle engineering problems by formulating suitable finite elements, assembling the corre	enondina
Skills	system matrices, and solving the resulting system of equations.	sponding
	system matrices, and solving the resulting system of equations.	
Personal Competence	a e	
Social Competence	e 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
Autonomy	Problems can be identified and the results are critically scrutinized.	routines.
	, , , , , , , , , , , , , , , , , , , ,	
Workload in Hours		
Credit points		
Course achievement	t Compulsory Bonus Form Description No 20 % Midterm	
Examination		
Examination duration and		
examination duration and scale		
Assignment for the		
•	a Energy Systems: Core Qualification: Elective Compulsory	
. cc.ming carricula	Aircraft Systems Engineering: Core Qualification: Elective Compulsory	
	International Management and Engineering: Specialisation II. Mechatronics: Elective Compulsory	
	International Management and Engineering: Specialisation II. Product Development and Production: Elective Compulsory	
	Mechatronics: Core Qualification: Compulsory	
	Biomedical Engineering: Specialisation Implants and Endoprostheses: Compulsory	
	Biomedical Engineering: Specialisation Management and Business Administration: Elective Compulsory	
	Biomedical Engineering: Specialisation Medical Technology and Control Theory: Elective Compulsory	
	Biomedical Engineering: Specialisation Artificial Organs and Regenerative Medicine: Elective Compulsory	
	Product Development, Materials and Production: Core Qualification: Compulsory	
	Technomathematics: Specialisation III. Engineering Science: Elective Compulsory	
	Theoretical Mechanical Engineering: Core Qualification: 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. Otto von Estorff
Language	EN
Cycle	WiSe
Content	- General overview on modern engineering
	- Displacement method
	- Hybrid formulation
	- Isoparametric elements
	- Numerical integration
	- Solving systems of equations (statics, dynamics)
	- Eigenvalue problems
	- Non-linear systems
	- Applications
	- Programming of elements (Matlab, hands-on sessions)
	- Applications
Literature	Bathe, KJ. (2000): Finite-Elemente-Methoden. Springer Verlag, Berlin

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

Module M0846: Contr	rol Systems Theory and Design			
Product Proof of Contr	or systems rincory and besign			
Courses				
Title	(19656)	Тур	Hrs/wk	СР
Control Systems Theory and Desig Control Systems Theory and Desig		Lecture Recitation Section (small)	2	4
Module Responsible				
Admission Requirements				
	Introduction to Control Systems			
Knowledge				
Educational Objectives	After taking part successfully, students have rea	ched the following learning results		
Professional Competence				
Knowledge		c systems are represented as state space m	odels: they can	interpret the system
	response to initial states or external excit		,	
	They can explain the system properties	controllability and observability, and their rel	ationship to stat	e feedback and state
	estimation, respectively			
	They can explain the significance of a min			
	They can extend all of the above to multi-	edback and how it can be used to achieve tra	cking and disturi	bance rejection
	They can explain the z-transform and its	• •		
		transfer function models of discrete-time sys	tems	
	They can explain the experimental identifier	fication of ARX models of dynamic systems, a	nd how the ident	ification problem can
	be solved by solving a normal equation			
	They can explain how a state space mode	el can be constructed from a discrete-time im	pulse response	
Skills		models into state space models and vice vers	ia.	
	They can assess controllability and obser			
	They can design LQG controllers for multi			
	They can carry out a controller design b	oth in continuous-time and discrete-time dom	nain, and decide	which is appropriate
	for a given sampling rate			
		s and state space models of dynamic systems standard software tools (Matlab Control To		
	Simulink)	y standard software tools (Matlab Control to	olbox, System ic	ientineation looibox,
Personal Competence				
•	Students can work in small groups on specific p	oblems to arrive at joint solutions.		
,		•		
Autonomy	Students can obtain information from provided	I sources (lecture notes, software document	ation, experimer	nt guides) and use it
	when solving given problems.			
	They can assess their knowledge in weekly on-li	ne tests and thereby control their learning pr	ogress.	
Workload in Hours	Independent Study Time 124, Study Time in Lec	ture 56		
Credit points	6			
Course achievement	None			
Examination	Written exam			
Examination duration and	120 min			
scale				
-	Electrical Engineering: Core Qualification: Comp	•		
Following Curricula	Energy Systems: Core Qualification: Elective Cor Aircraft Systems Engineering: Core Qualification	•		
	Computer Science in Engineering: Specialisation	• •		
	International Management and Engineering: Specialisation	, ,		
	International Management and Engineering: Spe	ecialisation II. Mechatronics: Elective Compuls	ory	
	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 Medical Biomedical Engineering: Specialisation Manager		mpulsory	
	Product Development, Materials and Production			
	Theoretical Mechanical Engineering: Core Qualif	ication: Compulsory		

Course L0656: Control System	ms Theory and Design
Тур	Lecture
Hrs/wk	2
СР	4
Workload in Hours	Independent Study Time 92, Study Time in Lecture 28
Lecturer	Prof. Herbert Werner
Language	EN
Cycle	WiSe
Content	State space methods (single-input single-output)
	Chaba are an and also and horse for for able on a shake for all and
	State space models and transfer functions, state feedback
	Coordinate basis, similarity transformations
	Solutions of state equations, matrix exponentials, Caley-Hamilton Theorem
	Controllability and pole placement
	State estimation, observability, Kalman decomposition
	Observer-based state feedback control, reference tracking
	Transmission zeros
	Optimal pole placement, symmetric root locus
	Multi-input multi-output systems
	 Transfer function matrices, state space models of multivariable systems, Gilbert realization
	Poles and zeros of multivariable systems, minimal realization
	Closed-loop stability
	Pole placement for multivariable systems, LQR design, Kalman filter
	Digital Control
	Discrete-time systems: difference equations and z-transform
	Discrete-time state space models, sampled data systems, poles and zeros
	Frequency response of sampled data systems, choice of sampling rate
	System identification and model order reduction
	Least squares estimation, ARX models, persistent excitation
	Identification of state space models, subspace identification
	Balanced realization and model order reduction
	Case study
	Modelling and multivariable control of a process evaporator using Matlab and Simulink
	Software tools
	Matlab/Simulink
Literature	
	Werner, H., Lecture Notes "Control Systems Theory and Design"
	T. Kailath "Linear Systems", Prentice Hall, 1980
	K.J. Astrom, B. Wittenmark "Computer Controlled Systems" Prentice Hall, 1997
	L. Ljung "System Identification - Theory for the User", Prentice Hall, 1999

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

Module M1173: Appli	ed Statistics			
Courses				
Title	Ту	у р	Hrs/wk	СР
Applied Statistics (L1584)	Lec	cture	2	3
Applied Statistics (L1586)		oject-/problem-based Learning	2	2
Applied Statistics (L1585)		citation 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 I	earning results		
Professional Competence				
Knowledge	Students can explain the statistical methods and the conditions of tl	heir 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 Management: Elective Compulsory			
Following Curricula	Mechatronics: Specialisation System Design: Elective Compulsory			
	Mechatronics: Specialisation Intelligent Systems and Robotics: Elect	ive Compulsory		
	Biomedical Engineering: Core Qualification: Compulsory			
	Product Development, Materials and Production: Core Qualification:	Elective Compulsory		
	Theoretical Mechanical Engineering: Specialisation Bio- and Medical	Technology: Elective Compul	sory	

Course L1584: Applied Statis	tire
Hrs/wk	
CP	
	Independent Study Time 62, Study Time in Lecture 28
	Prof. Michael Morlock
Language	DE/EN
Cycle	WiSe
Content	The goal is to introduce students to the basic statistical methods and their application to simple problems. The topics include:
	Chi square test
	Simple regression and correlation
	Multiple regression and correlation
	One way analysis of variance
	Two way analysis of variance
	Discriminant analysis
	Analysis of categorial data
	Chossing the appropriate statistical method
	Determining critical sample sizes
Literature	Applied Regression Analysis and Multivariable Methods, 3rd Edition, David G. Kleinbaum Emory University, Lawrence L. Kupper
	University of North Carolina at Chapel Hill, Keith E. Muller University of North Carolina at Chapel Hill, Azhar Nizam Emory University
	Published by Duxbury Press, CB © 1998, ISBN/ISSN: 0-534-20910-6

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

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

Courses				
Title		Тур	Hrs/wk	СР
Continuum Mechanics (L1533) Continuum Mechanics Exercise (L1	524)	Lecture Recitation Section (small)	2	3
Module Responsible	<u> </u>	Nectration Section (small)	2	
Admission Requirements	None			
Recommended Previous		Engineering Mechanics Land Engineeri	ng Mochanics II	at TUBE (forces ar
Knowledge	3 . 3.			
3	e.g., in the modules Mathematics I and Mathematics II		3,,,,	
Educational Objectives	After taking part successfully, students have reached t	he following learning results		
Professional Competence				
Knowledge	In this module, students learn the fundamental cond	cepts of nonlinear continuum mechan	ics. This theory	enables students
	describe arbitrary deformations of continuous bodies (solid, liquid or gaseous) under arbitrar	y loads. The mod	dule is a continuation
	of the basic module Engineering Mechanics II (elastos		opic, linear-elast	ic material behavio
	small deformations, simple geometries) of which are su	uccessively eliminated.		
	First, the students learn the necessary fundamentals o	f tensor calculus. Based on this, the de	scription of the d	leformations / strair
	of arbitrarily deformable bodies is dealt with. The stud	ents learn the mathematical formalism	for characterizi	ng the stress state
	a body and for formulating the balance equations for	mass, momentum, energy and entrop	y in various for	ms. Furthermore, th
	students know which constitutive assumptions have to	be made for modeling the material bel	navior of a mech	anical body.
Skills	The students can set up balance laws and apply basic	cs of deformation theory to specific as	pects, both in a	pplied contexts as
	research contexts.			
Personal Competence				
Social Competence	The students are able to develop solutions also for cor	mplex problems of solid mechanics to	present them to	specialists in writte
Social Competence	form and to develop ideas further.	nprex problems of solid incellumes, to	present them to	Specialists III Wiles
	·			
Autonomy	The students are able to assess their own strengths ar	nd weaknesses. They can independentl	y and on their o	wn identify and solv
	problems in the area of continuum mechanics and acqu	uire the knowledge required to this end	l.	
Workland in Hours	Independent Study Time 124, Study Time in Lecture 56	=		
Credit points		,		
Course achievement				
Examination				
Examination duration and				
scale				
Assignment for the	Materials Science: Specialisation Modeling: Elective Co	mpulsory		
Following Curricula	·	•		
	Mechatronics: Technical Complementary Course: Electi			
	Biomedical Engineering: Specialisation Artificial Organs	and Regenerative Medicine: Elective C	Compulsory	
	Biomedical Engineering: Specialisation Implants and Er	ndoprostheses: Elective Compulsory		
	Biomedical Engineering: Specialisation Medical Techno		-	
	Biomedical Engineering: Specialisation Management ar		mpulsory	
	Product Development, Materials and Production: Core	· · ·		
	Theoretical Mechanical Engineering: Core Qualification	: Elective Compulsory		

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

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: Model	lling and Optimization in Dynamic	5		
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, IIIMechanics I, II, III, IVSimulation of dynamical Systems			
Educational Objectives	After taking part successfully, students have reach	ned the following learning results		
Professional Competence				
-	Students demonstrate basic knowledge and und multibody systems and methods for optimizing dy			x rigid and flexible
Skills	Students are able			
	+ to think holistically			
	+ to independently, securly and critically analyz systems	e and optimize basic problems of	the dynamics of rigid an	d flexible multibody
	+ to describe dynamics problems mathematically			
	+ to optimize dynamics problems			
Personal Competence				
Social Competence	Students are able to			
	+ solve problems in heterogeneous groups and to	document the corresponding result	s.	
Autonomy	Students are able to			
	+ assess their knowledge by means of exercises.			
	+ acquaint themselves with the necessary knowle	dge to solve research oriented task	S.	
Workload in Hours	Independent Study Time 124, Study Time in Lectu	re 56		
	6			
Course achievement				
Examination	Oral exam			
Examination duration and scale	30 min			
Assignment for the	Energy Systems: Core Qualification: Elective Comp	pulsory		
_	Aircraft Systems Engineering: Core Qualification: E	•		
_	Mechatronics: Specialisation System Design: Elect			
	Mechatronics: Specialisation Intelligent Systems a			
	Product Development, Materials and Production: C	ore Qualification: Elective Compulso	ory	

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	
litle .	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 a
Knowledge	moments, stress, linear strain, free-body principle, linear-elastic constitutive laws, strain energy); basics of mathematics as taugl
	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	
Knowledge	The students understand the theoretical foundations of anisotropic elasticity, viscoelasticity and elasto-plasticity in the realm
	three-dimensional (linear) continuum mechanics. In the area of anisotropic elasticity, they know the concept of material symmetric symmetric elasticity.
	and its application in orthotropic, transversely isotropic and isotropic materials. They understand the concept of stiffness a
	compliance and how both can be characterized by appropriate parameters. Moreover, the students understand viscoelasticity bo
	in the time and frequency domain using the concepts of relaxation modulus, creep modulus, storage modulus and loss modulus.
	the area of elasto-plasticity, the students know the concept of yield stress or (in higher dimensions) yield surface and of plas
	potential. Additionally, the know the concepts of ideal plasticity, hardening and weakening. Moreover, they know von-Mis
	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
	This holds in particular for the area fo anisotropically elastic, viscoelastic and elasto-plastic material behavior. In these areas, t
	students can independently develop models for complex material behavior. To this end, they have the ability to read an
	understand relevant literature and identify the relevant results reported there. Moreover, they can implement models which th
	developed or found in the literature in computational software (e.g., based on the finite element method) and use it for practic
	calculations.
Personal Competence	
Social Competence	
	to discuss challening problems of materials modeling with experts using the proper terminoloy, to identify and ask critic
	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
	more general abstract framework and to predict their further evolution. Moreover, the students understand the advantages by
	also limitations of mathematical models and can thus independently decide when and to which extent they make sense as a ba
	for decisions.
Workload in Hours	Independent Study Time 124. Study Time in Lecture EG
Credit points	Independent Study Time 124, Study Time in Lecture 56
Course achievement	
Examination	
Examination duration and	
scale	OU THIN
Assignment for the	Materials Science: Specialisation Modeling: Florting Compulsory
Following Curricula	
ronowing curricula	Biomedical Engineering and Management: Specialisation Materials: Elective Compulsory Biomedical Engineering: Specialisation Artificial Organs and Regenerative Medicine: Elective Compulsory
	Biomedical Engineering: Specialisation Implants and Endoprostheses: Elective Compulsory
	Biomedical Engineering: Specialisation Implants and Endoprostneses: Elective Compulsory Biomedical Engineering: Specialisation Medical Technology and Control Theory: Elective Compulsory
	Biomedical Engineering: Specialisation Medical Technology and Control Theory: Elective Compulsory Biomedical Engineering: Specialisation Management and Business Administration: Elective Compulsory
	Product Development, Materials and Production: Core Qualification: Elective Compulsory
	Theoretical Mechanical Engineering: Specialisation Materials Science: Elective Compulsory
	Theoretical Mechanical Engineering: Specialisation Materials Science: Elective Compulsory Theoretical Mechanical Engineering: Specialisation Simulation Technology: Elective Compulsory
	Theoretical Engineering, Specialisation simulation recliniology, Elective Computatory

Course L1535: Material Mode	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				

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

Module M0604: High-	Order FEM					
Courses						
Title				Тур	Hrs/wk	СР
High-Order FEM (L0280)				Lecture	3	4
High-Order FEM (L0281)				Recitation Section (large)	1	2
Module Responsible	Prof. Alexander Düste	r				
Admission Requirements	None					
Recommended Previous	Knowledge of partial of	lifferential equations	is recommended.			
Knowledge						
Educational Objectives	After taking part succ	essfully, students hav	e reached the following	ng learning results		
Professional Competence						
Knowledge	Students are able to					
	+ give an overview of	the different (h, p, h)	p) finite element proce	edures.		
	+ explain high-order f					
			cedures, to identify t	hem in a given situation a	nd to explain their	mathematical and
	mechanical backgroui	nd.				
Skills	Students are able to					
	+ apply high-order fin	ite elements to probl	ems of structural med	hanics.		
	+ select for a given p	oblem of structural n	nechanics a suitable f	inite element procedure.		
	+ critically judge resu	Its of high-order finite	e elements.			
	+ transfer their knowl	edge of high-order fir	nite elements to new p	problems.		
Personal Competence						
	Students are able to					
,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,	+ solve problems in h	eterogeneous groups				
	·	+ present and discuss their results in front of others.				
	+ give and accept professional constructive criticism.					
		- 3				
Autonomy	Students are able to					
Autonomy	+ assess their knowle	dge by means of eye	rcises and F-I earning			
				esearch oriented tasks.		
	+ to transform the ac	-	-	escaren onenea tasks.		
		,				
Wantland in Harre	Indonesiant Children	no 124 Chudu Timo i	n Lastura EG			
Credit points	Independent Study Til	ne 124, Study Time I	II Lecture 36			
Course achievement	Compulsory Bonus	Form	Description			
Course achievement	No 10 %	Presentation	Forschendes	Lernen		
Examination	Written exam					
Examination duration and	120 min					
scale						
Assignment for the	Energy Systems: Core	Qualification: Electiv	e Compulsory			
Following Curricula	International Manager	nent and Engineering	g: Specialisation II. Pro	oduct Development and Prod	luction: Elective Co	mpulsory
	Materials Science: Spe	ecialisation Modeling:	Elective Compulsory			
	Mechanical Engineering	ng and Management:	Specialisation Produc	t Development and Product	on: Elective Compu	ilsory
	Mechatronics: Technic	al Complementary C	ourse: Elective Compu	ulsory		
	Product Development	Materials and Produ	ction: Core Qualificati	on: Elective Compulsory		
	Naval Architecture an	d Ocean Engineering:	Core Qualification: El	lective Compulsory		
	Technomathematics:					
	Theoretical Mechanica	l Engineering: Core C	Qualification: Elective	Compulsory		

Course L0280: High-Order FEM		
Тур	Lecture	
Hrs/wk	3	
СР	4	
Workload in Hours	Independent Study Time 78, Study Time in Lecture 42	
Lecturer	Prof. Alexander Düster	
Language	EN	
Cycle	SoSe	
Content	1. Introduction	
	2. Motivation	
	3. Hierarchic shape functions	
	4. Mapping functions	
	5. Computation of element matrices, assembly, constraint enforcement and solution	
	6. Convergence characteristics	
	7. Mechanical models and finite elements for thin-walled structures	
	8. Computation of thin-walled structures	
	9. Error estimation and hp-adaptivity	
	10. High-order fictitious domain methods	
Literature	[1] Alexander Düster, High-Order FEM, Lecture Notes, Technische Universität Hamburg-Harburg, 164 pages, 2014	
	[2] Barna Szabo, Ivo Babuska, Introduction to Finite Element Analysis – Formulation, Verification and Validation, John Wiley & Sons,	
	2011	

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

Module M0805: Techn	ical Acoustics I (Acoustic Waves, Noi	se Protection, Psycho Aco	ustics)	
Courses				
Title		Тур	Hrs/wk	СР
·	res, Noise Protection, Psycho Acoustics) (L0516)	Lecture	2	3
	res, Noise Protection, Psycho Acoustics) (L0518)	Recitation Section (large)	2	3
Module Responsible				
Admission Requirements				
	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 t	he following learning results		
Professional Competence				
Knowledge	The students possess an in-depth knowledge in acous	stics regarding acoustic waves, noise	protection, and p	sycho acoustics and
	are able to give an overview of the corresponding theo	retical and methodical basis.		
Skills	The students are canable to handle engineering	problems in acquistics by theory-ba	ased application	of the demanding
Skins	The students are capable to handle engineering problems in acoustics by theory-based application of the dem methodologies and measurement procedures treated within the module.			or are demanding
	,			
Personal Competence				
Social Competence	Students can work in small groups on specific problems	s to arrive at joint solutions.		
Autonomy	The students are able to independently solve challen	ging acoustical problems in the areas	treated within t	the module. Possible
	conflicting issues and limitations can be identified and	the results are critically scrutinized.		
	Independent Study Time 124, Study Time in Lecture 56			
Credit points				
Course achievement				
Examination				
Examination duration and	90 min			
scale	Form Contains Complete the Floring Complete			
-	Energy Systems: Core Qualification: Elective Compulso Aircraft Systems Engineering: Core Qualification: Electi			
rollowing curricula	International Management and Engineering: Specialisa	• •	oulsory	
	Mechatronics: Specialisation System Design: Elective C	•	, a.301 y	
	Product Development, Materials and Production: Core (
	Technomathematics: Specialisation III. Engineering Science	• •		
	Theoretical Mechanical Engineering: Specialisation Production		ctive Compulsory	
	Theoretical Mechanical Engineering: Specialisation Sim	ulation Technology: Elective Compulso	ry	
		· · · · · · · · · · · · · · · · · · ·		

Course L0516: Technical Aco	ustics I (Acoustic Waves, Noise Protection, Psycho Acoustics)
	Lecture
Hrs/wk	
СР	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Prof. Benedikt Kriegesmann, DrIng. Sören Keuchel
Language	EN
Cycle	SoSe
Content	- Introduction and Motivation
	- Acoustic quantities
	- Acoustic waves
	- Sound sources, sound radiation
	- Sound engergy and intensity
	- Sound propagation
	- Signal processing
	- Psycho acoustics
	- Noise
	- Measurements in acoustics
1144 4	Cramary L. Haeld M. (1006). Käynavashall Chrimaer Varlay, Davlin
Literature	Cremer, L.; Heckl, M. (1996): Körperschall. Springer Verlag, Berlin
	Veit, I. (1988): Technische Akustik. Vogel-Buchverlag, Würzburg
	Veit, I. (1988): Flüssigkeitsschall. Vogel-Buchverlag, Würzburg

Course L0518: Technical Aco	ourse L0518: Technical Acoustics I (Acoustic Waves, Noise Protection, Psycho Acoustics)	
Тур	Recitation Section (large)	
Hrs/wk	2	
СР	3	
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28	
Lecturer	Prof. Benedikt Kriegesmann, DrIng. Sören Keuchel	
Language	EN	
Cycle	SoSe	
Content	See interlocking course	
Literature	See interlocking course	

Module M0807: Bound	dary Element Methods			
Courses				
			Una feele	
Title Boundary Element Methods (L0523	1	Typ Lecture	Hrs/wk 2	CP 3
Boundary Element Methods (L0524		Recitation Section (large)	2	3
Module Responsible		Recitation Section (large)		3
Admission Requirements	None			
Recommended Previous	Mechanics I (Statics, Mechanics of Materials) and M	lechanics II (Hydrostatics Kinematics Dy	namics)	
Knowledge			narries)	
	Tractionates I, II, III particular affective equal			
Educational Objectives	After taking part successfully, students have reach	ed the following learning results		
Professional Competence				
Knowledge	The students possess an in-depth knowledge rega	ording the derivation of the boundary ele	ment method and	are able to give an
	overview of the theoretical and methodical basis of	tile metiod.		
Skills	The students are capable to handle engineeri corresponding system matrices, and solving the res	- '	boundary elemen	ts, assembling the
Personal Competence Social Competence Autonomy	Students can work in small groups on specific prob The students are able to independently solve chal Problems can be identified and the results are critic	llenging computational problems and de	velop own boundai	ry element routines.
Workload in Hours	Independent Study Time 124, Study Time in Lectur	e 56		
Credit points	6			
Course achievement	Compulsory Bonus Form	Description		
	No 20 % Midterm			
Examination duration and	90 min			
scale				
Assignment for the	Civil Engineering: Specialisation Structural Enginee			
Following Curricula	Civil Engineering: Specialisation Geotechnical Engir			
	Civil Engineering: Specialisation Coastal Engineerin			
	Energy Systems: Core Qualification: Elective Comp	•		
	Mechanical Engineering and Management: Speciali	·	on: Elective Comp	ulsory
	Mechatronics: Specialisation System Design: Electiv	• •		
	Product Development, Materials and Production: Co			
	Technomathematics: Specialisation III. Engineering	· ·		
	Theoretical Mechanical Engineering: Specialisation	Simulation Technology: Elective Compuls	ory	

Typ Lecture Hrs/wk 2 CP 3 Workload in Hours Independent Study Time 62, Study Time in Lecture 28 Lecturer Prof. Otto von Estorff Language EN Cycle SoSe Content - Boundary value problems - Integral equations - Fundamental Solutions - Element formulations - Numerical integration - Solving systems of equations (statics, dynamics) - Special BEM formulations - Coupling of FEM and BEM - Hands-on Sessions (programming of BE routines)	ourse L0523: Boundary Eler	ment Methods
Workload in Hours Independent Study Time 62, Study Time in Lecture 28 Lecturer Prof. Otto von Estorff Language EN Cycle SoSe Content - Boundary value problems - Integral equations - Fundamental Solutions - Element formulations - Numerical integration - Solving systems of equations (statics, dynamics) - Special BEM formulations - Coupling of FEM and BEM - Hands-on Sessions (programming of BE routines)	Тур	Lecture
Workload in Hours Independent Study Time 62, Study Time in Lecture 28 Lecturer Prof. Otto von Estorff Language EN Cycle SoSe Content - Boundary value problems - Integral equations - Fundamental Solutions - Element formulations - Numerical integration - Solving systems of equations (statics, dynamics) - Special BEM formulations - Coupling of FEM and BEM - Hands-on Sessions (programming of BE routines)	Hrs/wk	2
Lecturer Prof. Otto von Estorff Language EN Cycle SoSe Content - Boundary value problems - Integral equations - Fundamental Solutions - Element formulations - Numerical integration - Solving systems of equations (statics, dynamics) - Special BEM formulations - Coupling of FEM and BEM - Hands-on Sessions (programming of BE routines)	СР	3
Language EN Cycle SoSe Content - Boundary value problems - Integral equations - Fundamental Solutions - Element formulations - Numerical integration - Solving systems of equations (statics, dynamics) - Special BEM formulations - Coupling of FEM and BEM - Hands-on Sessions (programming of BE routines)	Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Cycle SoSe Content Boundary value problems Integral equations Fundamental Solutions Element formulations Numerical integration Solving systems of equations (statics, dynamics) Special BEM formulations Coupling of FEM and BEM Hands-on Sessions (programming of BE routines)	Lecturer	Prof. Otto von Estorff
Content - Boundary value problems - Integral equations - Fundamental Solutions - Element formulations - Numerical integration - Solving systems of equations (statics, dynamics) - Special BEM formulations - Coupling of FEM and BEM - Hands-on Sessions (programming of BE routines)	Language	EN
- Integral equations - Fundamental Solutions - Element formulations - Numerical integration - Solving systems of equations (statics, dynamics) - Special BEM formulations - Coupling of FEM and BEM - Hands-on Sessions (programming of BE routines)	Cycle	SoSe
- Fundamental Solutions - Element formulations - Numerical integration - Solving systems of equations (statics, dynamics) - Special BEM formulations - Coupling of FEM and BEM - Hands-on Sessions (programming of BE routines)	Content	- Boundary value problems
 Element formulations Numerical integration Solving systems of equations (statics, dynamics) Special BEM formulations Coupling of FEM and BEM Hands-on Sessions (programming of BE routines) 		- Integral equations
 Numerical integration Solving systems of equations (statics, dynamics) Special BEM formulations Coupling of FEM and BEM Hands-on Sessions (programming of BE routines) 		- Fundamental Solutions
- Solving systems of equations (statics, dynamics) - Special BEM formulations - Coupling of FEM and BEM - Hands-on Sessions (programming of BE routines)		- Element formulations
- Special BEM formulations - Coupling of FEM and BEM - Hands-on Sessions (programming of BE routines)		- Numerical integration
- Coupling of FEM and BEM - Hands-on Sessions (programming of BE routines)		- Solving systems of equations (statics, dynamics)
- Hands-on Sessions (programming of BE routines)		- Special BEM formulations
		- Coupling of FEM and BEM
		- Hands-on Sessions (programming of BE routines)
- Applications		- Applications
Literature Gaul, L.; Fiedler, Ch. (1997): Methode der Randelemente in Statik und Dynamik. Vieweg, Braunschweig, Wiesbaden	Literature	Gaul, L.; Fiedler, Ch. (1997): Methode der Randelemente in Statik und Dynamik. Vieweg, Braunschweig, Wiesbaden
Bathe, KJ. (2000): Finite-Elemente-Methoden. Springer Verlag, Berlin		Bathe, KJ. (2000): Finite-Elemente-Methoden. Springer Verlag, Berlin

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

	ear Dynamics			
Courses				
Title		Тур	Hrs/wk	СР
Nonlinear Dynamics (L0702)		Integrated Lecture	4	6
Module Responsible	Prof. Norbert Hoffmann			
Admission Requirements	None			
Recommended Previous				
Knowledge	Calculus			
	Linear Algebra Trainagring Machanian			
	Engineering Mechanics			
Educational Objectives A	After taking part successfully, students have reached th	e following learning results		
Professional Competence				
Knowledge	Charles have a ship has saffeed a state of house and a		to develop and make	
	Students are able to reflect existing terms and consents.	ncepts in Nonlinear Dynamics and	to develop and rese	arch new terms and
	concepts.Students are able to denote and expand methods	of modeling and analysis for nonli	near dynamical syste	ams
	Students are usie to denote and expand methods	of modeling and analysis for norm	near dynamical syst	21113.
Skills	Students are able to apply existing methods and	procesures of Naplinear Dynamics		
	Students are able to apply existing methods and Students are able to develop novel methods and	•		
	s because are able to develop novel methods and	procedures for monimical dynamica	Systems.	
Personal Competence				
Social Competence	Students can analyze problems of nonlinear dyna	mice also in groups		
	Students can achieve solution procedures for pro	- ·	ems also in groups.	
	, , , , , , , , , , , , , , , , , , , ,		3	
Autonomy	Students are able to approach given research tas	ks on the basis of given methods in	ndividually.	
	Students are able to identify and follow up novel		,	
		•		
	ndependent Study Time 124, Study Time in Lecture 56			
Credit points 6				
	None			
	Written exam			
	2 Hours			
scale				
_	Aircraft Systems Engineering: Core Qualification: Electiv		ulaani	
_	nternational Management and Engineering: Specialisati Mechanical Engineering and Management: Specialisatio			
	Mechatronics: Specialisation System Design: Elective Co		ıy	
	Mechatronics: Specialisation Intelligent Systems and Ro	•		
	Biomedical Engineering: Specialisation Artificial Organs		ve Compulsory	
	Biomedical Engineering: Specialisation Implants and Eng	-		
	Biomedical Engineering: Specialisation Medical Technolo			
В	Biomedical Engineering: Specialisation Management and	d Business Administration: Elective	Compulsory	
P	Product Development, Materials and Production: Core Q	ualification: Elective Compulsory		
Т	Theoretical Mechanical Engineering: Core Qualification:	Elective Compulsory		

Course L0702: Nonlinear Dyr	namics
	Integrated Lecture
Hrs/wk	
CP	
	Independent Study Time 124, Study Time in Lecture 56
	Prof. Norbert Hoffmann
Language	
Cycle	
	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				
Fitle Practical Course Product Developm	ent, Materials and Production (L1566)	Typ Practical Course	Hrs/wk	CP 6
Module Responsible	Prof. Jan Hendrik Dege			
Admission Requirements	None			
Recommended Previous				
Knowledge	Froduct Development.			
Kilowieuge	Lectures: Mechanics I-III			
	Lectures: Integrated Product Development I	incl. CAD practical training		
	Materials:			
	- Tracerraisi			
	 Lectures: Structural Metallic Materials, Metal 	lic Materials for Aircraft Applications, I	ntroduction to Materi	als Testing
	Lectures: Structure and Properties of Polyn	ners, Structure and Properties of Cor	mposites, Manufactur	ing of Polymers a
	Composites			
	Production:			
	Lecture: Production Engineering			
	 Lectures: Forming and Cutting Technology, N 	Methods of production process design		
	Lectures: Machine Tools and Robotic			
Educational Objectives	After taking part successfully, students have reach	ed the following learning results		
Professional Competence				
Knowledge	Students can			
	 represent more complex context of different 	fields of study.		
	 describe functionality of modern measurement 		nnologies.	
	-			
Skills	Students are capable of			
	 applying theoretical knowledge for practical 			
	applying provided experimental methods for		of study.	
	analyzing and evaluating experimental resul			
	applying modern measurement instrumenta	cions.		
Personal Competence	Charleste			
Social Competence	Students can			
	 carry out and document experimental work i 	n groups.		
	 present and discuss experimental results in 	mixed teams of different fields of stud	y.	
Autonomy	Students are able to			
		adoubly avided by tecology		
	carry out parts of experimental work independent	ndently guided by teachers.		
	choose and apply suitable instruments.			
	 assess own strengths and weaknesses. 			
Workload in Hours	Independent Study Time 96, Study Time in Lecture	84		
Credit points	6			
Course achievement	None			
Examination	Written elaboration			
Examination duration and				
scale				
Assignment for the	Biomedical Engineering: Core Qualification: Compu	sorv		
Assignment for the		1501 y		

Course L1566: Practical Cour	rse Product Development, Materials and Production
Тур	Practical Course
Hrs/wk	6
CP	6
Workload in Hours	Independent Study Time 96, Study Time in Lecture 84
Lecturer	Prof. Wolfgang Hintze, Prof. Bodo Fiedler, Prof. Claus Emmelmann, Prof. Dieter Krause, Prof. Gerold Schneider, Prof. Hermann
	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
	Production: Optimization of welding process parameters for hybrid plasma laser welding Evaluation of stock removal processes Analysis of basic laws in production logistics Analysis of positioning behaviour and trajectory accuracy of industrial robots
Literature	Nach Themenstellung / depending on topic

Module M1339: Desig	n optimization and probabilistic appr	oaches in structural analy	/sis	
Courses				
	tic Approaches in Structural Analysis (L1873) tic 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 t	he 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 reliables	pility analysis		
Skills	 Application of optimization algorithms and probate Programming with Matlab Implementation of algorithms Debugging 	abilistic methods in the design of struct	tures	
Personal Competence Social Competence Autonomy	 Team work Oral explanation of the the work Application of methods learned in the framework Familiarizing with source code provided Description of approaches and results 	k of a home work		
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56	5		
Credit points	6			
Course achievement	None			
Examination	Written elaboration			
Examination duration and scale	10 pages			
Assignment for the Following Curricula	Aircraft Systems Engineering: Core Qualification: Electi Product Development, Materials and Production: Core of Theoretical Mechanical Engineering: Core Qualification	Qualification: Elective Compulsory		

Hrs/wk 2 To 3 Workload in Hours Independent Study Time 62, Study Time in Lecture 28 Lecturer Prof. Benedikt Kriegesmann Costent In the course the theoretic basics for design optimization and reliability analysis are taught, where the focus is on the application of such methods. The lectures will consist of presentations as well as computer exercises. In the computer exercises, the methods learned will be implemented in Matlab for understanding the practical realization. The following contents will be considered: 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
Workload in Hours Lecturer Prof. Benedikt Kriegesmann Language Cycle Content In the course the theoretic basics for design optimization and reliability analysis are taught, where the focus is on the application of such methods. The lectures will consist of presentations as well as computer exercises. In the computer exercises, the methods learned will be implemented in Matlab for understanding the practical realization. The following contents will be considered: 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
Workload in Hours Independent Study Time 62, Study Time in Lecture 28 Lecturer Prof. Benedikt Kriegesmann Language DE Cycle SoSe In the course the theoretic basics for design optimization and reliability analysis are taught, where the focus is on the application of such methods. The lectures will consist of presentations as well as computer exercises. In the computer exercises, the methods learned will be implemented in Matlab for understanding the practical realization. The following contents will be considered: 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
Language DE Cycle SoSe Content In the course the theoretic basics for design optimization and reliability analysis are taught, where the focus is on the application of such methods. The lectures will consist of presentations as well as computer exercises. In the computer exercises, the methods learned will be implemented in Matlab for understanding the practical realization. The following contents will be considered: 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
Language Cycle Content In the course the theoretic basics for design optimization and reliability analysis are taught, where the focus is on the application of such methods. The lectures will consist of presentations as well as computer exercises. In the computer exercises, the methods learned will be implemented in Matlab for understanding the practical realization. The following contents will be considered: 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
Cycle SoSe Content In the course the theoretic basics for design optimization and reliability analysis are taught, where the focus is on the application of such methods. The lectures will consist of presentations as well as computer exercises. In the computer exercises, the methods learned will be implemented in Matlab for understanding the practical realization. The following contents will be considered: 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
Content In the course the theoretic basics for design optimization and reliability analysis are taught, where the focus is on the application of such methods. The lectures will consist of presentations as well as computer exercises. In the computer exercises, the methods learned will be implemented in Matlab for understanding the practical realization. The following contents will be considered: 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
such methods. The lectures will consist of presentations as well as computer exercises. In the computer exercises, the methods learned will be implemented in Matlab for understanding the practical realization. The following contents will be considered: 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
learned will be implemented in Matlab for understanding the practical realization. The following contents will be considered: 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
The following contents will be considered: 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
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
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
 Gradient based methods Genetic algorithms Optimization with constraints Topology optimization Reliability analysis Stochastic basics Monte Carlo methods Semi-analytic approaches robust design optimization
Genetic algorithms Optimization with constraints Topology optimization Reliability analysis Stochastic basics Monte Carlo methods Semi-analytic approaches robust design optimization
 Optimization with constraints Topology optimization Reliability analysis Stochastic basics Monte Carlo methods Semi-analytic approaches robust design optimization
 Topology optimization Reliability analysis Stochastic basics Monte Carlo methods Semi-analytic approaches robust design optimization
 Reliability analysis Stochastic basics Monte Carlo methods Semi-analytic approaches robust design optimization
 Stochastic basics Monte Carlo methods Semi-analytic approaches robust design optimization
 Monte Carlo methods Semi-analytic approaches robust design optimization
Semi-analytic approaches robust design optimization
robust design optimization
 Robustness measures
Coupling of design optimization and reliability analysis
Literature [1] Arora, Jasbir. Introduction to Optimum Design. 3rd ed. Boston, MA: Academic Press, 2011.
[2] Haldar, A., and S. Mahadevan. Probability, Reliability, and Statistical Methods in Engineering Design. John Wiley & Sons New
York/Chichester, UK, 2000.

Course L1874: Design 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	
	ich Met aus	
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			3
Personal Competence				
Social Competence	Students can work in small groups on specific problems	s 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	i e		
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	
Recommended Previous	Subjects of the Master program and the chosen specialisation.	
Knowledge		
Educational Objectives	After taking part successfully, students have reached the following learning results	
Professional Competence		
Knowledge	 Students can explain the project as well as their autonomously gained knowledge and relate it to current issues of their field of study. 	
	They can explain the basic scientific methods they have worked with.	
Skills	The students are able to autonomously solve a limited scientific task under the guidance of an experienced researcher. They can justify and explain their approach for problem solving; they can draw conclusions from their results, and then can find new ways and methods for their work. Students are capable of comparing and assessing alternative approaches with their own with regard to given criteria.	
Personal Competence		
Social Competence	The students are able to condense the relevance and the structure of the project work, the work procedure and the sub-problems	
	for the presentation and discussion in front of a bigger group. They can lead the discussion and give a feedback on the project to 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.

Module M1024: Metho	ods of Integrated Product Developme	nt		
Courses				
Title		Тур	Hrs/wk	СР
Integrated Product Development II	(L1254)	Lecture	3	3
Integrated Product Development II	(L1255)	Project-/problem-based Learning	2	3
Module Responsible	Prof. Dieter Krause			
Admission Requirements	None			
Recommended Previous	Basic knowledge of Integrated product development an	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 problem	s as well as a	dapt new boundary
	conditions,			
	solve product development problems with the as			
	 choose and execute appropriate moderation tech 	nniques.		
Personal Competence				
Social Competence	After passing the module students are able to:			
	 prepare and lead team meetings and moderation 	n processes,		
	work in teams on complex tasks,			
	represent problems and solutions and advance in	deas.		
Autonomy	After passing the module students are able to:			
	give a structured feedback and accept a critical feedback.	feedback,		
	implement the accepted feedback autonomous.			
Workload in Hours	Independent Study Time 110, Study Time in Lecture 70)		
Credit points	6			
Course achievement	None			
Examination	Oral exam			
Examination duration and	30 Minuten			
scale				
Assignment for the	Aircraft Systems Engineering: Core Qualification: Electiv	ve Compulsory		
Following Curricula	International Management and Engineering: Specialisat	ion II. Product Development and Production	n: Elective Co	mpulsory
-	Mechatronics: Specialisation System Design: Elective Co	ompulsory		-
	Product Development, Materials and Production: Specia	alisation Product Development: Compulsor	у	
	Product Development, Materials and Production: Specia	alisation Production: Elective Compulsory		
	Product Development, Materials and Production: Specia	alisation Materials: Elective Compulsory		
	Theoretical Mechanical Engineering: Specialisation Proc	duct Development and Production: Elective	Compulsory	

Production"	
Course L1254: Integrated Pro	oduct Development II
Тур	Lecture
Hrs/wk	3
СР	3
Workload in Hours	Independent Study Time 48, Study Time in Lecture 42
Lecturer	Prof. Dieter Krause
Language	DE
Cycle	WiSe
Content	Lecture
	The lecture extends and enhances the learned content of the module "Integrated Product Development and lightweight design" and is based on the knowledge and skills acquired there.
	and is based on the knowledge and skins acquired there.
	Topics of the course include in particular:
	Methods of product development,
	Presentation techniques,
	Industrial Design,
	Design for variety
	Modularization methods,
	Design catalogs,
	Adapted QFD matrix,
	Systematic material selection,
	Assembly oriented design,
	Construction management
	CE mark, declaration of conformity including risk assessment,
	Patents, patent rights, patent monitoring
	 Project management (cost, time, quality) and escalation principles,
	Development management for mechatronics, This is the second of the
	Technical Supply Chain Management.
	Exercise (PBL)
	In the exercise the content presented in the lecture "Integrated Product Development II" and methods of product development and
	design management will be enhanced.
	Students learn an independently moderated and workshop based approach through industry related practice examples to solve complex and currently existing issues in product development. They will learn the ability to apply important methods of product
	development and design management autonomous and acquire further expertise in the field of integrated product development.
	Besides personal skills, such as teamwork, guiding discussions and representing work results will be acquired through the
	workshop based structure of the event under its own planning and management.
Literature	
	Androscop, M.M. Docign for Accombly, Parlin, Springer 1995
	Andreasen, M.M., Design for Assembly, Berlin, Springer 1985. Ashby, M. F.: Materials Selection in Mechanical Design, München, Spektrum 2007.
	Ashby, M. F.: Materials Selection in Mechanical Design, München, Spektrum 2007.
	 Ashby, M. F.: Materials Selection in Mechanical Design, München, Spektrum 2007. Beckmann, H.: Supply Chain Management, Berlin, Springer 2004.
	 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
	 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.
	 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

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

Springer 2013.

Production"				
Module M0763: Aircr	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	Mathematics			
	Mechanics			
	Thermodynamics			
	Electrical Engineering			
	Fluid mechanics			
	After taking part successfully, students have rea	ached the following learning results		
Professional Competence				
Knowledge	Students are able to:			
	Assess challenges during the design of ai	rcraft energy systems		
	Describe essential components and designate	n points of hydraulic and electrical supply sy	stems	
	Give an overview of the functionality of a	ir conditioning systems		
	Describe different system concepts for definitions.	e-icing		
		of aircraft systems, and evaluate possible co	ncepts and limitat	tions
	Describe architectures for fuel supply sys			
	Explain possible approaches for the integ	ration of fuel cell systems and evaluate zero-	emission concept	S
Skills	Students are able to:			
	Design hydraulic and electric supply system			
	Analyze the thermodynamic behavior of a	air conditioning systems		
	Design ice protection systems Apply possible electrification concents to	evicting aircraft systems		
	Apply possible electrification concepts toDesign fuel supply systems	existing aircraft systems		
	Perform the design of a fuel cell system			
	,			
Personal Competence	•			
Social Competence	Students are able to:			
	Perform system design in groups and pre	sent and discuss results		
	Present systems engineering problems are			
Autonomy	Students are able to:			
	Reflect on the content of lectures autonom			
	Apply methods learned in the course of e	·		
	Identity complex system dependencies at	utonomously and abstract simplified models	and design proces	sses
Workload in Hours	Independent Study Time 110, Study Time in Lec	cture 70		
Credit points	6			
Course achievement	None			
Examination	Written exam			
Examination duration and	I 165 Minutes			
scale	,			
		: Elective Compulsory		
Assignment for the	Energy Systems: Specialisation Energy Systems			
Assignment for the Following Curricula		n: Compulsory		
-		• •	npulsory	
-	Aircraft Systems Engineering: Core Qualification	ecialisation II. Aviation Systems: Elective Com		
-	a Aircraft Systems Engineering: Core Qualification International Management and Engineering: Spe	ecialisation II. Aviation Systems: Elective Com : Specialisation Product Development: Electiv	e Compulsory	
-	a Aircraft Systems Engineering: Core Qualification International Management and Engineering: Spe Product Development, Materials and Production	ecialisation II. Aviation Systems: Elective Com : Specialisation Product Development: Electiv : Specialisation Production: Elective Compuls : Specialisation Materials: Elective Compulson	ve Compulsory ory	

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	

Module M1025: Fluidi	ics					
Courses						
Title Fluidics (L1256) Fluidics (L1371) Fluidics (L1257)				Typ Lecture Project-/problem-based Learning Recitation Section (large)	Hrs/wk 2 1	CP 3 2
Module Responsible	Prof. Dieter Krause			Nectation Section (large)		
Admission Requirements	1					
Recommended Previous		mechanics (stereo s	tatics, elastostatics,	hydrostatics, kinematics and	kinetics), flu	id mechanics, and
	AG					
Educational Objectives Professional Competence	After taking part succe	essfully, students have	e reached the following	ig learning results		
•	explain the interexplain open andescribe function	es and functionalities raction of hydraulic co d closed loop control	of hydrostatic, pneur omponents in hydraul of hydraulic systems,			is centrifugal pumps
Skills	design and dimeperform numeriselect and adap	ess hydraulic and pno ension hydraulic syste cal simulations of hyd t pump characteristic	eumatic components ems for mechanical ap iraulic systems based curves for hydraulic	oplications, on abstract problem definitions	,	
Personal Competence Social Competence	-	ule students are able sent functional contex ork autonomously.				
Autonomy	After passing the mode	ule students are able y knowledge for the s				
Workload in Hours	Independent Study Tin	ne 124, Study Time in	Lecture 56			
Credit points	6					
Course achievement	Compulsory Bonus Yes None	Form Attestation	Description Simulation hy	drostatischer Systeme		
Examination	Written exam					
Examination duration and scale Assignment for the		nent and Engineering:	Specialisation II. Med	hatronics: Elective Compulsory		
Following Curricula	Product Development, Product Development, Product Development,	Materials and Produc Materials and Produc Materials and Produc	tion: Specialisation Pr tion: Specialisation Pr tion: Specialisation M	duct Development and Production roduct Development: Compulsor roduction: Elective Compulsory aterials: Elective Compulsory opment and Production: Elective	у	ompulsory

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	WiSe			
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			
	Hydrodynamics			
	physical fundamentals			
	hydraulic continous-flow machines			
	hydrodynamic transmissions interpretable of makes and transmissions			
	interoperation of motor and transmission			
	ercise			
	III. dvoetetice			
	Hydrostatics			
	reading and design of hydraulic diagrams			
	dimensioning of hydrostatic traction and working drives			
	performance calculation			
	ydrodynamics			
	Tyd. Co. Training			
	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.			
	Formula			
	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			

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

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

Module M1193: Cabin	Systems Engineering				
Module MI193. Cabiii	Systems Engineering				
Courses					
Title		Тур	Hrs/wk	CP	
	nology in cabin electronics and avionics (L1557)	Lecture	2	2	
Computer and communication tech	nology in cabin electronics and avionics (L1558)	Recitation Section (small)	1	1	
Model-Based Systems Engineering	(MBSE) with SysML/UML (L1551)	Project-/problem-based Learning	g 3	3	
Module Responsible	Prof. Ralf God				
Admission Requirements	None				
Recommended Previous	Basic knowledge in:				
Knowledge	Mathematics				
	Mechanics				
	Thermodynamics				
	Electrical Engineering				
	Control Systems				
	Previous knowledge in:				
	Systems Engineering				
Educational Objectives	After taking part successfully, students have reache	ed the following learning results			
Professional Competence					
Knowledge	Students are able to:				
	describe the structure and operation of computer	architectures			
	explain the structure and operation of digital comment	munication Networks			
	 explain architectures of cabin electronics, integrat 	ted modular avionics (IMA) and Aircraft Dat	a Communicati	on Network (ADCN)	
	 understand the approach of Model-Based System 	ms Engineering (MBSE) in the design of I	nardware and	software-based cabi	
	systems				
Skills	Students are able to:				
S.i.i.s	understand, operate and maintain a Minicomputer	r			
	 build up a network communication and communicate with other network participants connect a minicomputer with a cabin management system (A380 CIDS) and communicate over a AFDX®-Network model system functions by means of formal languages SysML/UML and generate software code from the models execute software code on a minicomputer 				
	·				
Personal Competence	s				
Social Competence	Students are able to:				
	form teams of two or small groups for the practical				
	 work out partial results themselves and combine t 	them with others to form an overall solution	1		
	represent and contribute their own solution				
	take over the guidance of 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				
Washing die Hause	Independent Shada Tiran OS Shada Tiran in Lankara	0.4			
	Independent Study Time 96, Study Time in Lecture 8	04			
Credit points Course achievement					
	Written exam				
Examination duration and	120 minutes				
scale					
	Aircraft Systems Engineering: Core Qualification: Ele	ective Compulsory			
Following Curricula	International Management and Engineering: Special		ulsory		
-		ecialisation Product Development: Elective	-		
	i i roduct Developinent, materials and i roduction. So				
		ecialisation Production: Elective Compulsor	У		
	Product Development, Materials and Production: Sp. Product Development, Materials and Production: Sp. Product Development, Materials and Production: Sp.		у		

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

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 M0812: Aircra	aft Design I (Civ	il Aircraft De	sign)			
Courses						
Title				Тур	Hrs/wk	СР
Aircraft Design I (Design of Transpo	ort Aircraft) (L0820)			Lecture	3	3
Aircraft Design I (Design of Transpo	ort Aircraft) (L0834)			Recitation Section (large)	2	3
Module Responsible	Prof. Volker Gollnick					
Admission Requirements	None					
Recommended Previous		F				
Knowledge	Bachelor Mech	3				
	Bachelor Traffi Vardiplam Mass	-				
	Vordiplom MedModule Air Train	-				
	• Module All Tra	risport systems				
Educational Objectives	After taking part succ	essfully, students h	ave reached the followi	ng learning results		
Professional Competence						
Knowledge	1 Principle under	retanding of intograt	tod and civil aircraft dos	ian		
	·		ted and civil aircraft des and contributions of the	-		
	_		and contributions of the	•		
	·	the principle design		ait design		
	4. Introduction of	trie principie desigi	Tilletilous			
Skills	Understanding and application of design and calculation methods					
	Understanding of interdisciplinary and integrative interdependencies					
Personal Competence						
	Working in interdiscip	linary teams				
Social Competence	Tronking in interaction	minary teams				
	Communication					
Autonomy	Organization of workf	lows and -strategies	S			
Workload in Hours	Independent Study Ti	Independent Study Time 110, Study Time in Lecture 70				
Credit points	6					
Course achievement	Compulsory Bonus	Form	Description			
	No 10 %	Attestation	Durchführung	g einer Konzeptauslegung fü	r ein Verkehrsflugz	eug
Examination	Written exam					
Examination duration and	180 min					
scale						
Assignment for the	Aircraft Systems Engi	neering: Core Quali	fication: Compulsory			
Following Curricula	International Manage	ment and Engineeri	ng: Specialisation II. Av	ation Systems: Elective Com	pulsory	
	Product Development	, Materials and Proc	duction: Specialisation P	roduct Development: Electiv	re Compulsory	
	Product Development	, Materials and Proc	duction: Specialisation P	roduction: Elective Compuls	ory	
	Theoretical Mechanic	al Engineering: Spe	cialisation Aircraft Syste	ems Engineering: Elective Co	mpulsory	

	ourse L0820: Aircraft Design 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				
	2. Requirements and design objectives, main design parameter (u.a. payload-range-diagramme)				
	3. Statistical methods in overall aircraft design/data base methods				
	4. Cabin design (fuselage sizing, cabin interior, loading systems)				
	5. Principles of aerodynamic aircraft design (polar, geometry, 2D/3D aerodynamics)				
	6. Wing Design				
	7. Tail wings and landing gear				
	8. Principles of engine design and integration				
	9. Flight performance in cruise				
	10. Take off and landing field length				
	11. Loads and V-n-diagramme				
	12. Operating cost calculation				
Literature	J. Roskam: "Airplane Design"				
	D.P. Raymer: "Aircraft Design - A Conceptual Approach"				
	23. Taymer. Alleran 2001gh. A Conceptual Approach				
	J.P. Fielding: "Introduction to Aircraft Design"				
	Jenkinson, Simpkon, Rhods: "Civil Jet Aircraft Design"				

Course L0834: Aircraft Desig	ourse 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			

Production					
Module M0630: Robot	tics and Navigation in Medicine				
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	
	Prof. Alexander Schlaefer				
Admission Requirements	None				
Recommended Previous					
Knowledge	 principles of math (algebra, analysis/calculus) 				
3	 principles of programming, e.g., in Java or C++ 				
	solid R or Matlab skills				
Educational Objectives	After taking part successfully, students have reached the	e following learning results			
Professional Competence	Arter taking part successivity, students have reached the	tollowing learning results			
	The students can explain kinematics and tracking syst	ome in clinical contacts and illustra	to systems and	their components in	
Kriowieage	The students can explain kinematics and tracking syst				
	detail. Systems can be evaluated with respect to collis	sion detection and safety and regi	nations. Student	s can assess typical	
	systems regarding design and limitations.				
Skills	The students are able to design and evaluate navigation	systems and robotic systems for me	dical applications	i.	
Personal Competence					
Social Competence	The students are able to grasp practical tasks in group	s develop solution strategies inden	endently define	work processes and	
30ciai Competence	work on them collaboratively.	is, develop solution strategies indep	endentry, denne	work processes and	
	· ·	work processes and software soluti	ans using virtual	communication and	
	The students are able to collaboratively organize their	work processes and software solution	ons using virtual	communication and	
	software management tools.				
	The students can critically reflect on the results of other groups, make constructive suggestions for improvement, and also				
	incorporate them into their own work.				
Autonomy	The students can assess their level of knowledge and	independently control their learning	g processes on	this basis as well as	
	document their work results. They can critically evaluate	e the results achieved and present t	nem in an appro	oriate argumentative	
	manner to the other groups.				
Workload in Hours	Independent Study Time 110, Study Time in Lecture 70				
Credit points	6				
Course achievement	Compulsory Bonus Form Descri Yes 10 % Written elaboration	ption			
	Yes 10 % Written elaboration Yes 10 % Presentation				
Examination					
	Written exam				
Examination duration and .	90 minutes				
scale					
Assignment for the		, ,			
Following Curricula	Electrical Engineering: Specialisation Medical Technology				
	International Management and Engineering: Specialisation				
	International Management and Engineering: Specialisation		nnology: Elective	Compulsory	
	Mechatronics: Specialisation Intelligent Systems and Rob	otics: Elective Compulsory			
	Biomedical Engineering: Specialisation Artificial Organs a	and Regenerative Medicine: Elective (Compulsory		
	Biomedical Engineering: Specialisation Implants and End	oprostheses: Elective Compulsory			
	Biomedical Engineering: Specialisation Medical Technology	gy and Control Theory: Elective Com	oulsory		
	Biomedical Engineering: Specialisation Management and	Business Administration: Elective Co	mpulsory		
	Product Development, Materials and Production: Speciali	sation Product Development: Elective	e Compulsory		
	Product Development, Materials and Production: Speciali	•			
	Product Development, Materials and Production: Speciali	·	-		
	Theoretical Mechanical Engineering: Specialisation Bio- a	·			
	Specialization bio-				

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

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	T (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	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 Course	e (L1258) Project-/problem-based	Learning	3	3
Mechanisms, Systems and Process	es of Materials Testing (L0950) Lecture		2	2
Microsystems Technology (L0724)	Lecture		2	4
Sustainable Industrial Production (L	Lecture Lecture		2	4
Productivity Management (L0928)	Project-/problem-based	Learning	2	2
Productivity Management (L0931)	Recitation Section (sma	II)	1	1
Feedback Control in Medical Techn	ology (L0664) Lecture		2	3
Structural Mechanics of Fibre Reinf	forced Composites (L1514) Lecture		2	3
System Simulation (L1820)	Lecture		2	2
System Simulation (L1821)	Recitation Section (large	e)	1	2
Technical Design (L1513)	Lecture		2	3
Materials Testing (L0949)	Lecture		2	2
Reliability in Engineering Dynamics	s (L2994) Lecture		2	2
Reliability in Engineering Dynamics	s (L2995) Recitation Section (sma	II)	1	2
Reliability of Aircraft Systems (L074	49) Lecture		2	3
Module Responsible	Prof. Dieter Krause			
Admission Requirements	None			
Recommended Previous	None			
Knowledge				
Educational Objectives	After taking part successfully, students have reached the following learning results			
Professional Competence				
Knowledge				
	Students are able to express their extended knowledge and discuss the connection.	tion of diffe	erent specia	и пеіds or applicati
	areas of product development, materials and production			
	Students are qualified to connect different special fields with each other			
C1 '''				
Skills	Students can apply specialized solution strategies and new scientific methods in	selected a	reas	
	Students are able to transfer learned skills to new and unknown problems and ca			n annroaches
	- Stadents are able to transfer rearried skills to flew and unknown problems and co	ari acvelop	OWIT SOIGEO	парргоаспез
Personal Competence				
Social Competence	-			
Autonomy				
Autonomy	Students are able to develop their knowledge and skills by autonomous election	of courses.		
Maddenda	Dananda an abaira of sauresa			
Workload in Hours				
Credit points				
Assignment for the			mpulsory	
Following Curricula	Product Development, Materials and Production: Specialisation Production: Elective Cor			
	Product Development, Materials and Production: Specialisation Materials: Elective Com			

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

Course 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 Ir	ntegrated 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	

Typ Project-/problem-based Learning Hrs/wk 3 CP 3 Workload in Hours Independent Study Time 48, Study Time in Lecture 42 Examination Form Mündliche Prüfung Examination duration and scale Lecturer Prof. Dieter Krause Language DE/EN Cycle SoSe Content Development of a sandwich structure made of fibre reinforced plastics • getting familiar with fibre reinforced plastics as well as lightweight design • Design of a sandwich structure made of fibre reinforced plastics using finite element analysis (FEA) • Determination of material properties based on sample tests • manufacturing of the structure in the composite lab	
CP 3 Workload in Hours Independent Study Time 48, Study Time in Lecture 42 Examination Form Mündliche Prüfung Examination duration and scale Lecturer Prof. Dieter Krause Language DE/EN Cycle SoSe Content Development of a sandwich structure made of fibre reinforced plastics • getting familiar with fibre reinforced plastics as well as lightweight design • Design of a sandwich structure made of fibre reinforced plastics using finite element analysis (FEA) • Determination of material properties based on sample tests	
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Examination Form Mündliche Prüfung Examination duration and scale Lecturer Prof. Dieter Krause Language DE/EN Cycle SoSe Content Development of a sandwich structure made of fibre reinforced plastics • getting familiar with fibre reinforced plastics as well as lightweight design • Design of a sandwich structure made of fibre reinforced plastics using finite element analysis (FEA) • Determination of material properties based on sample tests	
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 Design of a sandwich structure made of fibre reinforced plastics using finite element analysis (FEA) Determination of material properties based on sample tests 	
Determination of material properties based on sample tests	
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, 20	2.
• Schulte, K., Fiedler, B., "Structure and Properties of Composite Materials", Hamburg, TUHH - TuTech Innovation 2005.	mbH,

Course L0950: Mechanisms,	Systems and Processes of Materials Testing
Тур	Lecture
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Examination Form	Klausur
Examination duration and	90 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)
Literature	Wear testing Non destructive testing application for overhaul of jet engines
Enterature	 E. Macherauch: Praktikum in Werkstoffkunde, Vieweg G. E. Dieter: Mechanical Metallurgy, McGraw-Hill R. Bürgel: Lehr- und Übungsbuch Festigkeitslehre, Vieweg R. Bürgel: Werkstoffe sícher beurteilen und richtig einsetzen, Vieweg

Course L0724: Microsystems	Technology
Тур	Lecture
Hrs/wk	2
СР	4
Workload in Hours	Independent Study Time 92, Study Time in Lecture 28
Examination Form	Mündliche Prüfung
Examination duration and	30 min
scale	
Lecturer	Prof. Hoc Khiem Trieu
Language	EN
Cycle	WiSe
Content	 Introduction (historical view, scientific and economic relevance, scaling laws) Semiconductor Technology Basics, Lithography (wafer fabrication, photolithography, improving resolution, next-generation
	lithography, nano-imprinting, molecular imprinting) • Deposition Techniques (thermal oxidation, epitaxy, electroplating, PVD techniques: evaporation and sputtering; CVD techniques: APCVD, LPCVD, PECVD and LECVD; screen printing)
	 Etching and Bulk Micromachining (definitions, wet chemical etching, isotropic etch with HNA, electrochemical etching, anisotropic etching with KOH/TMAH: theory, corner undercutting, measures for compensation and etch-stop techniques; plasma processes, dry etching: back sputtering, plasma etching, RIE, Bosch process, cryo process, XeF2 etching) Surface Micromachining and alternative Techniques (sacrificial etching, film stress, stiction: theory and counter measures; Origami microstructures, Epi-Poly, porous silicon, SOI, SCREAM process, LIGA, SU8, rapid prototyping) Thermal and Radiation Sensors (temperature measurement, self-generating sensors: Seebeck effect and thermopile; modulating sensors: thermo resistor, Pt-100, spreading resistance sensor, pn junction, NTC and PTC; thermal anemometer, mass flow sensor, photometry, radiometry, IR sensor: thermopile and bolometer) Mechanical Sensors (strain based and stress based principle, capacitive readout, piezoresistivity, pressure sensor: piezoresistive, capacitive and fabrication process; accelerometer: piezoresistive, piezoelectric and capacitive; angular rate sensor: operating principle and fabrication process; Magnetic Sensors (galvanomagnetic sensors: spinning current Hall sensor and magneto-transistor; magnetoresistive sensors: magneto resistance, AMR and GMR, fluxgate magnetometer) Chemical and Bio Sensors (thermal gas sensors: pellistor and thermal conductivity sensor; metal oxide semiconductor gas sensor, organic semiconductor gas sensor, Lambda probe, MOSFET gas sensor, pH-FET, SAW sensor, principle of biosensor, Clark electrode, enzyme electrode, DNA chip) Micro Actuators, Microfluidics and TAS (drives: thermal, electrostatic, piezo electric and electromagnetic; light modulators, DMD, adaptive optics, microscanner, microvalves: passive and active, micropumps, valveless micropump, electrokinetic micropumps, micromixer, filter, inkjet printhead, microdispenser, microfluidic switching elements, m
	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	
	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, Tim Jansen
Language	DE
Cycle	SoSe
Content	See interlocking course
Literature	See interlocking course

Course L0664: Feedback Control in Medical Technology		
Тур	Lecture	
Hrs/wk	2	
CP	3	
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28	
Examination Form	Mündliche Prüfung	
Examination duration and	20 min	
scale		
Lecturer	Johannes Kreuzer, Christian Neuhaus	
Language	DE	
Cycle	SoSe	
Content	Always viewed from the engineer's point of view, the lecture is structured as follows:	
Literature	 Leonhardt, S., & Walter, M. (2016). Medizintechnische Systeme. Berlin, Heidelberg: Springer Vieweg. Werner, J. (2005). Kooperative und autonome Systeme der Medizintechnik. München: Oldenbourg. Oczenski, W. (2017). Atmen: Atemhilfen; Atemphysiologie und Beatmungstechnik: Georg Thieme Verlag KG. 	

Course L1514: Structural Mechanics of Fibre Reinforced Composites		
Тур	Lecture	
Hrs/wk	2	
СР	3	
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28	
Examination Form	Mündliche Prüfung	
Examination duration and	30 min	
scale		
Lecturer	Prof. Benedikt Kriegesmann	
Language	EN	
Cycle	WiSe	
Content	Classical laminate theory	
	Rules of mixture	
	Failure mechanisms and criteria of composites	
	Boundary value problems of isotropic and anisotropic shells	
	Stability of composite structures	
	Optimization of laminated composites	
	Modelling composites in FEM	
	Numerical multiscale analysis of textile composites	
	Progressive failure analysis	
Literature	 Schürmann, H., "Konstruieren mit Faser-Kunststoff-Verbunden", Springer, Berlin, aktuelle Auflage. Wiedemann, J., "Leichtbau Band 1: Elemente", Springer, Berlin, Heidelberg, , aktuelle Auflage. Reddy, J.N., "Mechanics of Composite Laminated Plates and Shells", CRC Publishing, Boca Raton et al., current edition. Jones, R.M., "Mechanics of Composite Materials", Scripta Book Co., Washington, current edition. Timoshenko, S.P., Gere, J.M., "Theory of elastic stability", McGraw-Hill Book Company, Inc., New York, current edition. Turvey, G.J., Marshall, I.H., "Buckling and postbuckling of composite plates", Chapman and Hall, London, current edition. Herakovich, C.T., "Mechanics of fibrous composites", John Wiley and Sons, Inc., New York, current edition. Mittelstedt, C., Becker, W., "Strukturmechanik ebener Laminate", aktuelle Auflage. 	

Course L1820: System Simul	ation
Тур	Lecture
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Examination Form	Mündliche Prüfung
Examination duration and	30 min
scale	
Lecturer	Dr. Stefan Wischhusen, 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 L1821: System Simulation	
Тур	Recitation Section (large)
Hrs/wk	1
СР	2
Workload in Hours	Independent Study Time 46, Study Time in Lecture 14
Examination Form	Mündliche Prüfung
Examination duration and	30 min
scale	
Lecturer	Dr. Stefan Wischhusen, Dr. Johannes Brunnemann
Language	DE
Cycle	WiSe
Content	See interlocking course
Literature	See interlocking course

Course L1513: Technical Design	
Тур	Lecture
Hrs/wk	2
СР	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Examination Form	Schriftliche Ausarbeitung
Examination duration and	10-15 Entwurfszeichnungen, Skizzen und ca. 5-10 A4-Dokumentationsseiten (Themen- und Entwurfsbegründung)
scale	
Lecturer	Prof. Werner Granzeier, 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 GmbH, Auto & Design,

Production	
	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		
Тур	Lecture	
Hrs/wk	2	
СР	2	
Workload in Hours	ndependent 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 I	ingineering Dynamics	
Тур	Lecture	
Hrs/wk	2	
СР	2	
Workload in Hours	ndependent Study Time 32, Study Time in Lecture 28	
Examination Form	Klausur	
Examination duration and	90 min	
scale		
	Prof. Benedikt Kriegesmann, Dr. Eric Groß	
Language		
Cycle		
Content	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	k 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	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	ndependent Study Time 62, Study Time in Lecture 28	
Examination Form	Clausur	
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	

Courses Title Flight Control Systems (L0736) Flight Control Systems (L0740) Module Responsible Prof. Frank Thielecke Admission Requirements None Recommended Previous Knowledge Knowledge **mathematics** **mechanics** **electronics** **fluid mechanics** **electronics** **fluid mechanics** **control theory** Educational Objectives After taking part successfully, students have reached the follow of aircrafts in general along with corresponding propertition of give an overview over the functioning and the structure explain different configurations and designs and their or a control systems.	flight control systems as well as ties and applications. e of landing gears and landing g		CP 4 2
Flight Control Systems (L0736) Flight Control Systems (L0740) Module Responsible Prof. Frank Thielecke Admission Requirements None Recommended Previous Knowledge of: • mathematics • mechanics • thermo dynamics • electronics • fluid mechanics • control theory Educational Objectives After taking part successfully, students have reached the follow Professional Competence Knowledge Students are able to • describe the structure and the functioning of primary flor of aircrafts in general along with corresponding properties give an overview over the functioning and the structure.	Lecture Recitation Section (large) owing learning results flight control systems as well as ties and applications. e of landing gears and landing g	3 2	4 2
Flight Control Systems (L0736) Flight Control Systems (L0740) Module Responsible Prof. Frank Thielecke Admission Requirements None Recommended Previous Knowledge **Mathematics** **mathematics** **mechanics** **electronics** **fluid mechanics** **control theory** Educational Objectives After taking part successfully, students have reached the follow Professional Competence Knowledge **Knowledge** Students are able to* **describe the structure and the functioning of primary fluid of aircrafts in general along with corresponding propertition give an overview over the functioning and the structure and structure a	Lecture Recitation Section (large) owing learning results flight control systems as well as ties and applications. e of landing gears and landing g	3 2	4 2
Flight Control Systems (L0736) Flight Control Systems (L0740) Module Responsible Prof. Frank Thielecke Admission Requirements None Recommended Previous Knowledge **Mone Hardward Previous of Market Prof. Frank Thielecke **Mone Hardward Prof. Frank Thielecke **Mone Har	Lecture Recitation Section (large) owing learning results flight control systems as well as ties and applications. e of landing gears and landing g	3 2	4 2
Module Responsible	Recitation Section (large) owing learning results flight control systems as well as ties and applications. e of landing gears and landing g	2 actuation-, avior	2
Admission Requirements Recommended Previous Knowledge • mathematics • mechanics • thermo dynamics • electronics • fluid mechanics • control theory Educational Objectives After taking part successfully, students have reached the follow Professional Competence Knowledge Students are able to • describe the structure and the functioning of primary flor faircrafts in general along with corresponding propertition give an overview over the functioning and the structure	flight control systems as well as ties and applications. e of landing gears and landing g		nic-, high lift systems
Recommended Previous Knowledge • mathematics • mechanics • thermo dynamics • electronics • fluid mechanics • control theory Educational Objectives After taking part successfully, students have reached the follow Professional Competence Knowledge Students are able to • describe the structure and the functioning of primary flor faircrafts in general along with corresponding propertitions give an overview over the functioning and the structure	flight control systems as well as ties and applications. e of landing gears and landing g		nic-, high lift systems
Recommended Previous Knowledge • mathematics • mechanics • thermo dynamics • electronics • fluid mechanics • control theory Educational Objectives After taking part successfully, students have reached the follow Professional Competence Knowledge Students are able to • describe the structure and the functioning of primary flor faircrafts in general along with corresponding propertitions give an overview over the functioning and the structure	flight control systems as well as ties and applications. e of landing gears and landing g		nic-, high lift systems
* mathematics * mechanics * thermo dynamics * electronics * fluid mechanics * control theory **Educational Objectives** After taking part successfully, students have reached the following professional Competence **Knowledge** Students are able to • describe the structure and the functioning of primary fluid of aircrafts in general along with corresponding propertitions in give an overview over the functioning and the structure.	flight control systems as well as ties and applications. e of landing gears and landing g		nic-, high lift systems
mechanics thermo dynamics electronics fluid mechanics control theory Educational Objectives After taking part successfully, students have reached the following professional Competence Knowledge Students are able to describe the structure and the functioning of primary fluid of aircrafts in general along with corresponding propertials of give an overview over the functioning and the structure	flight control systems as well as ties and applications. e of landing gears and landing g		nic-, high lift systems
thermo dynamics electronics fluid mechanics control theory Educational Objectives After taking part successfully, students have reached the follow Professional Competence Knowledge Students are able to describe the structure and the functioning of primary flor aircrafts in general along with corresponding propertition of give an overview over the functioning and the structure	flight control systems as well as ties and applications. e of landing gears and landing g		nic-, high lift systems
electronics fluid mechanics control theory Educational Objectives After taking part successfully, students have reached the follow Professional Competence Knowledge Students are able to describe the structure and the functioning of primary fluid of aircrafts in general along with corresponding propertials of give an overview over the functioning and the structure.	flight control systems as well as ties and applications. e of landing gears and landing g		nic-, high lift systems
fluid mechanics control theory Educational Objectives After taking part successfully, students have reached the follow Professional Competence Knowledge Students are able to describe the structure and the functioning of primary flor aircrafts in general along with corresponding properties give an overview over the functioning and the structure.	flight control systems as well as ties and applications. e of landing gears and landing g		nic-, high lift systems
Control theory Educational Objectives After taking part successfully, students have reached the follow Professional Competence Knowledge Students are able to describe the structure and the functioning of primary flor faircrafts in general along with corresponding properties give an overview over the functioning and the structure.	flight control systems as well as ties and applications. e of landing gears and landing g		nic-, high lift systems
Professional Competence Knowledge Students are able to describe the structure and the functioning of primary fl of aircrafts in general along with corresponding properti give an overview over the functioning and the structure	flight control systems as well as ties and applications. e of landing gears and landing g		nic-, high lift systems
Professional Competence Knowledge Students are able to • describe the structure and the functioning of primary fl of aircrafts in general along with corresponding properti • give an overview over the functioning and the structure	flight control systems as well as ties and applications. e of landing gears and landing g		nic-, high lift systems
 Students are able to describe the structure and the functioning of primary fl of aircrafts in general along with corresponding properti give an overview over the functioning and the structure 	ties and applications. e of landing gears and landing g		nic-, high lift systems
 describe the structure and the functioning of primary fl of aircrafts in general along with corresponding properti give an overview over the functioning and the structure 	ties and applications. e of landing gears and landing g		nic-, high lift systems
of aircrafts in general along with corresponding properti give an overview over the functioning and the structure	ties and applications. e of landing gears and landing g		nic-, high lift systems
of aircrafts in general along with corresponding properti give an overview over the functioning and the structure	ties and applications. e of landing gears and landing g		nc-, nign int systems
give an overview over the functioning and the structure	e of landing gears and landing g	ear systems	
, , , , , , , , , , , , , , , , , , , ,			
Skills Students are able to			
size primary flight control actuation systems			
perform a controller design process for the flight contro	ol 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	er students		
Discuss developed solutions with experts			
Autonomy Students are able to:			
	ine a a state of the state of t		
derive requirements and perform appropriate yet simple derive requirements and perform appropriate yet simple	онпеа aesign processes for aircr	rart systems from	complex issues and
circumstances in a self-reliant manner	oc in a colf reliant manner		
apply new skills and methods in the context of exercise.	es iii a seii-reiiant manner		
Workload in Hours Independent Study Time 110, Study Time in Lecture 70			
Credit points 6			
Course achievement None			
Examination Written exam			
Examination duration and 165 Minutes			
scale			
Assignment for the Aircraft Systems Engineering: Core Qualification: Compulsory			
Following Curricula International Management and Engineering: Specialisation II. A		pulsory	
Product Development, Materials and Production: Specialisation			
Product Development, Materials and Production: Specialisation	on Production: Elective Compulso	ory	
Product Development, Materials and Production: Specialisation	on Materials: Elective Compulsor	у	
Theoretical Mechanical Engineering: Specialisation Aircraft Sys	stems Engineering: Elective Cor	mpulsory	

Course L0736: Flight Control	Systems
Тур	Lecture
Hrs/wk	3
СР	4
Workload in Hours	Independent Study Time 78, Study Time in Lecture 42
Lecturer	Prof. Frank Thielecke
Language	DE
Cycle	SoSe
Content	 Actuation (Principles of actuators; electro-mechanical actuators; modeling, analysis and sizing of position control systems; hydro-mechanic actuation systems) Flight Control Systems (control surfaces, hinge moments; requirements of stability and controllability, actuation power; principles of reversible and irreversible flight control systems; servo actuation systems) Landing Gear Systems (Configurations and geometries; analysis of landing gear systems with respect to damper dynamics, dynamics of the breaking aircraft and power consumption; design and analysis of breaking systems with respect to energy and heat; anti-skit systems) Fuel Systems (Architectures; aviation fuels; system components; fueling system; tank inerting system; fuel management; trim tank) De- and Anti-Ice Systems: (Atmospheric icing conditions; principles of de- and anti-ice systems)
Literature	 Moir, Seabridge: Aircraft Systems Torenbek: Synthesis of Subsonic Airplane Design Curry: Aircraft Landing Gear Design: Principles and Practices

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 M1161: Turbo	omachinery			
Courses				
Title Turbomachines (L1562) Turbomachines (L1563)		Typ Lecture Recitation Section (large)	Hrs/wk 3 1	CP 4 2
Module Responsible	Prof. Markus Schatz			
Admission Requirements	None			
Recommended Previous	Technical Thermodynamics I, II, Fluid Dynamics, Heat Transfer			
Knowledge	realised memorynamics (), frida bynamics, freat francis			
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 understand the different mathematic modelling o 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				
Course achievement				
Examination	Written exam			
Examination duration and	90 min			
scale				
Assignment for the	Energy Systems: Specialisation Energy Systems: Electiv	e Compulsory		
Following Curricula	Energy Systems: Specialisation Marine Engineering: Elec	tive Compulsory		
	Product Development, Materials and Production: Special	·		
	Product Development, Materials and Production: Special			
	Product Development, Materials and Production: Special		′	
	Theoretical Mechanical Engineering: Specialisation Ener			
	Theoretical Mechanical Engineering: Specialisation Ener	gy Systems: Elective Compulsory		

Course L1562: Turbomachine	⊇S
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 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 required Calculate the parameters of imaging systems using the mathematical or physical equations; Determine the influence of different system components on the spatial and temporal resolution of imaging systems Explain the importance of different imaging systems for a number of clinical applications;
	Select a suitable imaging system for an application.
Personal Competence	
Social Competence	
Autonomy	Students can:
	Understand which physical effects are used in medical imaging;
	Decide independently for which clinical issue a measuring system can be used.
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56
Credit points	6
Course achievement	None
Examination	Written exam
Examination duration and	90 min
scale	
Assignment for the	Electrical Engineering: Specialisation Medical Technology: Elective Compulsory
Following Curricula	
	Product Development, Materials and Production: Specialisation Product Development: Elective Compulsory
	Product Development, Materials and Production: Specialisation Production: Elective Compulsory
	Product Development, Materials and Production: Specialisation Materials: Elective Compulsory Theoretical Mechanical Engineering: Specialisation Bio- and Medical Technology: Elective Compulsory
	medical mechanical Engineering, Specialisation bio- and medical recliniously. Elective Computory

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 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-ZER		2	3
Elements of Integrated Production		2	3
Development Management for Me		2	3
Fatigue & Damage Tolerance (L03		2	3
Industry 4.0 for engineers (L2012)	Lecture	2	3
nnovation and Product Manageme	nt (L2168) Seminar	2	3
ightweight Design Practical Cours	e (L1258) Project-/problem-based Learning	3	3
Mechanisms, Systems and Process		2	2
Microsystems Technology (L0724)	Lecture	2	4
Sustainable Industrial Production (Lecture Lecture	2	4
Productivity Management (L0928)	Project-/problem-based Learning	2	2
Productivity Management (L0931)	Recitation Section (small)	1	1
Feedback Control in Medical Techr	ology (L0664) Lecture	2	3
Structural Mechanics of Fibre Rein		2	3
System Simulation (L1820)	Lecture	2	2
System Simulation (L1821)	Recitation Section (large)	1	2
Fechnical Design (L1513)	Lecture	2	3
Materials Testing (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 following learning results		
	Arter taking part successionly, students have reached the following learning results		
Professional Competence			
Knowledge	Students are able to express their extended knowledge and discuss the connection of difference of the connection of	fferent special	fields or applica
	areas of product development, materials and production		
	Students are qualified to connect different special fields with each other		
	• Students are qualified to conflect different special fields with each other		
Skills			
	Students can apply specialized solution strategies and new scientific methods in selected.	areas	
			approaches
Barrage 1.0	Students can apply specialized solution strategies and new scientific methods in selected.		approaches
Personal Competence	 Students can apply specialized solution strategies and new scientific methods in selected Students are able to transfer learned skills to new and unknown problems and can develop 		approaches
Personal Competence Social Competence	 Students can apply specialized solution strategies and new scientific methods in selected Students are able to transfer learned skills to new and unknown problems and can develop 		approaches
•	 Students can apply specialized solution strategies and new scientific methods in selected Students are able to transfer learned skills to new and unknown problems and can develop 	o own solutior	approaches
Social Competence	 Students can apply specialized solution strategies and new scientific methods in selected Students are able to transfer learned skills to new and unknown problems and can develop 	o own solutior	approaches
Social Competence	Students can apply specialized solution strategies and new scientific methods in selected Students are able to transfer learned skills to new and unknown problems and can develop Students are able to develop their knowledge and skills by autonomous election of courses.	o own solutior	approaches
Social Competence Autonomy	Students can apply specialized solution strategies and new scientific methods in selected Students are able to transfer learned skills to new and unknown problems and can develop Students are able to develop their knowledge and skills by autonomous election of courses Depends on choice of courses	o own solutior	approaches
Social Competence Autonomy Workload in Hours Credit points	Students can apply specialized solution strategies and new scientific methods in selected Students are able to transfer learned skills to new and unknown problems and can develop Students are able to develop their knowledge and skills by autonomous election of courses Depends on choice of courses	p own solution	approaches
Social Competence Autonomy Workload in Hours Credit points Assignment for the	Students can apply specialized solution strategies and new scientific methods in selected Students are able to transfer learned skills to new and unknown problems and can develop Students are able to develop their knowledge and skills by autonomous election of courses Depends on choice of courses Product Development, Materials and Production: Specialisation Product Development: Elective Co	p own solution	approaches
Social Competence Autonomy Workload in Hours Credit points	Students can apply specialized solution strategies and new scientific methods in selected Students are able to transfer learned skills to new and unknown problems and can develop Students are able to develop their knowledge and skills by autonomous election of courses Depends on choice of courses Product Development, Materials and Production: Specialisation Product Development: Elective Corproduct Development, Materials and Production: Specialisation Production: Elective Compulsory	p own solution	approaches
Social Competence Autonomy Workload in Hours Credit points Assignment for the	Students can apply specialized solution strategies and new scientific methods in selected Students are able to transfer learned skills to new and unknown problems and can develop Students are able to develop their knowledge and skills by autonomous election of courses Depends on choice of courses Product Development, Materials and Production: Specialisation Product Development: Elective Co	s.	approaches

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
СР	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Examination Form	Mündliche Prüfung
Examination duration and	30 Minuten
scale	
Lecturer	NN, Dr. Johannes Nicolas Gebhardt
Language	DE
Cycle	SoSe
Content	Processes and methods of product development - from idea to market launch identification of market and technology potentials development of a common product architecture Synchronized product development across all engineering disciplines product validation incl. customer view Steering and optimization of product development Design of processes for product development IT systems for product development Establishment of management standards Typical types of organization
Literature	Bender: Embedded Systems - qualitätsorientierte Entwicklung Ehrlenspiel: Integrierte Produktentwicklung: Denkabläufe, Methodeneinsatz, Zusammenarbeit Gausemeier/Ebbesmeyer/Kallmeyer: Produktinnovation - Strategische Planung und Entwicklung der Produkte von morgen Haberfellner/de Weck/Fricke/Vössner: Systems Engineering: Grundlagen und Anwendung Lindemann: Methodische Entwicklung technischer Produkte: Methoden flexibel und situationsgerecht anwenden Pahl/Beitz: Konstruktionslehre: Grundlagen erfolgreicher Produktentwicklung. Methoden und Anwendung VDI-Richtlinie 2206: Entwicklungsmethodik für mechatronische Systeme

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

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

Typ Project-/problem-based Learning Hrs/wk 3 CP 3 Workload in Hours Independent Study Time 48, Study Time in Lecture 42 Examination Form Mündliche Prüfung Examination duration and 30 min	
CP 3 Workload in Hours Independent Study Time 48, Study Time in Lecture 42 Examination Form Mündliche Prüfung	
Workload in Hours Independent Study Time 48, Study Time in Lecture 42 Examination Form Mündliche Prüfung	
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 Bäuteilen 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 Hans	nser Verlag, 2012.
 Schulte, K., Fiedler, B., "Structure and Properties of Composite Materials", Hamburg, TUHH - TuTec 2005. 	ch Innovation GmbH,

Course L0950: Mechanisms,	Systems and Processes of Materials Testing
Тур	Lecture
Hrs/wk	2
СР	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Examination Form	Klausur
Examination duration and	90 Minuten
scale	
Lecturer	Dr. Jan Oke Peters
Language	DE
Cycle	SoSe
Content	Application, analysis and discussion of basic and advanced testing methods to ensure correct selection of applicable testing procedure for investigation of part/materials deficiencies Stress-strain relationships Strain gauge application Visko elastic behavior Tensile test (strain hardening, necking, strain rate) Compression test, bending test, torsion test Crack growth upon static loading (J-Integral) Crack growth upon cyclic loading (micro- und macro cracks) Effect of notches Creep testing (physical creep test, influence of stress and temperature, Larson Miller parameter) Wear testing Non destructive testing application for overhaul of jet engines
Literature	 E. Macherauch: Praktikum in Werkstoffkunde, Vieweg G. E. Dieter: Mechanical Metallurgy, McGraw-Hill R. Bürgel: Lehr- und Übungsbuch Festigkeitslehre, Vieweg R. Bürgel: Werkstoffe sícher beurteilen und richtig einsetzen, Vieweg

Course L0724: Microsystems	Technology
Тур	Lecture
Hrs/wk	
СР	4
Workload in Hours	Independent Study Time 92, Study Time in Lecture 28
Examination Form	
Examination duration and	
scale	
Lecturer	Prof. Hoc Khiem Trieu
Language	
Cycle	
Content	
Content	 Introduction (historical view, scientific and economic relevance, scaling laws) Semiconductor Technology Basics, Lithography (wafer fabrication, photolithography, improving resolution, next-generation lithography, nano-imprinting, molecular imprinting) Deposition Techniques (thermal oxidation, epitaxy, electroplating, PVD techniques: evaporation and sputtering; CVD techniques: APCVD, LPCVD, PECVD and LECVD; screen printing) Etching and Bulk Micromachining (definitions, wet chemical etching, isotropic etch with HNA, electrochemical etching, anisotropic etching with KOH/TMAH: theory, corner undercutting, measures for compensation and etch-stop techniques; plasma processes, dry etching: back sputtering, plasma etching, RIE, Bosch process, cryo process, XeF2 etching) Surface Micromachining and alternative Techniques (sacrificial etching, film stress, stiction: theory and counter measures; Origami microstructures, Epi-Poly, porous silicon, SOI, SCREAM process, LIGA, SUB, rapid prototyping) Thermal and Radiation Sensors (temperature measurement, self-generating sensors: Seebeck effect and thermopile; modulating sensors: thermoreistor, 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; 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, Lambda probe, MOSFET gas sensor, pH-FET, SAW sensor, principle of biosensor
	and silicon fusion bonding; micro electroplating, 3D-MID)
Literature	M. Madou: Fundamentals of Microfabrication, CRC Press, 2002
	N. Schwesinger: Lehrbuch Mikrosystemtechnik, Oldenbourg Verlag, 2009
	N. Schwesinger. Lembuch Mikrosystemitechnik, Oldenbourg Venag, 2009
	T. M. Adams, R. A. Layton:Introductory MEMS, Springer, 2010
	C. Carlach, M. Dättal, Introduction to microcyctom technology, Miley, 2000
	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	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

- was 10031. Desductivity. Management	
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, Tim Jansen
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 Mechanics of Fibre Reinforced Composites		
Тур	Lecture	
Hrs/wk	2	
СР	3	
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28	
Examination Form	Mündliche Prüfung	
Examination duration and	30 min	
scale		
Lecturer	Prof. Benedikt Kriegesmann	
Language		
Cycle	WiSe	
Content	Classical laminate theory	
	Rules of mixture	
	Failure mechanisms and criteria of composites	
	Boundary value problems of isotropic and anisotropic shells	
	Stability of composite structures	
	Optimization of laminated composites	
	Modelling composites in FEM	
	Numerical multiscale analysis of textile composites	
	Progressive failure analysis	
Literature	 Schürmann, H., "Konstruieren mit Faser-Kunststoff-Verbunden", Springer, Berlin, aktuelle Auflage. Wiedemann, J., "Leichtbau Band 1: Elemente", Springer, Berlin, Heidelberg, , aktuelle Auflage. Reddy, J.N., "Mechanics of Composite Laminated Plates and Shells", CRC Publishing, Boca Raton et al., current edition. Jones, R.M., "Mechanics of Composite Materials", Scripta Book Co., Washington, current edition. Timoshenko, S.P., Gere, J.M., "Theory of elastic stability", McGraw-Hill Book Company, Inc., New York, current edition. Turvey, G.J., Marshall, I.H., "Buckling and postbuckling of composite plates", Chapman and Hall, London, current edition. Herakovich, C.T., "Mechanics of fibrous composites", John Wiley and Sons, Inc., New York, current edition. Mittelstedt, C., Becker, W., "Strukturmechanik ebener Laminate", aktuelle Auflage. 	

Course L1820: System Simul	ation
Тур	Lecture
Hrs/wk	2
СР	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Examination Form	Mündliche Prüfung
Examination duration and	30 min
scale	
Lecturer	Dr. Stefan Wischhusen, 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	 Modelica Association: "Modelica Language Specification - Version 3.5", Linköping, Sweden, 2021. OpenModelica: OpenModelica 1.17.0, https://www.openmodelica.org (siehe Download), 2021. M. Tiller: "Modelica by Example", https://book.xogeny.com, 2014. M. Otter, H. Elmqvist, et al.: "Objektorientierte Modellierung Physikalischer Systeme", at- Automatisierungstechnik (german), Teil 1 - 17, Oldenbourg Verlag, 1999 - 2000. P. Fritzson: "Principles of Object-Oriented Modeling and Simulation with Modelica 3.3", Wiley-IEEE Press, New York, 2015. P. Fritzson: "Introduction to Modeling and Simulation of Technical and Physical Systems with Modelica", Wiley, New York, 2011.

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

Course L1513: Technical Design	
Тур	Lecture
Hrs/wk	2
СР	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Examination Form	Schriftliche Ausarbeitung
Examination duration and	10-15 Entwurfszeichnungen, Skizzen und ca. 5-10 A4-Dokumentationsseiten (Themen- und Entwurfsbegründung)
scale	
Lecturer	Prof. Werner Granzeier, 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 GmbH, Auto & Design,

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	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	
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 I	ingineering 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	
	Prof. Benedikt Kriegesmann, Dr. Eric Groß
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

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	terials (L1661)	Lecture	2	3
Dislocation Theory of Plasticity (L16	562)	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	the following learning results		
Professional Competence				
Knowledge	Students can explain basic principles of crystallogra	phy, statics (free body diagram	s, tractions) and therm	nodynamics (energy
	minimization, energy barriers, entropy)			
Skille	Students are capable of using standardized calculation	mothods, tonsor calculations, d	orivativos intograls ton	cor transformations
SKIIIS	Students are capable of using standardized calculation	i methods: tensor calculations, di	erivatives, integrals, ten	sor transformations
Personal Competence				
Social Competence	Students can provide appropriate feedback and handle	e feedback on their own performa	ance constructively.	
Autonomy	Students are able to			
	- assess their own strengths and weaknesses			
	- assess their own state of learning in specific terms at	nd to define further work steps or	n this basis guided by te	achers.
	- work independently based on lectures and notes to s	olve problems, and to ask for hel	p or clarifications when	needed
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	90 min			
scale				
Assignment for the	Materials Science: Core Qualification: Compulsory			
Following Curricula	Mechanical Engineering and Management: Specialisati	ion Materials: Elective Compulsor	у	
	Product Development, Materials and Production: Speci	ialisation Product Development: E	Elective Compulsory	
	Product Development, Materials and Production: Speci	alisation Production: Elective Cor	mpulsory	
	Product Development, Materials and Production: Speci	ialisation Materials: Compulsory		
	Theoretical Mechanical Engineering: Specialisation Ma	terials Science: Elective Compuls	ory	

Mrs/wk 2	Course L1661: Mechanical Be	ehaviour of Brittle Materials
Workload in Hours Lecturer Rod. Gerold Schneider Language DE/EN Sosse 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 III 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. 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	Тур	Lecture
Morkload in Hours	Hrs/wk	2
Larguage 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, Welbull 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, 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	СР	3
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 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, A 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	Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
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 II 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	Lecturer	Prof. Gerold Schneider
Content 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 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-x-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	Language	DE/EN
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 III 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	Cycle	SoSe
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		D.J. Green, An introduction to the mechanical properties of ceramics", Cambridge University Press, 1998
D. Munz, T. Fett, Ceramics, Springer, 2001		B.R. Lawn, Fracture of Brittle Solids", Cambridge University Press, 1993
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D.W. Richerson, Modern Ceramic Engineering, Marcel Decker, New York, 1992		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	DE/EN
Cycle	SoSe
Content	This class will cover the principles of dislocation theory from a physical metallurgy perspective, providing a fundamental understanding of the relations between the strength and of crystalline solids and distributions of defects.
	We will review the concept of dislocations, defining terminology used, and providing an overview of important concepts (e.g. linear elasticity, stress-strain relations, and stress transformations) for theory development. We will develop the theory of dislocation plasticity through derived stress-strain fields, associated self-energies, and the induced forces on dislocations due to internal and externally applied stresses. Dislocation structure will be discussed, including core models, stacking faults, and dislocation arrays (including grain boundary descriptions). Mechanisms of dislocation multiplication and strengthening will be covered along with general principles of creep and strain rate sensitivity. Final topics will include non-FCC dislocations, emphasizing the differences in structure and corresponding implications on dislocation mobility and macroscopic mechanical behavior; and dislocations in finite volumes.
Literature	Vorlesungsskript Aktuelle Publikationen Bücher: Introduction to Dislocations, by D. Hull and D.J. Bacon Theory of Dislocations, by J.P. Hirth and J. Lothe Physical Metallurgy, by Peter Hassen

Production				
Module M1156: Syste	ems Engineering			
Courses				
itle		Тур	Hrs/wk	СР
ystems 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 price			
	Thermodynamics Electrical Engineering			
	Control Systems			
	Previous knowledge in:			
	Aircraft Cabin Systems			
Educational Objectives	After taking part successfully, students have reached the follow	ing learning results		
Professional Competence				
Knowledge	Students are able to:			
	understand systems engineering process models, methods an		of complex Systen	ns
	describe innovation processes and the need for technology Ma			
	explain the aircraft development process and the process of type and type an	•		
	explain the system development process, including requirement identify any important conditions and test procedures for airly			
	identify environmental conditions and test procedures for airb value the methodology of requirements-based engineering (RI)		ments engineering	a (MBRE)
	value the methodology of requirements based engineering (its	be, and model based require	menes engineering	g (I-IDIXL)
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 pro			
	understand and serve their suppliers and customers in large p assume responsibility for people and technology in the development	•	me	
	assume responsibility for people and technology in the develo	prinerit of safety-critical syste	IIIS	
Autonomy	Students are able to:			
	interact and communicate in a development team with divisio			
	independently research and identify certification specifications	S		
	formulate requirements on their own create test plans on their own and assemble certification pro	200000		
	create test plans on their own and accompany certification pro	Julesses		
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56			
Credit points	6			
Course achievement	None		·	<u>-</u>
Examination	Written exam			
Examination duration and	120 Minutes			
scale	Alicent Contains Familia and an Co. 10 Mills 11 Co. 1			
Assignment for the		viation Systems: Flasting Com-	anulcon.	
Following Curricula	International Management and Engineering: Specialisation II. Av International Management and Engineering: Specialisation II. Pr	•		omnulsory
	Mechatronics: Specialisation System Design: Elective Compulsor	·	action, Elective Ci	οπιμαίου! γ
	Mechatronics: Specialisation System Design: Elective Compulsor Mechatronics: Specialisation Intelligent Systems and Robotics: E	-		
	Product Development, Materials and Production: Specialisation I		ulsory	
	Product Development, Materials and Production: Specialisation I			
	Product Development, Materials and Production: Specialisation I			
	· · · · · · · · · · · · · · · · · · ·	ems Engineering: Elective Co	-	

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 Engi	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	

Production				
Module M0840: Optin	nal and Robust Control			
Courses				
Title		Тур	Hrs/wk	СР
Optimal and Robust Control (L0658	3)	Lecture	2	3
Optimal and Robust Control (L0659		Recitation Section (small)	2	3
Module Responsible	Prof. Herbert Werner			
Admission Requirements				
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 material	rix Riccati equation for the solution of	LQ problems.	
	They can explain the duality between optimal sta			
	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 - based on the small gain	theorem - a robust controller can gu	arantee stability	and performance for
	an uncertain plant.	diking on foodbook land on he was		and the same of the same
	 They understand how analysis and synthesis con 	lations on reedback loops can be repr	esented as linear	matrix inequalities.
Skills				
	Students are capable of designing and tuning LQ			
	They are capable of representing a H2 or H-infin after a bala for a bline it.	ity design problem in the form of a ge	neralized plant, a	nd of using standard
	software tools for solving it.		In a second	
	They are capable of translating time and frequency Sopritivity functions and of carrying out a mixed		loops into const	raints on closed-loop
	 sensitivity functions, and of carrying out a mixed They are capable of constructing an LFT uncertains 		and of docioning	na a miyad ahiactiya
	robust controller.	tainty moder for all uncertain system	, and or designin	ig a mixed-objective
	They are capable of formulating analysis and sy	nthesis conditions as linear matrix ine	equalities (LMI) a	nd of using standard
	LMI-solvers for solving them.	menesis conditions as inical matrix inc	.quanties (Ei-ii), a	na or asing standard
	They can carry out all of the above using standar	rd software tools (Matlab robust contro	ol toolbox).	
	, ,		,	
Personal Competence				
Social Competence	Students can work in small groups on specific problems	s to arrive at joint solutions.		
Autonomy	Students are able to find required information in source	es provided (lecture notes, literature, s	oftware docume	ntation) and use it to
	solve given problems.			
	Independent Study Time 124, Study Time in Lecture 56			
Credit points				
Course achievement				
Examination				
Examination duration and	30 min			
scale				
Assignment for the	Electrical Engineering: Specialisation Control and Power	r Systems Engineering: Elective Comp	ulsory	
Following Curricula	Energy Systems: Core Qualification: Elective Compulsor	ry		
	Aircraft Systems Engineering: Core Qualification: Electiv	ve Compulsory		
	Mechatronics: Specialisation Intelligent Systems and Ro	obotics: Elective Compulsory		
	Mechatronics: Specialisation System Design: Elective Co	ompulsory		
	Biomedical Engineering: Specialisation Artificial Organs	and Regenerative Medicine: Elective	Compulsory	
	Biomedical Engineering: Specialisation Implants and En	doprostheses: Elective Compulsory		
	Biomedical Engineering: Specialisation Medical Technol	ogy and Control Theory: Elective Com	pulsory	
	Biomedical Engineering: Specialisation Management an	d Business Administration: Elective Co	ompulsory	
	Product Development, Materials and Production: Specia	alisation Product Development: Elective	e Compulsory	
	Product Development, Materials and Production: Specia	alisation Production: Elective Compulso	ory	
	Product Development, Materials and Production: Specia	lisation Materials: Elective Compulsor	y	
	Theoretical Mechanical Engineering: Core Qualification:	Elective Compulsory		

Course L0658: Optimal and Robust Control		
Тур	Lecture	
Hrs/wk	2	
СР	3	
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28	
Lecturer	Prof. Herbert Werner	
Language	EN	
Cycle	SoSe	
Content	 Optimal regulator problem with finite time horizon, Riccati differential equation Time-varying and steady state solutions, algebraic Riccati equation, Hamiltonian system Kalman's identity, phase margin of LQR controllers, spectral factorization Optimal state estimation, Kalman filter, LQG control Generalized plant, review of LQG control Signal and system norms, computing H2 and H∞ norms Singular value plots, input and output directions Mixed sensitivity design, H∞ loop shaping, choice of weighting filters Case study: design example flight control Linear matrix inequalities, design specifications as LMI constraints (H2, H∞ and pole region) Controller synthesis by solving LMI problems, multi-objective design Robust control of uncertain systems, small gain theorem, representation of parameter uncertainty 	
Literature	 Werner, H., Lecture Notes: "Optimale und Robuste Regelung" Boyd, S., L. El Ghaoui, E. Feron and V. Balakrishnan "Linear Matrix Inequalities in Systems and Control", SIAM, Philadelphia, PA, 1994 Skogestad, S. and I. Postlewhaite "Multivariable Feedback Control", John Wiley, Chichester, England, 1996 Strang, G. "Linear Algebra and its Applications", Harcourt Brace Jovanovic, Orlando, FA, 1988 Zhou, K. and J. Doyle "Essentials of Robust Control", Prentice Hall International, Upper Saddle River, NJ, 1998 	

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	Prof. Herbert Werner	
Language	EN	
Cycle	SoSe	
Content	See interlocking course	
Literature	See interlocking course	

Module M1690: Aircra	aft Design II (Special Air Vehicle Design)		
Courses				
Title		Тур	Hrs/wk	СР
	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				
Recommended Previous	Aircraft Design I (Design of Transport Aircraft)			
Knowledge	Air Transportation Systems			
Educational Objectives	After taking part successfully, students have reached the	following learning results		
Professional Competence				
Knowledge	Understanding of various flight systems and its special unmanned air systems)	characteristics (supersonic aircraft,	rotorcraft, high p	performance aircraft,
	Understanding of pro´s and con´s and physical character	istics of different air systems		
	Understanding of special mission requirements and its im	pact on systems definition and cond	ceptual design	
	Intensified knowledge of performance design on various a	air systems		
Skills	Understanding and application of design and calculation	methods		
	Understanding of interdisciplinary and integrative interde	pendencies		
	mission oriented technical definition of air systems			
	special conceptual calculation methods for special equipr	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	6			
Course achievement	None			
Examination	Written exam			
Examination duration and	180 min			
scale		0 1		
_	Aircraft Systems Engineering: Core Qualification: Elective		nulcon	
Following Curricula	International Management and Engineering: Specialisatio Product Development, Materials and Production: Specialis	·		
	Product Development, Materials and Production: Specialis Product Development, Materials and Production: Specialis	·		
	Theoretical Mechanical Engineering: Specialisation Aircra	·	*	
		, c c. mg c. c. we col		

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, Jens Thöben		
Language	DE/EN		
Cycle	SoSe		
Content	Design of supersonic civil aircraft Principles of high performance and special operations aircraft design Principles of Rotorcraft Design Principles of Unmanned Air Systems design, air taxis, electric aircraft		
Literature	Gareth Padfield: Helicopter Flight Dynamics, butterworth ltd. Raymond Prouty: Helicopter Performance Stability and Control, Krieger Publ. Klaus Hünecke: Das Kampfflugzeug von Heute, Motorbuch Verlag Jay Gundelach: Designing Unmanned Aircraft Systems - Configurative Approach, AIAA		

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

Module M1344: Proce	ssing of fibre-polymer-composites			
Courses				
Title		Тур	Hrs/wk	СР
Processing of fibre-polymer-compos		Lecture	2	3
From Molecule to Composites Part (L1516)	Project-/problem-based Learning	2	3
Module Responsible	Prof. Bodo Fiedler			
Admission Requirements	None			
Recommended Previous	Knowledge in the basics of chemistry / physics / materia	als science		
Knowledge				
Educational Objectives	After taking part successfully, students have reached th	e following learning results		
Professional Competence				
Knowledge	Students are able to give a summary of the technical of	- ·	•	•
	relationships. They are capable of describing and con		-	appropriate technical
	language. They can explain the typical process of solvir	g practical problems and present relate	d results.	
Skills	Students can use the knowledge of fiber-reinforced cor	nposites (FRP) and its constituents (fiber	/ matrix) and	define the necessary
	testing and analysis.			
	The same and the same law above to same above the same lab	and the second		
	They can explain the complex structure-property relation	inship and		
	he interactions of chemical structure of the polymers, their processing with the different fiber types, including to explain			
	neighboring contexts (e.g. sustainability, environmenta	protection).		
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	•		·
	audience. Students have the ability to develop alternat	ive approaches to an engineering probl	em independe	ently or in groups and
	discuss advantages as well as drawbacks.			
Autonomy	Students are capable of independently solving mecha			•
	gaps in as well as extent their knowledge using the liter	•	•	-
	meaningfully extend given problems and pragmatically		solutions and o	concepts.
	Independent Study Time 124, Study Time in Lecture 56			
Credit points Course achievement	6 None			
	None			
	Written exam			
Examination duration and scale	90 min			
	Materials Sciences Specialisation Engineering Materials	Elective Compulsory		
Following Curricula	Materials Science: Specialisation Engineering Materials: Mechanical Engineering and Management: Specialisatio	• •		
ronowing curricula	Product Development, Materials and Production: Specials		`omnulsory	
	Product Development, Materials and Production: Specia	•		
	Product Development, Materials and Production: Special			
	Theoretical Mechanical Engineering: Specialisation Mate			
		palsory		

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

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

Module M1343: Struct	ture and properties of fibre-polymer	-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	lymer-composites (L2614)	Project-/problem-based Learning	2	2
Structure and properties of fibre-po	lymer-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 reached	the following learning results		
Professional Competence				
Knowledge	Students can use the knowledge of fiber-reinforced onecessary testing and analysis.	composites (FRP) and its constituents to p	olay (fiber / m	atrix) and define the
	They can explain the complex relationships structure-	property relationship and		
	the interactions of chemical structure of the polyn		fiber types,	including to explain
	neighboring contexts (e.g. sustainability, environment	al protection).		
Skills	Students are capable of			
	 using standardized calculation methods in a g evaluate the different materials. 	iven context to mechanical properties (m	odulus, stren	gth) to calculate and
	approximate sizing using the network theory ofselecting appropriate solutions for mechanical relations			on resistance.
Personal Competence				
Social Competence	Students can			
Social competence	Stadents can			
	arrive at funded work results in heterogenius gradule.			
	 provide appropriate feedback and handle feedb 	eack on their own performance constructive	ely.	
Autonomy	Students are able to			
	- assess their own strengths and weaknesses.			
	- assess their own state of learning in specific terms a	nd to define further work steps on this bas	is.	
	- assess possible consequences of their professional a	ctivity.		
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	90 min			
scale				
Assignment for the	Energy Systems: Core Qualification: Elective Compulse	ory		
Following Curricula	Aircraft Systems Engineering: Core Qualification: Elect	tive Compulsory		
	International Management and Engineering: Specialisa	·	on: Elective C	compulsory
	Materials Science: Specialisation Engineering Materials	, ,		
	Mechanical Engineering and Management: Core Qualif		omnulee:::	
	Product Development, Materials and Production: Spec Product Development, Materials and Production: Spec	·	ompuisory	
	·			
	·	• •		
	Renewable Energies: Specialisation Wind Energy System	·		
	Renewable Energies: Specialisation Solar Energy Syste	• •		
	Theoretical Mechanical Engineering: Specialisation Ma	iterials Science: Elective Compulsory		
	Renewable Energies: Specialisation Solar Energy Syste	s: Elective Compulsory ems: Elective Compulsory ems: Elective Compulsory		

Course L1894: Structure and properties of fibre-polymer-composites		
Тур	Lecture	
Hrs/wk	2	
СР	3	
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28	
Lecturer	Prof. Bodo Fiedler	
Language	EN	
Cycle	SoSe	
Content	- Microstructure and properties of the matrix and reinforcing materials and their interaction	
	- Development of composite materials	
	- Mechanical and physical properties	
	- Mechanics of Composite Materials	
	- Laminate theory	
	- Test methods	
	- Non destructive testing	
	- Failure mechanisms	
	- Theoretical models for the prediction of properties	
	- Application	
Literature	Hall, Clyne: Introduction to Composite materials, Cambridge University Press	
Literature	Daniel, Ishai: Engineering Mechanics of Composites Materials, Oxford University Press	
	Mallick: Fibre-Reinforced Composites, Marcel Deckker, New York	
	Manick: Fibre-Reinforced Composites, Marcel Deckker, New York	

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

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

Module M1174: Autor	nation Technology and Systems			
Courses				
Title		Тур	Hrs/wk	СР
Automation Technology and System		Lecture	4	4
Automation Technology and System		Project-/problem-based Learning	1	1
Automation Technology and Syster		Recitation Section (small)	1	1
	Prof. Thorsten Schüppstuhl			
Admission Requirements	None			
	without major course assessment			
Knowledge				
Educational Objectives	After taking part successfully, students have reached th	ne following learning results		
Professional Competence				
Knowledge	Students			
	 know the characteristic components of an autom 	ation systems and have good understand	ling of their int	teraction
	know methods for a systematical analysis of auto		ang or error are	.craction
	have special competences in industrial robot bas			
Skills	Students are able to			
	analyze complex Automation tasks			
	develop application based concepts and solution	s		
	 design subsystems and integrate into one system 			
	investigate and evaluate safety of machinery			
	 create simple programs for robots and programn 	nable logic controllers		
	design of circuit for pneumatic applications	3		
Personal Competence				
Social Competence	Students are able to			
	- find solutions for automation and handling tasks in gro	oups		
	- develop solutions in a production environment with q	ualified personnel at technical level and r	epresent decis	ions.
Autonomy	Students are able to			
,				
	analyze automation tasks independently			
	generate programs for robots and programmable			
	develop solutions for practice oriented tasks of a			
	 design safety concepts for automation applicatio 			
	assess consequences of their professional action	s and responsibilities		
Workload in Hours	Independent Study Time 96, Study Time in Lecture 84			
Credit points				
Course achievement				
	Written exam			
Examination duration and				
scale	120 11111			
	International Management and Engineering: Specialisat	ion II Product Development and Production	on: Flective Cr	mnulsory
•	Product Development, Materials and Production: Specialisate	·		лприізої у
i onowing curricula	Product Development, Materials and Production: Special	•	ziiipuisoi y	
	Product Development, Materials and Production: Special	, ,		
	Theoretical Mechanical Engineering: Specialisation Proc	•	e Compulsory	
		pc aa i rodaction. Licctiv	- 50pai501y	

Course L2329: Automation To	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 T	Course L2331: Automation Technology and Systems	
Тур	Project-/problem-based Learning	
Hrs/wk	1	
СР	1	
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14	
Lecturer	Prof. Thorsten Schüppstuhl	
Language	DE	
Cycle	SoSe	
Content	See interlocking course	
Literature	See interlocking course	

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

Module M1878: Susta	inable energy from wind and	water			
Courses					
Title		Туј	9	Hrs/wk	СР
Sustainability Management (L0007)	Lec	ture	2	1
Hydro Power Use (L0013)			ture	1	1
Wind Turbine Plants (L0011) Wind Energy Use - Focus Offshore	(10012)		ture ture	2	3 1
	Dr. Marvin Scherzinger	Lec	ture	1	1
Admission Requirements	None				
	Module: Technical Thermodynamics I,				
Knowledge					
	Module: Technical Thermodynamics II,				
	Module: Fundamentals of Fluid Mechanics				
Educational Objectives	After taking part successfully, students ha	ve reached the following le	earning results		
Professional Competence					
Knowledge	By ending this module students can expl	lain in detail knowledge o	f wind turbines with	h a particular focus of	wind energy use in
	offshore conditions and can critical comm				-
	to describe fundamentally the use of water			reproduce and explain	the basic procedure
	in the implementation of renewable energ	y projects in countries outs	side Europe.		
	Through active discussions of various to	pics within the seminar o	f the module, stude	ents improve their und	derstanding and the
	application of the theoretical background	and are thus able to transfe	er what they have le	earned in practice.	
Skills	Students are able to apply the acquired	theoretical foundations or	n exemplary water	or wind power system	s and evaluate and
	assess technically the resulting relationsh				
	compare critically the special procedure for	or the implementation of re	enewable energy pr	ojects in countries outs	side Europe with the
	in principle applied approach in Europe an	d can apply this procedure	on exemplary theo	retical projects.	
Personal Competence					
Social Competence	Students can discuss scientific tasks subje	et-specificly and multidiscip	olinary within a sem	ninar.	
A	Charles to a control of the control of	and the three and the second			
Autonomy	Students can independently exploit source lecture and to acquire the particular know			cture material to clear	the contents of the
	lecture and to acquire the particular know	ledge about the subject an	ea.		
Workload in Hours	Independent Study Time 96, Study Time in	n Lecture 84			
Credit points					
Course achievement	Compulsory Bonus Form Yes None Written elaboration	Description Schriftliche Ausar	hoitung (inkl. Vortra	ag) in Nachhaltigkoitem	anagomont
Examination		Schilline Ausar	beitung (iliki. voiti	ag) in Nachhaltigkeitsm	ianagement
Examination duration and					
scale					
Assignment for the	Civil Engineering: Specialisation Structural	Engineering: Elective Com	npulsory		
Following Curricula	Civil Engineering: Specialisation Geotechn	ical Engineering: Elective C	Compulsory		
	Civil Engineering: Specialisation Coastal En	ngineering: Elective Compu	ulsory		
	International Management and Engineerin			-	Compulsory
	International Management and Engineerin		3,		
	Product Development, Materials and Produ	·			
	Product Development, Materials and Produ Product Development, Materials and Produ				
	Renewable Energies: Core Qualification: Co	·	ilais. Elective Comp	uisUI y	
	Theoretical Mechanical Engineering: Speci	, ,	Elective Compulsor	у	
	Process Engineering: Specialisation Enviro				
	Water and Environmental Engineering: Spe	-		-	
	Water and Environmental Engineering: Spe	ecialisation Cities: Elective	Compulsory		

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

Course L0013: Hydro Power	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

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 SoSe
Content	 Introduction, importance of offshore wind power generation, Specific requirements for offshore engineering Physical fundamentals for utilization of wind energy Design and operation of offshore wind turbines, presentation of different concepts of offshore wind turbines, representation of the individual system components and their system-technical relationships Foundation engineering, offshore site investigation, presentation of different concepts of offshore foundation structures, planning and fabrication of foundation structures Electrical infrastructure of an offshore wind farm, Inner Park cabling, offshore substation, grid connection Installation of offshore wind farms, installation techniques and auxiliary devices, construction logistics Development and planning of offshore wind farms Operation and optimization of offshore wind farms Day excursion
Literature	 Gasch, R.; Twele, J.: Windkraftanlagen - Grundlagen, Entwurf, Planung und Betrieb; Vieweg + Teubner, Stuttgart, 2007, 7. Auflage Molly, J. P.: Windenergie - Theorie, Anwendung, Messung; C. F. Müller, Heidel-berg, 1997, 3. Auflage Hau, E.: Windkraftanalagen; Springer, Berlin, Heidelberg, 2008, 4.Auflage Heier, S.: Windkraftanlagen - Systemauslegung, Integration und Regelung; Vieweg + Teubner, Stuttgart, 2009, 5. Auflage Jarass, L.; Obermair, G.M.; Voigt, W.: Windenergie: Zuverlässige Integration in die Energieversorgung; Springer, Berlin, Heidelberg, 2009, 2. Auflage

Module 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	Course 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				
Admission Requirements			T (0	<u> </u>
Recommended Previous	Mathematics I-III, Computer Sciense, Engineering Thermod	ynamics I, II, Fluid Dynamics, Heat	Transfer, Control	Systems
Knowledge				
Educational Objectives	After taking part successfully, students have reached the f	ollowing 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 (Compulsory		
	Aeronautics: Core Qualification: Elective Compulsory			
	Product Development, Materials and Production: Specialisa	tion Product Development: Elective	Compulsory	
	Product Development, Materials and Production: Specialisa	tion Production: Elective Compulso	ry	
	Product Development, Materials and Production: Specialisa	tion Materials: Elective Compulsory	•	
	Renewable Energies: Specialisation Bioenergy Systems: El			
	Renewable Energies: Specialisation Solar Energy Systems:			
	Renewable Energies: Specialisation Wind Energy Systems:			
	Theoretical Mechanical Engineering: Specialisation Simulat		ry	
	Theoretical Mechanical Engineering: Specialisation Energy	Systems: Elective Compulsory		

	Theoretical Company of the Company o
Course L3150: System Simul	ation Modul
Тур	Lecture
Hrs/wk	
СР	
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	 Modelica Association: "Modelica Language Specification - Version 3.5", Linköping, Sweden, 2021. OpenModelica: OpenModelica 1.17.0, https://www.openmodelica.org (siehe Download), 2021. M. Tiller: "Modelica by Example", https://book.xogeny.com, 2014. M. Otter, H. Elmqvist, et al.: "Objektorientierte Modellierung Physikalischer Systeme", at- Automatisierungstechnik (german), Teil 1 - 17, Oldenbourg Verlag, 1999 - 2000. P. Fritzson: "Principles of Object-Oriented Modeling and Simulation with Modelica 3.3", Wiley-IEEE Press, New York, 2015. 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	itation 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 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	ı				.,,,		
Admission Requirements	None						
Recommended Previous	Fundamentals of elec	trical engine	eering				
Knowledge							
	Broad knowledge of n	nechanics					
	Fundamentals of cont	rol theory					
Educational Objectives	After taking part succ	essfully, stu	idents 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 derive and solve equations of motion for various manipulators.						
	Students can generat	Students can generate trajectories in various coordinate systems.					
	Chudonto con docion l						
	Students can design linear and partially nonlinear controllers for robotic manipulators.						
Personal Competence							
Social Competence	Students are able to work goal-oriented in small mixed groups.						
Autonomy	Students are able to r	ecognize ar	nd improve kn	owledge deficits in	ndependently.		
	With instructor assists	With instructor assistance, students are able to evaluate their own 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	Form		Description			
	Yes None	Subject practical v	theoretical	jeweiligen Se	n PBL-Einheiten sowie Erreic	nen des Ges	amtziels und der
Examination	Written exam	practical v	VOIK	Jewenigen 3e	551011-21616		
Examination duration and							
scale							
Assignment for the	Aircraft Systems Engi	neering: Co	re Qualificatio	n: Elective Compu	ılsory		
Following Curricula	International Manage	ment and Er	ngineering: Sp	ecialisation II. Pro	oduct Development and Producti	on: Elective Co	mpulsory
	International Manage	ment and Er	ngineering: Sp	ecialisation II. Me	chatronics: Elective Compulsory		
	Aeronautics: Core Qua			-			
	Mechanical Engineeri	-	-	e Qualification: Co	ompulsory		
	Mechatronics: Core Q			o Enocialization D	traduct Davalanment: Fleeti C	omnulee =: ·	
				•	roduct Development: Elective C roduction: Elective Compulsory	ompulsory	
	· ·				Materials: Elective Compulsory		
	-				elopment and Production: Elective	e Compulsory	
		-			Computer Science: Elective Con		

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	ect-/problem-based Learning			
Hrs/wk	2			
СР	2			
Workload in Hours	lependent Study Time 32, Study Time in Lecture 28			
Lecturer	Martin Gomse			
Language	EN			
Cycle	WiSe			
Content	See interlocking course			
Literature	See interlocking course			

Production"				
Module M0771: Flight	t Physics			
Courses				
Title Aerodynamics and Flight Mechanic Flight Mechanics II (L0730)	s I (L0727)	Typ Lecture Lecture	Hrs/wk 3 2	CP 3 2
Flight Mechanics II (L0731)		Recitation Section (large)	1	1
Module Responsible	Prof. Frank Thielecke			
Admission Requirements	None			
Recommended Previous Knowledge	Basic knowledge in: Mathematics Mechanics Thermodynamics Aviation			
Educational Objectives	After taking part successfully, students have reache	ed the following learning results		
	Accessions, Students have reached	a the following learning results		
Professional Competence	Students are able to			
	Describe the fundamental equations of aerod 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 air	d lateral motion	e and frictional flo	w
Skills	Students are able to Perform flight mechanic simulations Derive flight mechanic relations from virtual in the second sec	and real flight test data		
Personal Competence				
Social Competence	Students are able to:			
	Perform simulations in groups and discuss re Evaluate flight test data in groups, discuss ar			
Autonomy	Students are able to: • Process teaching content independently			
	Prepare, work out and process simulation mo	dels independently		
	Apply teaching content on virtual and real flig	ght test data		
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	160 Minutes			
Assignment for the	Aircraft Systems Engineering: Core Qualification: Co	mpulsory		
Following Curricula	International Management and Engineering: Special	isation II. Aviation Systems: Elective Com	pulsory	
	Aeronautics: Core Qualification: Compulsory			
	Product Development, Materials and Production: Sp	ecialisation Product Development: Electiv	e Compulsory	
	Product Development, Materials and Production: Sp	ecialisation Production: Elective Compulse	ory	
	Product Development, Materials and Production: Sp	·	-	
	Theoretical Mechanical Engineering: Specialisation	Aircraft Systems Engineering: Elective Co	mpulsory	

Course L0727: Aerodynamics	and Flight Mechanics I
Тур	Lecture
Hrs/wk	3
СР	3
Workload in Hours	Independent Study Time 48, Study Time in Lecture 42
Lecturer	Prof. Frank Thielecke, Dr. Ralf Heinrich
Language	DE
Cycle	WiSe
Content	 Aerodynamics (fundamental equations of aerodynamics; compressible and incompressible flows; airfoils and wings; viscous flows) Flight Mechanics (Equations of motion; flight performance; control surfaces; derivatives; lateral stability and control; trim conditions; flight maneuvers)
Literature	 Schlichting, H.; Truckenbrodt, E.: Aerodynamik des Flugzeuges I und II Etkin, B.: Dynamics of Atmospheric Flight Sachs/Hafer: Flugmechanik Brockhaus: Flugregelung J.D. Anderson: Introduction to flight

Course L0730: Flight Mechan	nics II					
Тур	Lecture					
Hrs/wk	2					
СР						
Workload in Hours	pendent 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	citation 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	СР
Product Planning (L0851)		Lecture	3	3
Product Planning Seminar (L0853)		Project-/problem-based Learning	2	3
Module Responsible	Prof. Cornelius Herstatt			
Admission Requirements	None			
Recommended Previous	Good basic-knowledge of Business Administration			
Knowledge				
	After taking part successfully, students have reached the fo	ollowing learning results		
Professional Competence				
Knowledge	Students will gain insights into:			
	Product Planning			
	 Process 			
	 Methods 			
	Design thinking			
	 Process 			
	 Methods 			
	User integration			
Skills	Students will gain deep insights into:			
	Product Planning			
	 Process-related aspects 			
	 Organisational-related aspects 			
	 Human-Ressource related aspects 			
	 Working-tools, methods and instruments 			
	٥			
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			
	Develop presentation skills			
Workload in Hours	Independent Study Time 110, Study Time in Lecture 70			
Credit points	6			
Course achievement	Compulsory Bonus Form Description	on		
	Yes 20 % Subject theoretical and			
	practical work			
Examination				
Examination duration and scale	90 minutes			
Assignment for the	Global Innovation Management: Core Qualification: Compul	sorv		
Following Curricula	International Management and Engineering: Specialisation	•	npulsory	
. onowing curricula	Mechanical Engineering and Management: Specialisation M		puisoi y	
	Product Development, Materials and Production: Specialisation in		ompulsorv	
	Product Development, Materials and Production: Specialisa	· ·		
	Product Development, Materials and Production: Specialisa	, ,		
	Theoretical Mechanical Engineering: Specialisation Product		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.
114.	Which W Fastering C. Budust Daving and Davidson and Edition McGray VIII 2010
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	ependent 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".			

ction Planning & Control an	d Digital Enterprise			
	Тур	Hrs/wk	СР	
	Lecture	2	2	
9929)	Lecture	2	2	
930)	Recitation Section (small)	1	1	
933)	Recitation Section (small)	1	1	
Prof. Hermann Lödding				
None				
Fundamentals of Production and Quality	Management			
After taking part successfully, students h	ave reached the following learning results			
Students can explain the contents of the	module in detail and take a critical position to them	ı.		
·				
. , , , , , , , , , , , , , , , , , , ,		•		
Students can develop joint solutions in m	nixed teams and present them to others.			
-				
Independent Study Time 96 Study Time in Lecture 84				
None				
Written exam				
180 Minuten				
International Management and Engineeri	ing: Specialisation II. Product Development and Prod	uction: Elective Co	ompulsory	
Logistics, Infrastructure and Mobility: Spe	ecialisation Production and Logistics: Elective Compu	ulsory		
Biomedical Engineering: Specialisation A	rtificial Organs and Regenerative Medicine: Elective	Compulsory		
Biomedical Engineering: Specialisation In	nplants and Endoprostheses: Elective Compulsory			
Biomedical Engineering: Specialisation M	ledical Technology and Control Theory: Elective Com	pulsory		
Biomedical Engineering: Specialisation M	lanagement and Business Administration: Compulso	ry		
Product Development, Materials and Prod	duction: Specialisation Product Development: Electiv	e Compulsory		
Product Development, Materials and Prod	duction: Specialisation Production: Compulsory			
Product Development, Materials and Prod	duction: Specialisation Materials: Elective Compulsor	У		
Theoretical Mechanical Engineering: Spec	cialisation Product Development and Production: Ele	ctive Compulsory		
	20929) 20930) 20930) 20933) Prof. Hermann Lödding None Fundamentals of Production and Quality After taking part successfully, students in Students can explain the contents of the Students are capable of choosing and ap Students can develop joint solutions in m - Independent Study Time 96, Study Time 6 None Written exam 180 Minuten International Management and Engineeri Logistics, Infrastructure and Mobility: Spe Biomedical Engineering: Specialisation A Biomedical Engineering: Specialisation In Biomedical Engineering: Specialisation M Biomedical Engineering: Specialisation M Product Development, Materials and Prod	Lecture 1929) Lecture 1930) Recitation Section (small) 1933) Recitation Section (small) 1943 None 1954 Fundamentals of Production and Quality Management After taking part successfully, students have reached the following learning results Students can explain the contents of the module in detail and take a critical position to them Students are capable of choosing and applying models and methods from the module to industriate are capable of choosing and applying models and methods from the module to industriate are capable of choosing and applying models and present them to others. Independent Study Time 96, Study Time in Lecture 84 6 None Written exam 180 Minuten International Management and Engineering: Specialisation II. Product Development and Productiositics, Infrastructure and Mobility: Specialisation Production and Logistics: Elective Complishmedical Engineering: Specialisation Medical Technology and Control Theory: Elective Elective Biomedical Engineering: Specialisation Medical Technology and Control Theory: Elective Complishmedical Engineering: Specialisation Medical Technology and Control Theory: Elective Compulsory Product Development, Materials and Production: Specialisation Product Development: Elective Product Development, Materials and Production: Specialisation Materials: Elective Compulsory Product Development, Materials and Production: Specialisation Materials: Elective Compulsory Product Development, Materials and Production: Specialisation Materials: Elective Compulsory Product Development, Materials and Production: Specialisation Materials: Elective Compulsory Product Development, Materials and Production: Specialisation Materials: Elective Compulsory Product Development, Materials and Production: Specialisation Materials: Elective Compulsory Product Development, Materials and Production: Specialisation Materials: Elective Compulsory Product Development,	Typ Hrs/wk Lecture 2 1929) Lecture 2 1930) Recitation Section (small) 1 1933) Recitation Section (small) 1 1 Prof. Hermann Lödding None Fundamentals of Production and Quality Management After taking part successfully, students have reached the following learning results Students can explain the contents of the module in detail and take a critical position to them. Students are capable of choosing and applying models and methods from the module to industrial problems. Students can develop joint solutions in mixed teams and present them to others. - Independent Study Time 96, Study Time in Lecture 84 6 None Written exam 180 Minuten International Management and Engineering: Specialisation II. Product Development and Production: Elective Congulsory Biomedical Engineering: Specialisation Artificial Organs and Regenerative Medicine: Elective Compulsory Biomedical Engineering: Specialisation Implants and Endoprostheses: Elective Compulsory Biomedical Engineering: Specialisation Management and Business Administration: Compulsory Biomedical Engineering: Specialisation Management and Business Administration: Compulsory Product Development, Materials and Production: Specialisation Product Development: Elective 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	ture	
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	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 Managemer	nt		
Courses				
Title		Тур	Hrs/wk	СР
Safety, Reliability and Risk Assessm		Seminar	2	3
Environment and Sustainability (L0)		Lecture	2	3
Module Responsible				
Admission Requirements				
Recommended Previous	none			
Knowledge				
Educational Objectives	After taking part successfully, students hav	re 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 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 guestions. 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	Consisting 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 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.

FIOGUCCIOII	Production"			
Module M1155: Aircra	ift 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 follow	ving 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 call	abin Systems		
	• elucidate the necessity of cabin operating systems and emer	gency Systems		
	• assess the challenges human factors integration in a cabin e	nvironment		
Chille	Chudonta 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 all Allillik design cabin systems for safe operations	•		
	design eachin systems for safe operations design emergency systems for safe man-machine interaction	1		
	solve comfort needs and entertainment requirements in the			
Personal Competence				
Social Competence	Students are able to:			
	comprehend existing system solutions and explain them on the system solutions and explain them on the system solutions.	the basis of existing requiremen	nts	
	discuss with experts in technical language			
	explain system functions			
	classify the criticality of functions			
	describe systems as is			
Autonomy	Students are able to:			
	independently reflect on lecture content and expert presents	tions		
	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	Independent Study Time 124, Study Time in Lecture 56			
	None			
	Written exam			
Examination Examination duration and				
Examination duration and scale	120 Millutes			
	Electrical Engineering, Specialization Control and Berry System	no Engineering, Fleeting Comm	ulcon.	
	Electrical Engineering: Specialisation Control and Power System	ns Engineering: Elective Compi	11501 Y	
Following Curricula	Aircraft Systems Engineering: Core Qualification: Compulsory International Management and Engineering: Specialisation II. A	viation Systems: Floative Com-	ouleon,	
	Aeronautics: Core Qualification: Compulsory	wiation systems. Elective Comp	Juisti y	
	Product Development, Materials and Production: Specialisation	Product Development: Floctive	Compulsory	
	Product Development, Materials and Production: Specialisation			
	Product Development, Materials and Production: Specialisation			
	Theoretical Mechanical Engineering: Specialisation Aircraft Sys			
		Ling. Elective Col	y	

Course L1545: Aircraft Cabin	Systems	
Тур	Lecture	
Hrs/wk	3	
CP		
Workload in Hours	Independent Study Time 78, Study Time in Lecture 42	
Lecturer	Prof. Ralf God	
Language	DE	
Cycle	WiSe	
Content	The objective of the lecture with the corresponding exercise is the acquisition of knowledge about aircraft cabin systems and cabin operations. A basic understanding of technological and systems engineering effort to maintain an artificial but comfortable and safe travel and working environment at cruising altitude is to be achieved.	
	The course provides a comprehensive overview of current technology and cabin systems in modern passenger aircraft. The Fulfillment of requirements for the cabin as the central system of work are covered on the basis of the topics comfort, ergonomics, human factors, operational processes, maintenance and energy supply: • Materials used in the cabin • Ergonomics and human factors • Cabin interior and non-electrical systems • Cabin electrical systems and lights • Cabin electronics, communication-, information- and IFE-systems • Cabin and passenger process chains • RFID Aircraft Parts Marking	
	Energy sources and energy conversion	
Literature	 Skript zur Vorlesung Jenkinson, L.R., Simpkin, P., Rhodes, D.: Civil Jet Aircraft Design. London: Arnold, 1999 Rossow, CC., Wolf, K., Horst, P. (Hrsg.): Handbuch der Luftfahrzeugtechnik. Carl Hanser Verlag, 2014 Moir, I., Seabridge, A.: Aircraft Systems: Mechanical, Electrical and Avionics Subsystems Integration, Wiley 2008 Davies, M.: The standard handbook for aeronautical and astronautical engineers. McGraw-Hill, 2003 Kompendium der Flugmedizin. Verbesserte und ergänzte Neuauflage, Nachdruck April 2006. Fürstenfeldbruck, 2006 Campbell, F.C.: Manufacturing Technology for Aerospace Structural Materials. Elsevier Ltd., 2006 	

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

Module M1183: Laser Systems and Methods of Manufacturing Design and Analysis				
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, 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: Ele	ective Compulsory	
Following Curricula	Product Development, Materials and Production: Specialisation Production: Compulsory			
	Product Development, Materials and	Production: Specialisation Materials: Elective Compu	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. Wolfgang Hintze
Language	DE
Cycle	WiSe
Content	 Modelling and simulation of maching and forming processes Numerical simulation of forces, temperatures, deformation in machining Analysis of vibration problems in maching (chatter, modal analysis,) Knowledge based process planning Design of experiments Machinability of nonmetallic materials Analysis of interaction between maching process and machine tool systems with regard to process stability and quality Simulation of maching processes by virtual reality methods
Literature	Tönshoff, H.K.; Denkena, B.; Spanen Grundlagen, Springer (2004) Klocke, F.; König, W.; Fertigungsverfahren Umformen, Springer (2006) Weck, M.; Werkzeugmaschinen Fertigungssysteme 3, Springer (2001) Weck, M.; Werkzeugmaschinen Fertigungssysteme 5, Springer (2001)

Courses				
		T	Hen fools	CD
Fitle Structure and Properties of Polyme	rs (1.0389)	Typ Lecture	Hrs/wk 2	CP 3
Processing and design with polyme		Lecture	2	3
Module Responsible				
Admission Requirements	None			
Recommended Previous	Basics: chemistry / physics / material science			
Knowledge				
Educational Objectives	After taking part successfully, students have r	eached the following learning results		
Professional Competence				
Knowledge	Students can use the knowledge of plastics ar	nd define the necessary testing and analy	rsis.	
	They can explain the complex relationships st	ructure-property relationship and		
	They can explain the complex relationships so	ructure-property relationship and		
	the interactions of chemical structure of the p	olymers, including to explain neighboring	g contexts (e.g. sustaina	ability, environmenta
	protection).			
Skills	Students are capable of			
	- using standardized calculation methods in	a given context to mechanical prope	erties (modulus, streng	jtn) to calculate an
	evaluate the different materials.			
	- selecting appropriate solutions for mechanic	cal recycling problems and sizing example	e stiffness, corrosion re	sistance.
Personal Competence				
Social Competence	Students can			
Social competence	Stadents can			
	- arrive at funded work results in heterogenius	s groups and document them.		
	- provide appropriate feedback and handle fee	edback on their own performance constru	ictively.	
Autonomy	Students are able to			
	- assess their own strengths and weaknesses.			
	- assess their own strengths and weaknesses.			
	- assess their own state of learning in specific	terms and to define further work steps o	n this basis.	
	- assess possible consequences of their profes	ssional activity.		
Workload in Hours	Independent Study Time 124, Study Time in L	ecture 56		
Credit points	6			
Course achievement	None			
Examination	Written exam			
Examination duration and	180 min			
scale				
Assignment for the	Materials Science and Engineering: Specialisa		oulsory	
Following Curricula	Materials Science: Specialisation Engineering Biomedical Engineering: Specialisation Implar			
	Biomedical Engineering: Specialisation Implar Biomedical Engineering: Specialisation Artifici		ective Compulsory	
	Biomedical Engineering: Specialisation Manag			
	Biomedical Engineering: Specialisation Medical			
	Product Development, Materials and Production	**		
	Product Development, Materials and Production	on: Specialisation Materials: Elective Com	pulsory	
	Product Development, Materials and Production	·		
	Theoretical Mechanical Engineering: Specialis	ation Materials Science: Elective Compuls	sory	

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

TTOGGCCTOTT					
Module M1170: Pheno	omena and Methods in Materials	s Science			
Courses					
Title		Тур		Hrs/wk	СР
Experimental Methods for the Char	acterization of Materials (L1580)	Lecture		2	2
Phase equilibria and transformation	ns (L1579)	Lecture		2	2
Übung zu Phänomene und Methode	en der Materialwissenschaft (L2991)	Recitation	Section (large)	2	2
Module Responsible	Prof. Jörg Weißmüller				
Admission Requirements	None				
Recommended Previous	Basic knowledge in Materials Science, e.g. We	kstoffwissenschaft I/II			
Knowledge					
Educational Objectives	After taking part successfully, students have re	eached the following learning	results		
Professional Competence					
Knowledge	The students will be able to explain the prope	rties of advanced materials	along with their ap	plications in tech	nology, in particular
	metallic, ceramic, polymeric, semiconductor, r	nodern composite materials	(biomaterials) and	nanomaterials.	
Skills	The students will be able to select material	configurations according to	the technical nee	ds and, if neces	sarv. to design new
	materials considering architectural principles	-			
	modern materials science, which enables			-	
	applications.	•			
Personal Competence					
Social Competence	The students are able to present solutions to s	pecialists and to develop ide	as further.		
Autonomy	The students are able to				
	assess their own strengths and weaknes	coc			
	gather new necessary expertise by their				
	gather new necessary expertise by their	OWII.			
Workload in Hours	Independent Study Time 96, Study Time in Led	ture 84			
Credit points	6				
Course achievement	None				
Examination	Written exam				
Examination duration and	90 min				
scale					
Assignment for the	Chemical and Bioprocess Engineering: Special	sation General Process Engir	eering: Elective Co	ompulsory	
Following Curricula	Chemical and Bioprocess Engineering: Speciali	sation Chemical Process Eng	ineering: Elective (Compulsory	
	International Management and Engineering: Sp	pecialisation II. Product Deve	lopment and Produ	ction: Elective Co	ompulsory
	Materials Science: Core Qualification: Compuls	ory			
	Product Development, Materials and Productio	n: Specialisation Product Dev	elopment: Elective	Compulsory	
	Product Development, Materials and Productio	n: Specialisation Production:	Elective Compulso	ry	
	Product Development, Materials and Productio	n: Specialisation Materials: C	ompulsory		
	Theoretical Mechanical Engineering: Specialisa	tion Materials Science: Elect	ive 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 Fundamentals of Maintenance, Repair and Overhaul (MRO) (L3160)		Typ Lecture	Hrs/wk	CP 4
Fundamentals of Maintenance, Rep		Recitation Section (large)	1	2
Module Responsible				
Admission Requirements	None			
Kecommended Previous Knowledge	We recommend knowledge in the areas of general engi fields like mechanical engineering, mechatronics and content.	-	-	-
Educational Objectives	After taking part successfully, students have reached the	e following learning results		
Professional Competence				
Knowledge	The students are able to describe fundamental correlation 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 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 with environment of multiple stakeholders.	a clear focus on the approached	solutions by res	pecting the complex
Autonomy	The students are enabled to find solutions for optim determining factors independently.	ization problems and to take req	uired decision fo	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				
Assignment for the	Aircraft Systems Engineering: Core Qualification: Elective	e Compulsory		
Following Curricula	Aeronautics: Core Qualification: Elective Compulsory			
	Mechatronics: Specialisation Intelligent Systems and Rol	otics: Elective Compulsory		
	Mechatronics: Specialisation System Design: Elective Co	mpulsory		
	Mechatronics: Core Qualification: Elective Compulsory			
	Product Development, Materials and Production: Special	•		
	Product Development, Materials and Production: Special	·	•	
	Product Development, Materials and Production: Special	·	-	
	Theoretical Mechanical Engineering: Specialisation Produ	•		/
	Theoretical Mechanical Engineering: Specialisation Aircra	irt Systems Engineering: Elective Co	mpulsory	

Course L3160: Fundamentals	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 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 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 M0867: Production Planning & Control and Digital Enterprise				
Courses				
Title Typ Hrs/wk Cl				
The Digital Enterprise (L0932)		Lecture	2	2
Production Planning and Control (LC	0929)	Lecture	2	2
Production Planning and Control (LC		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 ther	n.	
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	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 Pro	duction: Elective C	ompulsory
Following Curricula	Logistics, Infrastructure and Mobility: Spec	cialisation Production and Logistics: Elective Comp	oulsory	
	Biomedical Engineering: Specialisation Art	tificial Organs and Regenerative Medicine: Elective	Compulsory	
	Biomedical Engineering: Specialisation Im	plants 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 Prod	uction: Specialisation Production: Compulsory		
	Product Development, Materials and Production: Specialisation Materials: Elective Compulsory			
	Theoretical Mechanical Engineering: Spec	cialisation Product Development and Production: El	ective Compulsory	

Course L0932: The Digital En	rerprise
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	

Production"				
Module M0763: Aircra	aft Energy Systems			
-				
Courses				
Title		Typ	Hrs/wk	CP
Aircraft Energy Systems (L0735) Aircraft Energy Systems (L0739)		Lecture Recitation Section (large)	3 2	4
Module Responsible	Prof Frank Thielecke			
Admission Requirements				
Recommended Previous				
Knowledge				
	Mathematics			
	Mechanics Thermodynamics			
	Electrical Engineering			
	Fluid mechanics			
Educational Objectives	After taking part successfully, students have reached to	he following learning results		
Professional Competence				
Knowledge	Students are able to:			
	Assess challenges during the design of aircraft e	nergy systems		
	Describe essential components and design point	s of hydraulic and electrical supply sys	stems	
	Give an overview of the functionality of air condi-	tioning systems		
	Describe different system concepts for de-icing			
	Identify constraints for the electrification of aircr	·	ncepts and limitat	ions
	Describe architectures for fuel supply systems a	- ·		
	Explain possible approaches for the integration of the integratio	or fuel cell systems and evaluate zero-	emission concepts	5
Skills	Students are able to:			
	Design hydraulic and electric supply systems of	aircrafts		
	Analyze the thermodynamic behavior of air cond			
	Design ice protection systems			
	Apply possible electrification concepts to existing	g 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 an Present systems engineering problems and discu 			
	• Present systems engineering problems and disci	ass solutions with experts		
Autonomy	Students are able to:			
,				
	Reflect on the content of lectures autonomously			
	 Apply methods learned in the course of exercise Identify complex system dependencies autonom 	·	nd design process	200
	- identify complex system dependencies autonom	lously and abstract simplified models a	ind design proces.	363
Workload in Hours	Independent Study Time 110, Study Time in Lecture 70)		
Credit points				
Course achievement				
Examination				
Examination duration and	165 Minutes			
scale	Francis Contains Considiration 5			
	Energy Systems: Specialisation Energy Systems: Election			
Following Curricula	Aircraft Systems Engineering: Core Qualification: Comp International Management and Engineering: Specialisa		nulsory	
	Product Development, Materials and Production: Specialsa	•		
	Product Development, Materials and Production: Special	·		
	Product Development, Materials and Production: Specia			
	Theoretical Mechanical Engineering: Specialisation Airc	raft Systems Engineering: Elective Cor	mpulsory	

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 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 M1183: Laser	Systems and Methods of	f Manufacturing Design and Analy	ysis	
Courses				
Title		Тур	Hrs/wk	СР
Laser Systems and Process Techno	•	Lecture	2	3
Methods for Analysing Production F	Processes (L0876)	Lecture	2	3
Module Responsible	Prof. Wolfgang Hintze			
Admission Requirements	None			
Recommended Previous				
Knowledge				
Educational Objectives	After taking part successfully, studer	nts have reached the following learning results		
Professional Competence				
Knowledge				
Skills				
Personal Competence				
Social Competence				
Autonomy				
Workload in Hours	Independent Study Time 124, Study	Time in Lecture 56		
Credit points	6			
Course achievement	None			
Examination	Written exam			
Examination duration and	180 min			
scale				
Assignment for the	Product Development, Materials and	Production: Specialisation Product Development:	Elective Compulsory	
Following Curricula	Product Development, Materials and	Production: Specialisation Production: Compulsor	ry	
	Product Development, Materials and	Production: Specialisation Materials: Elective Cor	mpulsory	
	Theoretical Mechanical Engineering:	Specialisation Product Development and Product	ion: 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. Wolfgang Hintze
Language	DE
Cycle	WiSe
Content	 Modelling and simulation of maching and forming processes Numerical simulation of forces, temperatures, deformation in machining Analysis of vibration problems in maching (chatter, modal analysis,) Knowledge based process planning Design of experiments Machinability of nonmetallic materials Analysis of interaction between maching process and machine tool systems with regard to process stability and quality Simulation of maching processes by virtual reality methods
Literature	Tönshoff, H.K.; Denkena, B.; Spanen Grundlagen, Springer (2004) Klocke, F.; König, W.; Fertigungsverfahren Umformen, Springer (2006) Weck, M.; Werkzeugmaschinen Fertigungssysteme 3, Springer (2001) Weck, M.; Werkzeugmaschinen Fertigungssysteme 5, Springer (2001)

FIOGUCTION				
Module M1193: Cabin	Systems Engineering			
Courses				
Title		Тур	Hrs/wk	СР
	nnology in cabin electronics and avionics (L1557)	Lecture	2	2
Computer and communication technology in cabin electronics and avionics (L1558) Recitation Section (small			1	1
Model-Based Systems Engineering	(MBSE) with SysML/UML (L1551)	Project-/problem-based Learning	3	3
Module Responsible	Prof. Ralf God			
Admission Requirements	None			
Recommended Previous	Basic knowledge in:			
Knowledge				
	Mechanics			
	Thermodynamics			
	Electrical Engineering			
	Control Systems			
	Previous knowledge in:			
	Systems Engineering			
Educational Objectives	After taking part cuccossfully students have reached th	on following loarning results		
Professional Competence	After taking part successfully, students have reached th	ic ronowing realling results		
-				
Knowledge	Students are able to:	the shows		
	describe the structure and operation of computer arch			
	explain the structure and operation of digital commun			N (45 CM)
	explain architectures of cabin electronics, integrated in the cabin electronics.			
	understand the approach of Model-Based Systems .	Engineering (MBSE) in the design of r	ardware and s	oftware-based cabin
	systems			
Skills	Students are able to:			
	understand, operate and maintain a Minicomputer			
	build up a network communication and communicate with other network participants			
	• connect a minicomputer with a cabin management system (A380 CIDS) and communicate over a AFDX®-Network			
	model system functions by means of formal languages SysML/UML and generate software code from the models			
	execute software code on a minicomputer			
	·			
Personal Competence				
Social Competence	Students are able to:			
	form teams of two or small groups for the practical wo			
	work out partial results themselves and combine them	n with others 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:			
, income my	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: Electiv	ve Compulsory		
Following Curricula	International Management and Engineering: Specialisat	ion II. Aviation Systems: Elective Comp	ulsory	
	Product Development, Materials and Production: Specia	lisation Product Development: Elective	Compulsory	
	Product Development, Materials and Production: Specia	lisation Production: Elective Compulsor	y	
	Product Development, Materials and Production: Specia			
	Theoretical Mechanical Engineering: Specialisation Aircr	raft Systems Engineering: Elective Com	pulsory	

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	
CP	
_	
	Independent Study Time 16, Study Time in Lecture 14
	Prof. Ralf God
Language	
Cycle	WiSe
	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 currer
	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

Hrs/wk 3 CP 3	oject-/problem-based Learning dependent Study Time 48, Study Time in Lecture 42
CP 3	dependent Study Time 48, Study Time in Lecture 42
	dependent Study Time 48, Study Time in Lecture 42
Workload in Hours Ind	dependent Study Time 48, Study Time in Lecture 42
WOI KIOAU III HOUIS	
Lecturer Pro	of. Ralf God
Language DE	
Cycle SoS	Se
Content Obj	bjectives 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?
• Si	Survey of MBSE methodologies
• TI	The modelling languages SysML /UML
• To	Tools for MBSE
• B	Best practices for MBSE
• R	Requirements specification, functional architecture, specification of a solution
• FI	From model to software code
• V	Validation and verification: XiL methods
• A	Accompanying MBSE project
Literature - Sk	Skript zur Vorlesung
- W	Weilkiens, 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 M0812: Aircra	aft Design I (Civ	il Aircraft De	sign)			
Courses						
Title				Тур	Hrs/wk	СР
Aircraft Design I (Design of Transpo				Lecture	3 2	3
Aircraft Design I (Design of Transpo	1			Recitation Section (large)	2	3
Module Responsible						
Admission Requirements Recommended Previous	None					
Kecommended Previous Knowledge	Bachelor Mech.	Eng.				
Kilowieuge	Bachelor Traffic	Systems				
	 Vordiplom Mec 	h. Eng.				
	Module Air Tran	sport Systems				
Educational Objectives	After taking part succ	essfully, students h	ave reached the followi	ng learning results		
Professional Competence						
Knowledge	1 Dringinle under	atandina of interval	and and sivil sineraft das	i a u		
			ted and civil aircraft des	-		
	3	2. Understanding of the interactions and contributions of the various disciplines				
	7	Impact of the relevant design parameter on the civil aircraft design Introduction of the principle design methods				
	4. Introduction of	trie principie desigi	Tilletilous			
Skills	Understanding and application of design and calculation methods					
	Understanding of inte	rdisciplinary and int	tegrative interdepender	ncies		
Personal Competence						
Social Competence	Working in interdiscip	linary teams				
	Communication					
4	Overeninetic of 16	aura and streets.				
Autonomy						
	Independent Study Til	ne 110, study IIM6	e in Lecture 70			
Credit points Course achievement	Compulsory Bonus	Form	Description			
Course achievement	No 10 %	Attestation	•	g einer Konzeptauslegung für	ein Verkehrsflugz	reua
Examination			_ a. a	,		3
Examination duration and	180 min					
scale						
Assignment for the	Aircraft Systems Engi	neering: Core Qualif	fication: Compulsory			
-		-		ation Systems: Elective Com	pulsory	
	_	-		roduct Development: Electiv		
				roduction: Elective Compulso		
				ms Engineering: Elective Cor	-	
				-		

Course L0820: Aircraft Desig	n 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
	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"

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

Production					
Module M0630: Robo	tics and Navigation in Medicine				
Courses					
Title		Тур	Hrs/wk	СР	
Robotics and Navigation in Medicir	ne (L0335)	Lecture	2	3	
Robotics and Navigation in Medicin		Project Seminar	2	2	
Robotics and Navigation in Medicir		Recitation Section (small)	1	1	
	Prof. Alexander Schlaefer				
Admission Requirements					
Recommended Previous					
Knowledge					
	 principles of programming, e.g., in Java or 	*C++			
	solid R or Matlab skills				
Educational Objectives	After taking part successfully, students have read	ched the following learning results			
Professional Competence					
-	The students can explain kinematics and track	ring systems in clinical contexts and illustr	ate systems and	their components in	
	detail. Systems can be evaluated with respect				
	systems regarding design and limitations.		,		
Skills	The students are able to design and evaluate na	vigation systems and robotic systems for me	edical applications		
Personal Competence	,				
Social Competence	The students are able to grasp practical tasks	in groups, develop solution strategies inde	pendently, define	work processes and	
	work on them collaboratively.				
	The students are able to collaboratively organize	ze their work processes and software solut	ions using virtual	communication and	
	software management tools.				
	The students can critically reflect on the resu	ilts of other groups, make constructive su	ggestions for imp	provement, and also	
	incorporate them into their own work.				
Autonomy	The students can assess their level of knowled	dge and independently control their learning	na processes on	this basis as well as	
	document their work results. They can critically				
	manner to the other groups.			, .	
Workload in Hours	Independent Study Time 110, Study Time in Lect	ture 70			
Credit points	6				
Course achievement		Description			
	Yes 10 % Presentation				
	Yes 10 % Written elaboration				
Examination					
Examination duration and					
scale					
	Computer Science: Specialisation II: Intelligence				
Following Curricula	- · · · ·				
	International Management and Engineering: Spe				
	International Management and Engineering: Spec		nnology: Elective	Compulsory	
	Mechatronics: Specialisation Intelligent Systems	' '			
	Biomedical Engineering: Specialisation Artificial (5	Compulsory		
	Biomedical Engineering: Specialisation Implants	,			
	Biomedical Engineering: Specialisation Medical T	echnology and Control Theory: Elective Con	npulsory		
	Biomedical Engineering: Specialisation Managem		ompulsory		
	Product Development, Materials and Production:	Specialisation Product Development: Electiv	ompulsory ve Compulsory		
	Product Development, Materials and Production: Product Development, Materials and Production:	Specialisation Product Development: Elective Specialisation Production: Elective Compuls	compulsory ve Compulsory ory		
	Product Development, Materials and Production:	Specialisation Product Development: Electiv Specialisation Production: Elective Compuls Specialisation Materials: Elective Compulso	compulsory ve Compulsory ory		

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			

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 Lea	rning 3	3
Advanced Training Course SE-ZERT	C(L2739) Project-/problem-based Lea	rning 2	3
Elements of Integrated Production	Systems (L0927) Project-/problem-based Lea	rning 2	3
Development Management for Med	chatronics (L1512) Lecture	2	3
Fatigue & Damage Tolerance (L03)	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 Lea	rning 3	3
Mechanisms, Systems and Process	es of Materials Testing (L0950) Lecture	2	2
Microsystems Technology (L0724)	Lecture	2	4
Sustainable Industrial Production (I	.2863) Lecture	2	4
Productivity Management (L0928)	Project-/problem-based Lea	rning 2	2
Productivity Management (L0931)	Recitation Section (small)	1	1
Feedback Control in Medical Techn	ology (L0664) Lecture	2	3
Structural Mechanics of Fibre Reinf	orced Composites (L1514) Lecture	2	3
System Simulation (L1820)	Lecture	2	2
System Simulation (L1821)	Recitation Section (large)	1	2
Technical Design (L1513)	Lecture	2	3
Materials Testing (L0949)	Lecture	2	2
Reliability in Engineering Dynamics	s (L2994) Lecture	2	2
Reliability in Engineering Dynamics		1	2
Reliability of Aircraft Systems (L07		2	3
Module Responsible			
Admission Requirements	None		
Recommended Previous	None		
Knowledge			
Educational Objectives	After taking part successfully, students have reached the following learning results		
Professional Competence			
Knowledge		6 1166	16.11
	Students are able to express their extended knowledge and discuss the connection	1 of different speci	al neids or application
	areas of product development, materials and production		
	Students are qualified to connect different special fields with each other		
Skills			
SKIIIS	Students can apply specialized solution strategies and new scientific methods in sel	ected areas	
	Students are able to transfer learned skills to new and unknown problems and can describe the students are able to transfer learned skills to new and unknown problems.		on approaches
Personal Competence			
Social Competence	-		
Autonomy			
, accitothy	Students are able to develop their knowledge and skills by autonomous election of or the students are able to develop their knowledge and skills by autonomous election of or the students.	courses.	
Workload in Hours	Depends on choice of courses		
Credit points	'		
Assignment for the		tive Compulsory	
Following Curricula	Product Development, Materials and Production: Specialisation Production: Elective Compu		
Following Curricula	Product Development, Materials and Production: Specialisation Materials: Elective Computer Product Development, Materials and Production: Specialisation Materials: Elective Computer Product Development, Materials and Production: Specialisation Materials: Elective Computer Product Development, Materials and Production: Specialisation Materials: Elective Computer Product Development, Materials and Production: Specialisation Materials: Elective Computer Product Development, Materials and Production: Specialisation Materials: Elective Computer Product Development, Materials and Production: Specialisation Materials: Elective Computer Product Development, Materials: Elective Computer Product Development Production: Elective Computer Product Development Production: Elective Computer Product Development	•	
	repopular peveropment, materials and production. Specialisation Materials: Elective Compuls	VIII	

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	

Typ Proje	ect-/problem-based Learning
Hrs/wk 3	
CP 3	
Workload in Hours Inde	ependent Study Time 48, Study Time in Lecture 42
Examination Form Müne	ndliche Prüfung
Examination duration and 30 m	nin
scale	
Lecturer Prof.	. Dieter Krause
Language DE/E	EN
Cycle SoSe	е
Content Deve	relopment of a sandwich structure made of fibre reinforced plastics
.	getting familiar with fibre reinforced plastics as well as lightweight design
	Design of a sandwich structure made of fibre reinforced plastics using finite element analysis (FEA)
	Determination of material properties based on sample tests
	manufacturing of the structure in the composite lab
	Testing of the developed structure
	Concept presentation
•	Self-organised teamwork
Literature	Schürmann, H., "Konstruieren mit Faser-Kunststoff-Verbunden", Springer, Berlin, 2005.
	Puck, A., "Festigkeitsanalsyse von Faser-Matrix-Laminaten", Hanser, München, Wien, 1996.
	• R&G, "Handbuch Faserverbundwerkstoffe", Waldenbuch, 2009.
	VDI 2014 "Entwicklung von Bauteilen aus Faser-Kunststoff-Verbund"
	Ehrenstein, G. W., "Faserverbundkunststoffe", Hanser, München, 2006.
	Klein, B., "Leichtbau-Konstruktion", Vieweg & Sohn, Braunschweig, 1989.
	Wiedemann, J., "Leichtbau Band 1: Elemente", Springer, Berlin, Heidelberg, 1986.
	Wiedemann, J., "Leichtbau Band 2: Konstruktion", Springer, Berlin, Heidelberg, 1986.
	Backmann, B.F., "Composite Structures, Design, Safety and Innovation", Oxford (UK), Elsevier, 2005.
	• Krause, D., "Leichtbau", In: Handbuch Konstruktion, Hrsg.: Rieg, F., Steinhilper, R., München, Carl Hanser Verlag, 2012.
•	• Schulte, K., Fiedler, B., "Structure and Properties of Composite Materials", Hamburg, TUHH - TuTech Innovation GmbH, 2005.

Course L0950: Mechanisms,	Systems and Processes of Materials Testing
Тур	Lecture
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Examination Form	Klausur
Examination duration and	90 Minuten
scale	
Lecturer	Dr. Jan Oke Peters
Language	DE
Cycle	SoSe
Content	Application, analysis and discussion of basic and advanced testing methods to ensure correct selection of applicable testing procedure for investigation of part/materials deficiencies • Stress-strain relationships • Strain gauge application • Visko elastic behavior • Tensile test (strain hardening, necking, strain rate) • Compression test, bending test, torsion test • Crack growth upon static loading (J-Integral) • Crack growth upon cyclic loading (micro- und macro cracks) • Effect of notches • Creep testing (physical creep test, influence of stress and temperature, Larson Miller parameter) • Wear testing • Non destructive testing application for overhaul of jet engines
Literature	 E. Macherauch: Praktikum in Werkstoffkunde, Vieweg G. E. Dieter: Mechanical Metallurgy, McGraw-Hill R. Bürgel: Lehr- und Übungsbuch Festigkeitslehre, Vieweg R. Bürgel: Werkstoffe sícher beurteilen und richtig einsetzen, Vieweg

Course L0724: Microsystems	Technology
Тур	Lecture
Hrs/wk	2
СР	4
Workload in Hours	Independent Study Time 92, Study Time in Lecture 28
Examination Form	Mündliche Prüfung
Examination duration and	30 min
scale	
Lecturer	Prof. Hoc Khiem Trieu
Language	EN
Cycle	
Content	
Content	 Introduction (historical view, scientific and economic relevance, scaling laws) Semiconductor Technology Basics, Lithography (wafer fabrication, photolithography, improving resolution, next-generation lithography, nano-imprinting, molecular imprinting) Deposition Techniques (thermal oxidation, epitaxy, electroplating, PVD techniques: evaporation and sputtering; CVD techniques: APCVD, LPCVD, PECVD and LECVD; screen printing) Etching and Bulk Micromachining (definitions, wet chemical etching, isotropic etch with HNA, electrochemical etching, anisotropic etching with KOH/TMAH: theory, corner undercutting, measures for compensation and etch-stop techniques; plasma processes, dry etching: back sputtering, plasma etching, RIE, Bosch process, cryo process, XeF2 etching) Surface Micromachining and alternative Techniques (sacrificial etching, film stress, stiction: theory and counter measures; Origami microstructures, Epi-Poly, porous silicon, SOI, SCREAM process, LIGA, SUB, rapid prototyping) Thermal and Radiation Sensors (temperature measurement, self-generating sensors: Seebeck effect and thermopile; modulating sensors: thermo resistor, Pt-100, spreading resistance sensor, pn junction, NTC and PTC; thermal anemometer, mass flow sensor, photometry, radiometry, IR sensor: thermopile and bolometer) Mechanical Sensors (strain based and stress based principle, capacitive readout, piezoresistivity, pressure sensor: piezoresistive, capacitive and fabrication process; Magnetic Sensors (galvanomagnetic sensors: spinning current Hall sensor and magneto-transistor; magnetoresistive sensors: magneto resistance, AMR and GMR, fluxgate magnetometer) Chemical and Bio Sensors (thermal gas sensors: spinning current Hall sensor and magneto-transistor; magnetoresistive sensors: ragneto resistance, AMR and GMR, fluxgate magnetometer) Chemical and Bio Sensors (thermal gas sensors: spinning current Hall sensor a
Literature	M. Madou: Fundamentals of Microfabrication, CRC Press, 2002
	N. Schwesinger: Lehrbuch Mikrosystemtechnik, Oldenbourg Verlag, 2009
	T. M. Adams, R. A. Layton:Introductory MEMS, Springer, 2010
	C. Codesh W. Differed Jacks deathing to reference to the class of William 2000
	G. Gerlach; W. Dötzel: Introduction to microsystem technology, Wiley, 2008

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	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, Tim Jansen
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:
Literature	 Leonhardt, S., & Walter, M. (2016). Medizintechnische Systeme. Berlin, Heidelberg: Springer Vieweg. Werner, J. (2005). Kooperative und autonome Systeme der Medizintechnik. München: Oldenbourg. Oczenski, W. (2017). Atmen: Atemhilfen; Atemphysiologie und Beatmungstechnik: Georg Thieme Verlag KG.

	chanics of Fibre Reinforced Composites
,	Lecture
Hrs/wk	2
СР	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Examination Form	Mündliche Prüfung
Examination duration and	30 min
scale	
Lecturer	Prof. Benedikt Kriegesmann
Language	EN
Cycle	WiSe
Content	Classical laminate theory
	Rules of mixture
	Failure mechanisms and criteria of composites
	Boundary value problems of isotropic and anisotropic shells
	Stability of composite structures
	Optimization of laminated composites
	Modelling composites in FEM
	Numerical multiscale analysis of textile composites
	Progressive failure analysis
Literature	 Schürmann, H., "Konstruieren mit Faser-Kunststoff-Verbunden", Springer, Berlin, aktuelle Auflage. Wiedemann, J., "Leichtbau Band 1: Elemente", Springer, Berlin, Heidelberg, , aktuelle Auflage. Reddy, J.N., "Mechanics of Composite Laminated Plates and Shells", CRC Publishing, Boca Raton et al., current edition. Jones, R.M., "Mechanics of Composite Materials", Scripta Book Co., Washington, current edition. Timoshenko, S.P., Gere, J.M., "Theory of elastic stability", McGraw-Hill Book Company, Inc., New York, current edition. Turvey, G.J., Marshall, I.H., "Buckling and postbuckling of composite plates", Chapman and Hall, London, current edition. Herakovich, C.T., "Mechanics of fibrous composites", John Wiley and Sons, Inc., New York, current edition. Mittelstedt, C., Becker, W., "Strukturmechanik ebener Laminate", aktuelle Auflage.

Course L1820: System Simulation	
Тур	Lecture
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Examination Form	Mündliche Prüfung
Examination duration and	30 min
scale	
Lecturer	Dr. Stefan Wischhusen, 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 L1821: System Simulation	
Тур	Recitation Section (large)
Hrs/wk	1
СР	2
Workload in Hours	Independent Study Time 46, Study Time in Lecture 14
Examination Form	Mündliche Prüfung
Examination duration and	30 min
scale	
Lecturer	Dr. Stefan Wischhusen, Dr. Johannes Brunnemann
Language	DE
Cycle	WiSe
Content	See interlocking course
Literature	See interlocking course

Course L1513: Technical Design	
Тур	Lecture
Hrs/wk	2
СР	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Examination Form	Schriftliche Ausarbeitung
Examination duration and	10-15 Entwurfszeichnungen, Skizzen und ca. 5-10 A4-Dokumentationsseiten (Themen- und Entwurfsbegründung)
scale	
Lecturer	Prof. Werner Granzeier, 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 GmbH, Auto & Design,

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

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

Course 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	Prof. Benedikt Kriegesmann, Dr. Eric Groß
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	Prof. Benedikt Kriegesmann, Dr. Eric Groß
Language	
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 M1161: Turbo	omachinery			
Courses				
Title		Тур	Hrs/wk	СР
Turbomachines (L1562)		Lecture	3	4
Turbomachines (L1563)		Recitation Section (large)	1	2
Module Responsible	Prof. Markus Schatz			
Admission Requirements	None			
Recommended Previous	Technical Thermodynamics I, II, Fluid Dynamics, Heat Transf	er		
Knowledge				
Educational Objectives	After taking part successfully, students have reached the fol	owing learning results		
Professional Competence				
Knowledge	The students can			
	distinguish the physical phenomena of conversion of a	enerav.		
	understand the different mathematic modelling of tur			
	calculate and evaluate turbomachinery.	··		
Skills	The students are able to			
	- understand the physics of Turbomachinery,			
	- solve excersises self-consistent.			
Personal Competence				
Social Competence	The students are able to			
,				
	 discuss in small groups and develop an approach. 			
Autonomy	The students are able to			
	 develop a complex problem self-consistent, 			
	 analyse the results in a critical way, 			
	 have an qualified exchange with other students. 			
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56			
Credit points				
Course achievement				
Examination				
Examination duration and				
scale				
Assignment for the	Energy Systems: Specialisation Energy Systems: Elective Co	mpulsory		
Following Curricula	1			
-	Product Development, Materials and Production: Specialisati	on Product Development: Elective	Compulsory	
	Product Development, Materials and Production: Specialisati	on Production: Elective Compulso	ry	
	Product Development, Materials and Production: Specialisati	on Materials: Elective Compulsory	,	
	Theoretical Mechanical Engineering: Specialisation Energy S	stems: Elective Compulsory		
	Theoretical Mechanical Engineering: Specialisation Energy S	ystems: Elective Compulsory		

Course L1562: Turbomachines		
Тур	Lecture	
Hrs/wk	3	
СР		
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

Production"				
Module M0764: Flight	t Control Systems			
Courses				
Title		Тур	Hrs/wk	СР
Flight Control Systems (L0736)		Lecture	3	4
Flight Control Systems (L0740)		Recitation Section (large)	2	2
Module Responsible	Prof. Frank Thielecke			
Admission Requirements	None			
Recommended Previous	basic knowledge of:			
Knowledge	and the second of			
	mathematics mechanics			
	thermo dynamics			
	electronics			
	fluid mechanics			
	control theory			
	After taking part successfully, students have reached th	e following learning results		
Professional Competence				
Knowledge	Students are able to			
	describe the structure and the functioning of prir	nary flight control systems as well as	actuation-, avio	nic-, high lift systems
	of aircrafts in general along with corresponding p	roperties and applications.		
	 give an overview over the functioning and the str 	ucture of landing gears and landing g	ear systems	
	 explain different configurations and designs and 	heir origins		
Skille	Students are able to			
SKIIIS	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 ye	simplified design processes for airci	raft systems from	complex issues and
	circumstances in a self-reliant manner			·
	apply new skills and methods in the context of ex	ercises in a self-reliant manner		
Waldard In Harris	lada and dark Chada Tiraa 110 Chada Tiraa in Lask wa 70			
Workload in Hours				
Credit points				
Course achievement				
	Written exam			
Examination duration and	165 Minutes			
scale				
Assignment for the	1	•		
Following Curricula	International Management and Engineering: Specialisati			
	Product Development, Materials and Production: Specia	•		
	Product Development, Materials and Production: Specia			
	Product Development, Materials and Production: Specia			
	Theoretical Mechanical Engineering: Specialisation Aircr	ait systems Engineering: Elective Coi	ripuisory	

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 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	Arter taking part successibility, students have reached the following learning results
Knowledge	
Knowieuge	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; The big and seek of the provided associated as the 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
Autonomy	Students can:
	Understand which physical effects are used in medical imaging;
	Decide independently for which clinical issue a measuring system can be used.
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56
Credit points Course achievement	6 None
Examination Examination duration and	Written exam 90 min
examination duration and scale	
Assignment for the	Electrical Engineering: Specialisation Medical Technology: Elective Compulsory
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	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 M1209: Selected Topics of Product Development, Materials Science and Production (Alternative B: 6 LP)

Γitle	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
atigue & Damage Tolerance (L031	LO) Lecture	2	3
ndustry 4.0 for engineers (L2012)	Lecture	2	3
nnovation and Product Manageme	nt (L2168) Seminar	2	3
ightweight Design Practical Cours	e (L1258) Project-/problem-based Learning	3	3
Mechanisms, Systems and Process	es of Materials Testing (L0950) Lecture	2	2
Nicrosystems Technology (L0724)	Lecture	2	4
Sustainable Industrial Production (I	Lecture Lecture	2	4
Productivity Management (L0928)	Project-/problem-based Learning	2	2
roductivity Management (L0931)	Recitation Section (small)	1	1
eedback Control in Medical Techn	ology (L0664) Lecture	2	3
Structural Mechanics of Fibre Reinf	forced Composites (L1514) Lecture	2	3
System Simulation (L1820)	Lecture	2	2
system Simulation (L1821)	Recitation Section (large)	1	2
echnical Design (L1513)	Lecture	2	3
laterials Testing (L0949)	Lecture	2	2
Reliability in Engineering Dynamics	s (L2994) Lecture	2	2
Reliability in Engineering Dynamics	s (L2995) Recitation Section (small)	1	2
eliability of Aircraft Systems (L07		2	3
Module Responsible	Prof. Diotor Krauso		
Admission Requirements	None		
•			
Recommended Previous	None		
Knowledge			
Educational Objectives	After taking part successfully, students have reached the following learning results		
Professional Competence			
o.			
Knowledge			
•	Students are able to express their extended knowledge and discuss the connection of c	lifferent specia	I fields or applica
•	 Students are able to express their extended knowledge and discuss the connection of careas of product development, materials and production 	lifferent specia	l fields or applica
•	Students are able to express their extended knowledge and discuss the connection of c	lifferent specia	l fields or applica
Knowledge	 Students are able to express their extended knowledge and discuss the connection of careas of product development, materials and production 	lifferent specia	l fields or applica
•	 Students are able to express their extended knowledge and discuss the connection of careas of product development, materials and production Students are qualified to connect different special fields with each other 	·	l fields or applica
Knowledge	Students are able to express their extended knowledge and discuss the connection of careas of product development, materials and production Students are qualified to connect different special fields with each other Students can apply specialized solution strategies and new scientific methods in selected.	l areas	
Knowledge	 Students are able to express their extended knowledge and discuss the connection of careas of product development, materials and production Students are qualified to connect different special fields with each other 	l areas	
Knowledge	Students are able to express their extended knowledge and discuss the connection of careas of product development, materials and production Students are qualified to connect different special fields with each other Students can apply specialized solution strategies and new scientific methods in selected.	l areas	
Knowledge Skills Personal Competence	Students are able to express their extended knowledge and discuss the connection of careas of product development, materials and production Students are qualified to connect different special fields with each other Students can apply specialized solution strategies and new scientific methods in selected.	l areas	
Skills Personal Competence Social Competence	Students are able to express their extended knowledge and discuss the connection of careas of product development, materials and production Students are qualified to connect different special fields with each other Students can apply specialized solution strategies and new scientific methods in selected.	l areas	
Knowledge Skills Personal Competence	Students are able to express their extended knowledge and discuss the connection of careas of product development, materials and production Students are qualified to connect different special fields with each other Students can apply specialized solution strategies and new scientific methods in selected.	d areas op own solutior	
Skills Personal Competence Social Competence	 Students are able to express their extended knowledge and discuss the connection of careas of product development, materials and production Students are qualified to connect different special fields with each other Students can apply specialized solution strategies and new scientific methods in selected Students are able to transfer learned skills to new and unknown problems and can developed 	d areas op own solutior	
Skills Personal Competence Social Competence	 Students are able to express their extended knowledge and discuss the connection of careas of product development, materials and production Students are qualified to connect different special fields with each other Students can apply specialized solution strategies and new scientific methods in selected Students are able to transfer learned skills to new and unknown problems and can developed 	d areas op own solutior	
. Knowledge Skills Personal Competence Social Competence Autonomy	Students are able to express their extended knowledge and discuss the connection of careas of product development, materials and production Students are qualified to connect different special fields with each other Students can apply specialized solution strategies and new scientific methods in selected Students are able to transfer learned skills to new and unknown problems and can devel Students are able to develop their knowledge and skills by autonomous election of cours Depends on choice of courses	d areas op own solutior	
Skills Personal Competence Social Competence Autonomy Workload in Hours	Students are able to express their extended knowledge and discuss the connection of careas of product development, materials and production Students are qualified to connect different special fields with each other Students can apply specialized solution strategies and new scientific methods in selected Students are able to transfer learned skills to new and unknown problems and can devel Students are able to develop their knowledge and skills by autonomous election of cours Depends on choice of courses	d areas op own solution es.	
Skills Personal Competence Social Competence Autonomy Workload in Hours Credit points	Students are able to express their extended knowledge and discuss the connection of careas of product development, materials and production Students are qualified to connect different special fields with each other Students can apply specialized solution strategies and new scientific methods in selected Students are able to transfer learned skills to new and unknown problems and can devel Students are able to develop their knowledge and skills by autonomous election of cours Depends on choice of courses	d areas op own solution es. Compulsory	
Skills Personal Competence Social Competence Autonomy Workload in Hours Credit points Assignment for the	Students are able to express their extended knowledge and discuss the connection of careas of product development, materials and production Students are qualified to connect different special fields with each other Students can apply specialized solution strategies and new scientific methods in selected. Students are able to transfer learned skills to new and unknown problems and can devel. Students are able to develop their knowledge and skills by autonomous election of cours. Depends on choice of courses Product Development, Materials and Production: Specialisation Product Development: Elective Compulsory.	d areas op own solution es. Compulsory	
Skills Personal Competence Social Competence Autonomy Workload in Hours Credit points Assignment for the	Students are able to express their extended knowledge and discuss the connection of conference of the product development, materials and production Students are qualified to connect different special fields with each other Students can apply specialized solution strategies and new scientific methods in selected Students are able to transfer learned skills to new and unknown problems and can devel Students are able to develop their knowledge and skills by autonomous election of cours Depends on choice of courses 6 Product Development, Materials and Production: Specialisation Product Development: Elective of	d areas op own solution es. Compulsory	

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

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

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

Course L1512: Development	Management for Mechatronics
Тур	Lecture
Hrs/wk	2
СР	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Examination Form	Mündliche Prüfung
Examination duration and	30 Minuten
scale	
Lecturer	NN, Dr. Johannes Nicolas Gebhardt
Language	DE
Cycle	SoSe
Content	Processes and methods of product development - from idea to market launch identification of market and technology potentials development of a common product architecture Synchronized product development across all engineering disciplines product validation incl. customer view Steering and optimization of product development Design of processes for product development IT systems for product development Establishment of management standards Typical types of organization
Literature	 Bender: Embedded Systems - qualitätsorientierte Entwicklung Ehrlenspiel: Integrierte Produktentwicklung: Denkabläufe, Methodeneinsatz, Zusammenarbeit Gausemeier/Ebbesmeyer/Kallmeyer: Produktinnovation - Strategische Planung und Entwicklung der Produkte von morgen Haberfellner/de Weck/Fricke/Vössner: Systems Engineering: Grundlagen und Anwendung Lindemann: Methodische Entwicklung technischer Produkte: Methoden flexibel und situationsgerecht anwenden Pahl/Beitz: Konstruktionslehre: Grundlagen erfolgreicher Produktentwicklung. Methoden und Anwendung VDI-Richtlinie 2206: Entwicklungsmethodik für mechatronische Systeme

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

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

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

Course L1258: Lightweight D	esign Practical Course
Тур	Project-/problem-based Learning
Hrs/wk	3
СР	3
Workload in Hours	Independent Study Time 48, Study Time in Lecture 42
Examination Form	Mündliche Prüfung
Examination duration and	30 min
scale	
Lecturer	Prof. Dieter Krause
Language	DE/EN
Cycle	SoSe
Content	Development of a sandwich structure made of fibre reinforced plastics
	getting familiar with fibre reinforced plastics as well as lightweight design
	Design of a sandwich structure made of fibre reinforced plastics using finite element analysis (FEA)
	Determination of material properties based on sample tests
	manufacturing of the structure in the composite lab
	Testing of the developed structure
	Concept presentation
	Self-organised teamwork
Literature	Schürmann, H., "Konstruieren mit Faser-Kunststoff-Verbunden", Springer, Berlin, 2005.
	Puck, A., "Festigkeitsanalsyse von Faser-Matrix-Laminaten", Hanser, München, Wien, 1996.
	R&G, "Handbuch Faserverbundwerkstoffe", Waldenbuch, 2009.
	VDI 2014 "Entwicklung von Bauteilen aus Faser-Kunststoff-Verbund"
	Ehrenstein, G. W., "Faserverbundkunststoffe", Hanser, München, 2006.
	Klein, B., "Leichtbau-Konstruktion", Vieweg & Sohn, Braunschweig, 1989.
	Wiedemann, J., "Leichtbau Band 1: Elemente", Springer, Berlin, Heidelberg, 1986.
	Wiedemann, J., "Leichtbau Band 2: Konstruktion", Springer, Berlin, Heidelberg, 1986.
	Backmann, B.F., "Composite Structures, Design, Safety and Innovation", Oxford (UK), Elsevier, 2005.
	Krause, D., "Leichtbau", In: Handbuch Konstruktion, Hrsg.: Rieg, F., Steinhilper, R., München, Carl Hanser Verlag, 2012.
	• Schulte, K., Fiedler, B., "Structure and Properties of Composite Materials", Hamburg, TUHH - TuTech Innovation GmbH, 2005.
L	

Course L0950: Mechanisms,	Systems and Processes of Materials Testing
Тур	Lecture
Hrs/wk	2
СР	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Examination Form	Klausur
Examination duration and	90 Minuten
scale	
Lecturer	Dr. Jan Oke Peters
Language	DE
Cycle	SoSe
Content	Application, analysis and discussion of basic and advanced testing methods to ensure correct selection of applicable testing procedure for investigation of part/materials deficiencies Stress-strain relationships Strain gauge application Visko elastic behavior Tensile test (strain hardening, necking, strain rate) Compression test, bending test, torsion test Crack growth upon static loading (J-Integral) Crack growth upon cyclic loading (micro- und macro cracks) Effect of notches Creep testing (physical creep test, influence of stress and temperature, Larson Miller parameter) Wear testing Non destructive testing application for overhaul of jet engines
Literature	 E. Macherauch: Praktikum in Werkstoffkunde, Vieweg G. E. Dieter: Mechanical Metallurgy, McGraw-Hill R. Bürgel: Lehr- und Übungsbuch Festigkeitslehre, Vieweg R. Bürgel: Werkstoffe sícher beurteilen und richtig einsetzen, Vieweg

Course L0724: Microsystems	Technology
Тур	Lecture
Hrs/wk	2
СР	4
Workload in Hours	Independent Study Time 92, Study Time in Lecture 28
Examination Form	Mündliche Prüfung
Examination duration and	30 min
scale	
Lecturer	Prof. Hoc Khiem Trieu
Language	EN
Cycle	WiSe
Content	 Introduction (historical view, scientific and economic relevance, scaling laws) Semiconductor Technology Basics, Lithography (wafer fabrication, photolithography, improving resolution, next-generation
	lithography, nano-imprinting, molecular imprinting) • Deposition Techniques (thermal oxidation, epitaxy, electroplating, PVD techniques: evaporation and sputtering; CVD techniques: APCVD, LPCVD, PECVD and LECVD; screen printing)
	 Etching and Bulk Micromachining (definitions, wet chemical etching, isotropic etch with HNA, electrochemical etching, anisotropic etching with KOH/TMAH: theory, corner undercutting, measures for compensation and etch-stop techniques; plasma processes, dry etching: back sputtering, plasma etching, RIE, Bosch process, cryo process, XeF2 etching) Surface Micromachining and alternative Techniques (sacrificial etching, film stress, stiction: theory and counter measures; Origami microstructures, Epi-Poly, porous silicon, SOI, SCREAM process, LIGA, SU8, rapid prototyping) Thermal and Radiation Sensors (temperature measurement, self-generating sensors: Seebeck effect and thermopile; modulating sensors: thermo resistor, Pt-100, spreading resistance sensor, pn junction, NTC and PTC; thermal anemometer, mass flow sensor, photometry, radiometry, IR sensor: thermopile and bolometer) Mechanical Sensors (strain based and stress based principle, capacitive readout, piezoresistivity, pressure sensor: piezoresistive, capacitive and fabrication process; accelerometer: piezoresistive, piezoelectric and capacitive; angular rate sensor: operating principle and fabrication process) Magnetic Sensors (galvanomagnetic sensors: spinning current Hall sensor and magneto-transistor; magnetoresistive sensors: magneto resistance, AMR and GMR, fluxgate magnetometer) Chemical and Bio Sensors (thermal gas sensors: pellistor and thermal conductivity sensor; metal oxide semiconductor gas sensor, organic semiconductor gas sensor, Lambda probe, MOSFET gas sensor, pH-FET, SAW sensor, principle of biosensor, Clark electrode, enzyme electrode, DNA chip) Micro Actuators, Microfluidics and TAS (drives: thermal, electrostatic, piezo electric and electromagnetic; light modulators, DMD, adaptive optics, microscanner, microvalves: passive and active, micropumps, valveless micropump, electrokinetic micropumps, micromixer, filter, inkjet printhead, microdispenser, microfluidic switching elements, m
	 Design, Simulation, Test (development and design flows, bottom-up approach, top-down approach, testability, modelling: multiphysics, FEM and equivalent circuit simulation; reliability test, physics-of-failure, Arrhenius equation, bath-tub relationship) System Integration (monolithic and hybrid integration, assembly and packaging, dicing, electrical contact: wire bonding, TAB and flip chip bonding; packages, chip-on-board, wafer-level-package, 3D integration, wafer bonding: anodic bonding and silicon fusion bonding; micro electroplating, 3D-MID)
Literature	M. Madou: Fundamentals of Microfabrication, CRC Press, 2002
	N. Schwesinger: Lehrbuch Mikrosystemtechnik, Oldenbourg Verlag, 2009
	T. M. Adams, R. A. Layton:Introductory MEMS, Springer, 2010 G. Gerlach; W. Dötzel: Introduction to microsystem technology, Wiley, 2008
	L

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, Tim Jansen
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 Me	Course L1514: Structural Mechanics of Fibre Reinforced Composites	
Тур	Lecture	
Hrs/wk	2	
СР	3	
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28	
Examination Form	Mündliche Prüfung	
Examination duration and	30 min	
scale		
Lecturer	Prof. Benedikt Kriegesmann	
Language	EN	
Cycle	WiSe	
Content	Classical laminate theory	
	Rules of mixture	
	Failure mechanisms and criteria of composites	
	Boundary value problems of isotropic and anisotropic shells	
	Stability of composite structures	
	Optimization of laminated composites	
	Modelling composites in FEM	
	Numerical multiscale analysis of textile composites	
	Progressive failure analysis	
Literature	 Schürmann, H., "Konstruieren mit Faser-Kunststoff-Verbunden", Springer, Berlin, aktuelle Auflage. Wiedemann, J., "Leichtbau Band 1: Elemente", Springer, Berlin, Heidelberg, , aktuelle Auflage. Reddy, J.N., "Mechanics of Composite Laminated Plates and Shells", CRC Publishing, Boca Raton et al., current edition. Jones, R.M., "Mechanics of Composite Materials", Scripta Book Co., Washington, current edition. Timoshenko, S.P., Gere, J.M., "Theory of elastic stability", McGraw-Hill Book Company, Inc., New York, current edition. Turvey, G.J., Marshall, I.H., "Buckling and postbuckling of composite plates", Chapman and Hall, London, current edition. Herakovich, C.T., "Mechanics of fibrous composites", John Wiley and Sons, Inc., New York, current edition. Mittelstedt, C., Becker, W., "Strukturmechanik ebener Laminate", aktuelle Auflage. 	

Course L1820: System Simul	ation
Тур	Lecture
Hrs/wk	2
СР	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Examination Form	Mündliche Prüfung
Examination duration and	30 min
scale	
Lecturer	Dr. Stefan Wischhusen, 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 L1821: System Simulation		
Тур	Recitation Section (large)	
Hrs/wk	1	
СР	2	
Workload in Hours	Independent Study Time 46, Study Time in Lecture 14	
Examination Form	Mündliche Prüfung	
Examination duration and	30 min	
scale		
Lecturer	Dr. Stefan Wischhusen, Dr. Johannes Brunnemann	
Language	DE	
Cycle	WiSe	
Content	See interlocking course	
Literature	See interlocking course	

Course L1513: Technical Des	ign
Тур	Lecture
Hrs/wk	2
СР	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Examination Form	Schriftliche Ausarbeitung
Examination duration and	10-15 Entwurfszeichnungen, Skizzen und ca. 5-10 A4-Dokumentationsseiten (Themen- und Entwurfsbegründung)
scale	
Lecturer	Prof. Werner Granzeier, 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 GmbH, Auto & Design,

Production	
	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					
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	ndependent Study Time 32, Study Time in Lecture 28				
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 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			

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	ems Engineering				
Courses					
itle		Тур	Hrs/wk	СР	
ystems 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 The arms of th				
	Thermodynamics Electrical Engineering				
	Control Systems				
	Control Systems				
	Previous knowledge in:				
	Aircraft Cabin Systems				
Educational Objectives	After taking part successfully, students have reached the follow	ing learning results			
Professional Competence					
Knowledge	Students are able to:				
	understand systems engineering process models, methods an		f complex System	ns	
	describe innovation processes and the need for technology Ma				
	explain the aircraft development process and the process of t	•			
	explain the system development process, including requiremental conditions and test procedures for airly				
	identify environmental conditions and test procedures for airb value the methodology of requirements-based engineering (R		ments engineerin	a (MRRE)	
	value the methodology of requirements based engineering (it	be, and moder bused requires	nenes engineerin	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 applicating 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 properties and appropriate their suppliers and quaternasis larger.				
	understand and serve their suppliers and customers in large projects				
	assume responsibility for people and technology in the development of safety-critical systems				
Autonomy	Students are able to:				
	interact and communicate in a development team with division				
	independently research and identify certification specification	S			
	formulate requirements on their own create test plans on their own and accompany certification process.	ncassas			
	- create test plans on their own and accompany certification pr	UCC3383			
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 Systems Engineering, Care Qualification, Care III				
Assignment for the Following Curricula		viation Systems: Floative Com	nulsony		
Following Curricula	International Management and Engineering: Specialisation II. Av	•		ompulsory	
	Mechatronics: Specialisation System Design: Elective Compulso	·	action. Elective C	opaisoi y	
	Mechatronics: Specialisation Intelligent Systems and Robotics: E	•			
	Product Development, Materials and Production: Specialisation	, ,	lsory		
	Product Development, Materials and Production: Specialisation				
	Product Development, Materials and Production: Specialisation				
	Theoretical Mechanical Engineering: Specialisation Aircraft Syst	ems Engineering: Elective Co	mpulsory		

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 M1226: Mech	anical Properties				
Courses					
Title		Тур	Hrs/wk	СР	
Mechanical Behaviour of Brittle Materials (L1661)		Lecture	2	3	
Dislocation Theory of Plasticity (L1662) 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 crystallogra	phy, statics (free body diagram	ns, 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 performa	ance constructively.		
Autonomy	Students are able to	Students are able to			
	- assess their own strengths and weaknesses				
	- assess their own state of learning in specific terms ar	id 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				
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	90 min				
scale					
Assignment for the	Materials Science: Core Qualification: Compulsory				
Following Curricula	Mechanical Engineering and Management: Specialisation	on Materials: Elective Compulsor	"у		
	Product Development, Materials and Production: Specialisation Product Development: Elective Compulsory				
	Product Development, Materials and Production: Specialisation Production: Elective Compulsory				
	Product Development, Materials and Production: Specialisation Materials: Compulsory				
	Theoretical Mechanical Engineering: Specialisation Materials Science: Elective Compulsory				

Course L1661: Mechanical Behaviour 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
	Toughening mechanisms: crack bridging, fibres
	Heterogeneous materials III
	Toughening mechanisms. Process zone
	Testing methods to determine the fracture toughness of brittle materials
	R-curve, stable/unstable crack growth, fractography
	Thermal shock
	Subcritical crack growth)
	v-K-curve, life time prediction
	Kriechen
	Mechanical properties of biological materials
	Examples of use for a mechanically reliable design of ceramic components
Literature	D R H Jones, Michael F. Ashby, Engineering Materials 1, An Introduction to Properties, Applications and Design, Elesevier
	D.J. Green, An introduction to the mechanical properties of ceramics", Cambridge University Press, 1998
	B.R. Lawn, Fracture of Brittle Solids", Cambridge University Press, 1993
	D. Munz, T. Fett, Ceramics, Springer, 2001
	D.W. Richerson, Modern Ceramic Engineering, Marcel Decker, New York, 1992
-	

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

Production				
Module M0840: Optin	nal and Robust Control			
Courses				
Title		Тур	Hrs/wk	СР
Optimal and Robust Control (L0658	3)	Lecture	2	3
Optimal and Robust Control (L0659	0)	Recitation Section (small)	2	3
Module Responsible	Prof. Herbert Werner			
Admission Requirements	None			
Recommended Previous				
Knowledge	Classical control (frequency response, root locus) State space methods			
	Linear algebra, singular value decomposition			
	Elitedi digesia, singulai valde decomposition			
Educational Objectives	After taking part successfully, students have reached the following	lowing learning results		
Professional Competence				
Knowledge	Students can explain the significance of the matrix Ric	ccati equation for the solution of	I O problems	
	They can explain the duality between optimal state fe			
	They can explain how the H2 and H-infinity norms are			traints.
	They can explain how an LQG design problem can be			
	They can explain how model uncertainty can be repre-	esented in a way that lends itself	to robust control	ler design
	They can explain how - based on the small gain theo	rem - a robust controller can gu	arantee stability	and performance for
	an uncertain plant.			
	 They understand how analysis and synthesis condition 	ns on feedback loops can be repr	esented as linear	matrix inequalities.
Skills				
S.i.i.s	 Students are capable of designing and tuning LQG cor 	ntrollers for multivariable plant m	odels.	
	They are capable of representing a H2 or H-infinity de	esign problem in the form of a ge	neralized plant, a	nd of using standard
	software tools for solving it.			
	They are capable of translating time and frequency of the capable of translating time and translating time an		loops into const	raints on closed-loop
	sensitivity functions, and of carrying out a mixed-sens			
	 They are capable of constructing an LFT uncertainty robust controller. 	model for an uncertain system	i, and of designir	ig a mixed-objective
	They are capable of formulating analysis and synthes	is conditions as linear matrix inc	agualities (LMI) a	nd of using standard
	LMI-solvers for solving them.	is conditions as linear matrix inc	equalities (Li-II), a	na or asing standard
	They can carry out all of the above using standard sof	tware tools (Matlab robust contro	ol toolbox).	
Personal Competence				
	Students can work in small groups on specific problems to a			
Autonomy	·	ovided (lecture notes, literature,	software docume	ntation) and use it to
	solve given problems.			
Wedded to Uson	Indianandant Study Time 124 Study Time in Lastyna 56			
Credit points	Independent Study Time 124, Study Time in Lecture 56			
Course achievement				
Examination				
Examination duration and				
scale	30 11111			
Assignment for the		ems Engineering: Elective Comp	ulsory	
Following Curricula	Energy Systems: Core Qualification: Elective Compulsory			
	Aircraft Systems Engineering: Core Qualification: Elective Co	. ,		
	Mechatronics: Specialisation Intelligent Systems and Robotic	, ,		
	Mechatronics: Specialisation System Design: Elective Compu	•	Compulsor	
	Biomedical Engineering: Specialisation Artificial Organs and Biomedical Engineering: Specialisation Implants and Endopro	-	Compuisory	
	Biomedical Engineering: Specialisation Implants and Endopro Biomedical Engineering: Specialisation Medical Technology a		nulson/	
	Biomedical Engineering: Specialisation Management and Bus	•		
	Product Development, Materials and Production: Specialisation			
	Product Development, Materials and Production: Specialisation			
	Product Development, Materials and Production: Specialisati	•	-	
	Theoretical Mechanical Engineering: Core Qualification: Elect	·		

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	Prof. Herbert Werner
Language	EN
Cycle	SoSe
Content	 Optimal regulator problem with finite time horizon, Riccati differential equation Time-varying and steady state solutions, algebraic Riccati equation, Hamiltonian system Kalman's identity, phase margin of LQR controllers, spectral factorization Optimal state estimation, Kalman filter, LQG control Generalized plant, review of LQG control Signal and system norms, computing H2 and H∞ norms Singular value plots, input and output directions Mixed sensitivity design, H∞ loop shaping, choice of weighting filters Case study: design example flight control Linear matrix inequalities, design specifications as LMI constraints (H2, H∞ and pole region) Controller synthesis by solving LMI problems, multi-objective design Robust control of uncertain systems, small gain theorem, representation of parameter uncertainty
Literature	 Werner, H., Lecture Notes: "Optimale und Robuste Regelung" Boyd, S., L. El Ghaoui, E. Feron and V. Balakrishnan "Linear Matrix Inequalities in Systems and Control", SIAM, Philadelphia, PA, 1994 Skogestad, S. and I. Postlewhaite "Multivariable Feedback Control", John Wiley, Chichester, England, 1996 Strang, G. "Linear Algebra and its Applications", Harcourt Brace Jovanovic, Orlando, FA, 1988 Zhou, K. and J. Doyle "Essentials of Robust Control", Prentice Hall International, Upper Saddle River, NJ, 1998

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

Title Typ Letters Typ Typ Letters Typ Typ Letters Typ Typ Letters Typ Typ Typ	Module M1343: Struc	ture and properties of fibre-polymer-	composites		
Sincuture and progenties of fiber polymer composites (L1984) Intrustume and progenties of fiber polymer composites (L1984) Recommended Previous Bascisc commended Previous Bascisc chemistry / physics / materials science Recommended Previous Bascisc chemistry / physics / materials science Recommended Previous Bascisc chemistry / physics / materials science Recommended Previous Bascisc chemistry / physics / materials science Recommended Previous Bascisc chemistry / physics / materials science Beducational Objectives Recommended Previous Bascisc chemistry / physics / materials science Recommended Previous Bascisc chemistry / physics / materials science Recommended Previous Bascisc chemistry / physics / materials science Recommended Previous Bascisc chemistry / physics / materials science Brofessional Competence Knowledge Budents can use the knowledge of fiber-reinforced composites (FRIP) and its constituents to play (fiber / matrix) and define the interactions of chemical structure of the polymers, their processing with the different fiber types, including to explanation the interactions of chemical structure of the polymers, their processing with the different fiber types, including to explanation their interactions of chemical structure of the polymers, their processing with the different fiber types, including to explanation their interactions are explained the complex relationships structure-property relationship and the interactions of chemical structure of the polymers, their processing with the different fiber types, including to explanation their interactionships and structure of the polymers, their processing with the different fiber types, including to explanation their different materials. • subject of their professional properties (modulus, strength) to calculate an evaluate the different materials. • approximate sizing using the network theory of the structural elements implement and evaluate. • assess possible consequences of their professional activity. Workload in Hours Cour	Courses				
Size and properties of fiber polymer composites (1514) Module Responsible Prof. 80do Fiedler	Title		Тур	Hrs/wk	СР
Module Responsible Prof. Bod Fielder Module Responsible Prof. Bod Fielder Mission Requirements (None) Recommended Previous Basics: chemistry physics / materials science Recommended Previous Basics: chemistry physics / materials science Foressional Competence Knowledge Educational Objectives Butdents can use the knowledge of fiber-reinforced composites (FIPP) and its constituents to play (fiber / matrix) and define the interactions or chemical structure of the polymers, their processing with the different fiber types, including to explain the interactions of chemical structure of the polymers, their processing with the different fiber types, including to explain the interactions of chemical structure of the polymers, their processing with the different fiber types, including to explain the interactions of chemical structure of the polymers, their processing with the different fiber types, including to explain elighboring contexts (e.g. sustainability, environmental protection). Skillor Skillor Skillor Students are capable of using standarded calculation methods in a given context to mechanical properties (modulus, strength) to calculate an evaluate the different materials. approximate sizing using the network theory of the structural elements implement and evaluate. activities are able to assess their own strengths and weaknesses. assess their own s	Structure and properties of fibre-po	lymer-composites (L1894)	Lecture	2	3
Module Responsible Admission Requirements None Recommended Previous Recommended Previous Recommended Previous Selection of Dejectives After taking part successfully, students have reached the following learning results Professional Competence Knowledge Students can use the knowledge of fiber-reinforced composites (FRP) and its constituents to play (fiber / matrix) and define the cessary testing and analysis. They can explain the complex relationships structure property relationship and the interactions of chemical structure of the polymers, their processing with the different fiber types, including to explain neighboring contexts (e.g. sustainability, environmental protection). Skillis Students are capable of • using standardized calculation methods in a given context to mechanical properties (modulus, strength) to calculate an evaluate the different materials. • approximate sizing using the network theory of the structural elements implement and evaluate. • selecting appropriate solutions for mechanical recycling problems and sizing example stiffness, corrosion resistance. Personal Competence Social Competence					
Admission Requirements Recommended Previous Basics: chemistry / physics / materials science Knowledge Educational Objectives Knowledge After taking part successfully, students have reached the following learning results They can explain the complex relationships structure property relationship and the interactions of chemical structure of the polymers, their processing with the different fiber types, including to explanelly properties of chemical structure of the polymers, their processing with the different fiber types, including to explanelly properties of the interactions of chemical structure of the polymers, their processing with the different fiber types, including to explanelly properties of the interactions of chemical structure of the polymers, their processing with the different fiber types, including to explanelly processing with the different fiber types, including to explanelly processing with the different fiber types, including to explanelly processing with the different fiber types, including to explanelly processing with the different fiber types, including to explanelly processing with the different fiber types, including to explanelly processing with the different fiber types, including to explanelly processing with the different fiber types, including to explanelly processing with the different fiber types, including to explanelly processing with the different fiber types, including to explanelly processing with the different fiber types, including to explanelly processing with the different fiber types, including to explanelly processing with the different fiber types, including to explanelly processing with the different fiber types, including to explanelly processing with the different fiber types, including to explanelly processing with the different fiber types, including to explanelly processing with the different fiber types, including to explanelly processing with the different fiber types, including to explanelly processing with the different fiber types, including to explane			Recitation Section (large)	1	1
Recommended Previous Basics: chemistry / physics / materials science Knowledge Educational Objectives After taking part successfully, students have reached the following learning results Professional Competence Knowledge Students can use the knowledge of fiber-reinforced composites (FRP) and its constituents to play (fiber / matrix) and define the necessary testing and analysis. They can explain the complex relationships structure-property relationship and the interactions of chemical structure of the polymers, their processing with the different fiber types, including to explain neighboring contexts (e.g. sustainability, environmental protection). Skills Students are capable of using standardized calculation methods in a given context to mechanical properties (modulus, strength) to calculate an evaluate the different materials. approximate sking using the network theory of the structural elements implement and evaluate. selecting appropriate solutions for mechanical recycling problems and sixing example stiffness, corrosion resistance. Personal Competence Social Competence Social Competence Students are able to arrive at funded work results in heterogenius groups and document them. provide appropriate feedback and handle feedback on their own performance constructively. Autonomy Students are able to assess their own strengths and weaknesses. assess their own state of learning in specific terms and to define further work steps on this basis. assess possible consequences of their professional activity. Workdoad in Hours Independent Study Time 110. Study Time in Lecture 70 Credit points Course achievement None Examination and Somila Assignment for the Energy Systems: Core Qualification: Elective Compulsory Archanical Engineering and Manaagements, Specialisation in Product Development and Production: Elective Compulsory Product Development, Materials and Production: Specialisation Product Development: Elective Compulsory Product Development, Materials and Production: Specialisation	<u> </u>				
Educational Objectives Professional Competence Knowledge Students can use the knowledge of fiber-reinforced composites (FRP) and its constituents to play (fiber / matrix) and define the necessary testing and analysis. They can explain the complex relationships structure-property relationship and the interactions of chemical structure of the polymers, their processing with the different fiber types, including to explanely high process of contexts (e.g., sustainability, environmental protection). Skills Students are capable of using standardized calculation methods in a given context to mechanical properties (modulus, strength) to calculate an evaluate the different materials. approximate sizing using the network theory of the structural elements implement and evaluate. approximate sizing using the network theory of the structural elements implement and evaluate. approximate sizing using the network theory of the structural elements implement and evaluate. approximate sizing using the network theory of the structural elements implement and evaluate. approximate sizing using the network theory of the structural elements implement and evaluate. approximate sizing using the network theory of the structural elements implement and evaluate. approximate sizing using papropriate solutions for mechanical recycling problems and sizing example stiffness, corrosion resistance. Personal Competence Students are able to assess their own strengths and weaknesses. assess possible consequences of their professional activity. Workload in Hours Credit points Course achievement Following Curricula Assignment for the Examination Written exam Examination Written exam Examination Assignment for the Following Curricula Arizer Systems: Core Qualification: Elective Compulsory Methodical Engineering: Socialisation II. Product Developme					
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Renewable Energies: Specialisation Solar Energy Systems: Elective Compulsory		* '	• •		
Theoretical Mechanical Engineering: Specialisation Materials Science: Elective Compulsory		* '			

Course L1894: Structure and properties of fibre-polymer-composites		
Тур	Lecture	
Hrs/wk	2	
СР	3	
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28	
Lecturer	Prof. Bodo Fiedler	
Language	EN	
Cycle	SoSe	
Content	- Microstructure and properties of the matrix and reinforcing materials and their interaction	
	- Development of composite materials	
	- Mechanical and physical properties	
	- Mechanics of Composite Materials	
	- Laminate theory	
	- Test methods	
	- Non destructive testing	
	- Failure mechanisms	
	- Theoretical models for the prediction of properties	
	- Application	
Literature	Hall, Clyne: Introduction to Composite materials, Cambridge University Press	
Literature	Daniel, Ishai: Engineering Mechanics of Composites Materials, Oxford University Press	
	Mallick: Fibre-Reinforced Composites, Marcel Deckker, New York	
	Manick: Fibre-Reinforced Composites, Marcel Deckker, New York	

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

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

Module M1344: Proce	ssing of fibre-polymer-composites			
Courses				
Title		Тур	Hrs/wk	СР
Processing of fibre-polymer-compos		Lecture	2	3
From Molecule to Composites Part	(L1516)	Project-/problem-based Learning	2	3
Module Responsible	Prof. Bodo Fiedler			
Admission Requirements	None			
Recommended Previous	Knowledge in the basics of chemistry / physics / materia	ls science		
Knowledge				
Educational Objectives	After taking part successfully, students have reached th	e following learning results		
Professional Competence				
Knowledge	Students are able to give a summary of the technical of	etails of the manufacturing processes co	omposites and	d illustrate respective
	relationships. They are capable of describing and com	nmunicating relevant problems and que	stions using a	appropriate technical
	language. They can explain the typical process of solving	g practical problems and present related	results.	
Skills	Students can use the knowledge of fiber-reinforced con	posites (FRP) and its constituents (fiber	/ matrix) and	define the necessary
Skiii S	testing and analysis.	iposites (i.i.) and its constituents (iise.	, macrix, and	denne are necessary
	They can explain the complex structure-property relation	nship and		
	the interactions of chemical structure of the polyme	rs, their processing with the different	fiber types.	including to explain
	neighboring contexts (e.g. sustainability, environmental		31,,	, , , , , , , , , , , , , , , , , , ,
Personal Competence				
Social Competence	Students are able to cooperate in small, mixed-subject	groups in order to independently derive	solutions to o	iven problems in the
	context of civil engineering. They are able to effectively	present and explain their results alone	or in groups	in front of a qualified
	audience. Students have the ability to develop alternat	ive 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 mecha-	nical engineering problems using provid	ed literature.	They are able to fill
	gaps in as well as extent their knowledge using the liter	ature and other sources provided by the	supervisor. F	urthermore, they can
	meaningfully extend given problems and pragmatically	solve them by means of corresponding s	olutions and o	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: Specialisation Engineering Materials:	Elective Compulsory		
Following Curricula	Mechanical Engineering and Management: Specialisatio	n Materials: Elective Compulsory		
	Product Development, Materials and Production: Specia	lisation Product Development: Elective Co	ompulsory	
	Product Development, Materials and Production: Specia	isation Production: Elective Compulsory		
	Product Development, Materials and Production: Specia	isation Materials: Elective Compulsory		
	Theoretical Mechanical Engineering: Specialisation Mate	rials Science: Elective Compulsory		

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

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

Module M1690: Aircra	aft Design II (Special Air Vehicle Design)		
		•		
Courses				
	gn of Rotorcraft, special operations aircraft, UAV) (L0844) gn of Rotorcraft, special operations aircraft, UAV) (L0847)	Typ Lecture Recitation Section (large)	Hrs/wk 3 2	CP 3 3
Module Responsible		<u> </u>		
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	erformance aircraft
	Understanding of pro's and con's and physical character	istics of different air systems		
	Understanding of special mission requirements and its im	pact on systems definition and cond	eptual design	
	Intensified knowledge of performance design on various a	air systems		
Skills	Understanding and application of design and calculation	methods		
	Understanding of interdisciplinary and integrative interde	pendencies		
	mission oriented technical definition of air systems			
	special conceptual calculation methods for special equipr	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	6			
Course achievement	None			
Examination	Written exam			
Examination duration and scale	180 min			
	Aircraft Systems Engineering: Core Qualification: Elective	Compulsory		
Following Curricula	International Management and Engineering: Specialisation		pulsory	
,	Product Development, Materials and Production: Specialis	•		
	Product Development, Materials and Production: Specialis	sation Production: Elective Compulso	ory	
	Theoretical Mechanical Engineering: Specialisation Aircra	ft Systems Engineering: Elective Co	mpulsory	

Course L0844: Aircraft Desig	n II (Conceptual Design of Rotorcraft, special operations aircraft, UAV)
Тур	Lecture
Hrs/wk	3
СР	3
Workload in Hours	Independent Study Time 48, Study Time in Lecture 42
Lecturer	Prof. Volker Gollnick, 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 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 M1174: Autor	nation Technology and Systems			
Courses				
Title		Тур	Hrs/wk	СР
Automation Technology and System	ns (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 Schüppstuhl			
Admission Requirements	None			
	without major course assessment			
Knowledge				
	After taking part successfully, students have reached	the following learning results		
Professional Competence				
Knowledge	Students			
	 know the characteristic components of an autor 	mation systems and have good understand	ing of their in	teraction
	 know methods for a systematical analysis of au 	tomation tasks and are able to use them		
	 have special competences in industrial robot ba 	sed automation systems		
Skills	Students are able to			
	analyze complex Automation tasks			
	develop application based concepts and solutio	ns		
	 design subsystems and integrate into one systems 			
	 investigate and evaluate safety of machinery 			
	create simple programs for robots and programmable logic controllers			
	design of circuit for pneumatic applications	-		
Personal Competence				
Social Competence	Students are able to			
	- find solutions for automation and handling tasks in g	roups		
	- develop solutions in a production environment with	qualified personnel at technical level and re	epresent decis	sions.
Autonomy	Students are able to			
	analyze automation tasks independently			
	 generate programs for robots and programmab 			
	develop solutions for practice oriented tasks of			
	design safety concepts for automation applications and a state of the sign professional action.			
	 assess consequences of their professional actio 	ns and responsibilities		
Workload in Hours	Independent Study Time 96, Study Time in Lecture 84			
Credit points	6			
Course achievement	None			
Examination	Written exam			
Examination duration and	120 min			
scale				
	International Management and Engineering: Specialisa			ompulsory
Following Curricula	Product Development, Materials and Production: Spec	·	ompulsory	
	Product Development, Materials and Production: Spec	· · ·		
	Product Development, Materials and Production: Spec			
	Theoretical Mechanical Engineering: Specialisation Pro	oduct Development and Production: Elective	e Compulsory	

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 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 M1878: Susta	inable energy	from wind and wa	ater		
Courses					
Title			Тур	Hrs/wk	СР
Sustainability Management (L0007	")		Lecture	2	1
Hydro Power Use (L0013)			Lecture	1	1
Wind Turbine Plants (L0011) Wind Energy Use - Focus Offshore	(10012)		Lecture Lecture	2 1	3 1
Module Responsible		or	Lecture	1	1
Admission Requirements		Ci			
Recommended Previous	1	nermodynamics I.			
Knowledge					
	Module: Technical Th	nermodynamics II,			
	Module: Fundamenta	als of Fluid Mechanics			
Educational Objectives	After taking part suc	cessfully, students have re	eached the following learning results		
Professional Competence					
Knowledge	By ending this mode	ule students can explain i	in detail knowledge of wind turbines w	ith a particular focus o	of wind energy use in
			these aspects in consideration of currer		
			wer to generate electricity. The student	s reproduce and explain	n the basic procedure
	in the implementation	n of renewable energy pro	ojects in countries outside Europe.		
	Through active disci	ussions of various topics	within the seminar of the module, stu	dents improve their ur	nderstanding and the
	application of the the	eoretical background and a	are thus able to transfer what they have	e learned in practice.	
Skills	Students are able to	apply the acquired theo	pretical foundations on exemplary water	er or wind power system	ms and evaluate and
			n the context of dimensioning and ope		
	compare critically the	e special procedure for the	e implementation of renewable energy	projects in countries ou	tside Europe with the
	in principle applied a	pproach in Europe and car	n apply this procedure on exemplary the	eoretical projects.	
Personal Competence					
Social Competence		s scientific tasks subiet-sp	ecificly and multidisciplinary within a se	minar.	
,					
Autonomy	-		n the context of the emphasis of the I	ecture material to clea	r the contents of the
	lecture and to acquir	e the particular knowledge	e about the subject area.		
Workload in Hours	Independent Study T	ime 96, Study Time in Lec	ture 84		
Credit points	6				
Course achievement		Form	Description		
Francischion	Yes None	Written elaboration	Schriftliche Ausarbeitung (inkl. Vor	trag) in Nachhaltigkeitsi	management
Examination duration and	Written exam 150 min				
scale					
Assignment for the		ecialisation Structural Eng	ineering: Elective Compulsory		
•		_	Engineering: Elective Compulsory		
			eering: Elective Compulsory		
	International Manage	ement and Engineering: Sp	pecialisation II. Energy and Environment	al Engineering: Elective	Compulsory
	International Manage	ement and Engineering: Sp	pecialisation II. Renewable Energy: Elect	ive Compulsory	
			n: Specialisation Production: Elective Co		
	· ·		n: Specialisation Product Development:		
	·		·	npulsory	
	_	•	•	orv	
	THEOLEGICAL MECHANIC	aı Engineening. Specialisa		Ji y	
	Process Engineering	Specialisation Environme		oulsory	
			ntal Process Engineering: Elective Comp isation Environment: Compulsory	oulsory	
rollowing Curricula	Civil Engineering: Sp International Manage International Manage Product Developmen Product Developmen Product Developmen Renewable Energies:	ecialisation Coastal Engine ement and Engineering: Sp ement and Engineering: Sp it, Materials and Production it, Materials and Production it, Materials and Production core Qualification: Comp	pering: Elective Compulsory pecialisation II. Energy and Environment pecialisation II. Renewable Energy: Elect n: Specialisation Production: Elective Co n: Specialisation Product Development: n: Specialisation Materials: Elective Con	ive Compulsory Impulsory Elective Compulsory Inpulsory	Compulsory

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

Course L0013: Hydro Power I	Use Control of the Co		
Тур	Lecture		
Hrs/wk			
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

Module M1888: Enviro	onmental protection management			
Courses				
Title		Тур	Hrs/wk	СР
Health, Safety and Environmental M	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 reached t	ne following learning results		
Professional Competence				
Knowledge				
Skills				
Personal Competence				
Social Competence				
Autonomy				
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 min			
scale				
Assignment for the	Civil Engineering: Specialisation Water and Traffic: Elec	tive Compulsory		
Following Curricula	Bioprocess Engineering: Specialisation C - Bioecond	omic Process Engineering, Focus	Management and 0	Controlling: Elective
	Compulsory			
	Environmental Engineering: Specialisation Energy and	Resources: Elective Compulsory		
	International Management and Engineering: Specialisa	tion II. Energy and Environmental E	ngineering: Elective (Compulsory
	Product Development, Materials and Production: Specia	alisation Product Development: Elec	tive Compulsory	
	Product Development, Materials and Production: Specia	alisation Production: Elective Comp	ulsory	
	Product Development, Materials and Production: Specia	alisation Materials: Elective Compul	sory	
	Renewable Energies: Specialisation Bioenergy Systems	: Elective Compulsory		
	Process Engineering: Specialisation Environmental Proc		ory	
	Water and Environmental Engineering: Specialisation E			
	Water and Environmental Engineering: Specialisation C	ities: 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

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 Thermo	dynamics I, II, Fluid Dynamics, Heat	Transfer, Control	Systems
Knowledge				
Educational Objectives	After taking part successfully, students have reached the	following learning results	<u></u>	
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	Compulsory		
	Aeronautics: Core Qualification: Elective Compulsory			
	Product Development, Materials and Production: Specialis	ation Product Development: Elective	e Compulsory	
	Product Development, Materials and Production: Specialis	ation Production: Elective Compulso	ry	
	Product Development, Materials and Production: Specialis	ation Materials: Elective Compulsory	/	
	Renewable Energies: Specialisation Bioenergy Systems: E	' '		
	Renewable Energies: Specialisation Solar Energy Systems	: Elective Compulsory		
	Renewable Energies: Specialisation Wind Energy Systems	• •		
	Theoretical Mechanical Engineering: Specialisation Simula	·	ry	
	Theoretical Mechanical Engineering: Specialisation Energy	/ Systems: 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		

	cs							
Courses								
Title					Тур	н	rs/wk	CP
Robotics: Modelling and Control (L016	68)				Integrated Lecture	4	13/WK	4
Robotics: Modelling and Control (L130							2	
Module Responsible D	Dr. Martin Gomse							
Admission Requirements N	None							
Recommended Previous F	undamentals of elect	rical engine	ering					
Knowledge								
B	Broad knowledge of m	nechanics						
F	Fundamentals of contr	rol theory						
Educational Objectives A	After taking part succe	essfully, stu	dents have r	eached the following	ng learning results			
Professional Competence								
Knowledge S	Students are able to d	lescribe fun	damental pro	perties of robots a	and solution approaches for	r multiple	problems in	robotics.
<i>Skills</i> S	Students are able to derive and solve equations of motion for various manipulators.							
	itudante can ganarata trajectoriae in various coordinata cuctome							
	Students can generate trajectories in various coordinate systems.							
S	Students can design linear and partially nonlinear controllers for robotic manipulators.							
Personal Competence								
Social Competence S	Students are able to w	vork goal-or	iented in sma	all mixed groups.				
Autonomy S	Students are able to re	ecognize an	id improve kr	owledge deficits in	ndependently.			
v	With instructor assista	nce, studer	nts are able t	evaluate their ov	vn knowledge level and def	fine a furt	ther course o	of study.
Workload in Hours In	ndependent Study Tir	me 96, Stud	y Time in Led	ture 84				
Credit points 6	5							
Course achievement C	Compulsory Bonus	Form		Description				
Y	res None	-	theoretical		n PBL-Einheiten sowie	Erreicher	n des Gesa	amtziels und der
		practical v	vork	jeweiligen Se	ssion-Ziele			
-	Written exam							
	L20 min							
scale	Viscosit Cuetama Engis		o Ouglificatio	n. Flastina Caman	.leen.			
_	Aircraft Systems Engir	-			ilsory Iduct Development and Pro	duction:	Elective Con	onulcon/
	_				chatronics: Elective Compu		Liective Con	ripuisor y
	Aeronautics: Core Qua		-		chadronies. Elective compe	21301 y		
	Mechanical Engineerir			-	mpulsorv			
	Mechatronics: Core Qu							
				n: Specialisation P	roduct Development: Elect	ive Comp	oulsory	
	•			•	roduction: Elective Compul		-	
P	Product Development,	, Materials a	and Productio	n: Specialisation M	laterials: Elective Compuls	ory		
Т	Theoretical Mechanica	al Engineerii	ng: Specialisa	ition Product Deve	lopment and Production: E	lective Co	ompulsory	
Т	Theoretical Mechanica	al Engineerii	ng: Specialisa	tion Robotics and	Computer Science: Elective	e Compu	Isory	

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

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

Production				
Module M0771: Flight	t Physics			
Courses				
Title		Тур	Hrs/wk	СР
Aerodynamics and Flight Mechanic	s I (L0727)	Lecture	3	3
Flight Mechanics II (L0730)		Lecture	2	2
Flight Mechanics II (L0731)		Recitation Section (large)	1	1
Module Responsible	Prof. Frank Thielecke			
Admission Requirements	None			
Recommended Previous	Basic knowledge in:			
Knowledge				
	Mathematics			
	Mechanics			
	Thermodynamics			
	Aviation			
Educational Objectives	After taking part successfully, students have reached the	ollowing learning results		
Professional Competence				
•	Students are able to			
	Describe the fundamental equations of aerodynami	cs 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	measurement technology		
Skills	Students are able to			
	Perform flight mechanic simulations			
	Derive flight mechanic relations from virtual and real	al flight test data		
Personal Competence				
Social Competence	Students are able to:			
	a Doutewas sinculations in everyon and discuss year the			
	Perform simulations in groups and discuss results Traducts flight test data in groups discuss and presults.	ant the vestiles		
	 Evaluate flight test data in groups, discuss and pres 	ent the results		
Autonomy	Students are able to:			
	- December to a bigger a sub-ortion december 1			
	Process teaching content independently Propers work out and process simulation models in	danandantly		
	Prepare, work out and process simulation models in Apply teaching content on virtual and real flight tos			
	Apply teaching content on virtual and real flight tes	Luula		
Workload in Hours	Independent Study Time 96, Study Time in Lecture 84			
Credit points	6			
Course achievement	None			
Examination	Written exam			
Examination duration and	160 Minutes			
scale				
Assignment for the	Aircraft Systems Engineering: Core Qualification: Compuls	ory		
Following Curricula	1	•	pulsory	
•	Aeronautics: Core Qualification: Compulsory	-	· •	
	Product Development, Materials and Production: Specialisa	ation Product Development: Elective	e Compulsory	
	Product Development, Materials and Production: Specialisa	ation Production: Elective Compulso	ory	
	Product Development, Materials and Production: Specialisa	•	-	
	Theoretical Mechanical Engineering: Specialisation Aircraft			
	3 3	3 3 3 3 3 3	. ,	

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

ourse L0730: Flight Mechan	nics II				
Тур	Lecture				
Hrs/wk					
СР	2				
Workload in Hours	endent Study Time 32, Study Time in Lecture 28				
Lecturer	Prof. Frank Thielecke				
Language	DE				
Cycle	SoSe				
Content	stationary asymmetric flight dynamics of lateral movement methods of flight simulation eyperimental methods of flight mechanics model validation using system identification wind tunnel techniques				
Literature	 Schlichting, H.; Truckenbrodt, E.: Aerodynamik des Flugzeuges I und II Etkin, B.: Dynamics of Atmospheric Flight Sachs/Hafer: Flugmechanik Brockhaus: Flugregelung J.D. Anderson: Introduction to flight 				

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

Module M0815: Produ	ıct Planning				
Courses					
Title		Туј	1	Hrs/wk	СР
Product Planning (L0851)			ture	3	3
Product Planning Seminar (L0853)			ect-/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 le	earning 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	ments			
Personal Competence					
Social Competence					
, , , , , , , , , , , , , , , , , , , ,	Interact within a team				
	Raise awareness for globabl issues				
Autonomy					
	Gain access to knowledge sources				
	Interpret complex cases				
	Develop presentation skills				
Workload in Hours	Independent Study Time 110, Study Time in Lect	ture 70			
Credit points	6				
Course achievement	Compulsory Bonus Form	Description	<u> </u>		
	Yes 20 % Subject theoretical a	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: Spec	cialisation I. Elective	s Management: Elective Cor	npulsory	
	Mechanical Engineering and Management: Specia	alisation Manageme	nt: Elective Compulsory		
	Product Development, Materials and Production:	Specialisation Produ	ict Development: Elective Co	ompulsory	
	Product Development, Materials and Production:	Specialisation Produ	iction: Elective Compulsory		
	Product Development, Materials and Production:	Specialisation Mater	rials: Elective Compulsory		
	Theoretical Mechanical Engineering: Specialisation	on Product Developn	nent 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.
114.	Which W Fastering C. Budust Daving and Davidson and Edition McGray VIII 2010
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".	

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	re 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
, idea in a single		rch-oriented duties in for risk management ar		-
	the potential social, economic and cultural		,	,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,
	·	·		
Workload in Hours	Independent Study Time 124, Study Time in	n Lecture 56		
Credit points	6			
Course achievement	None			
Examination	Written elaboration			
Examination duration and	Elaboration and presentation (45 minutes in	n groups)		
scale				
Assignment for the	Civil Engineering: Core Qualification: Comp	ulsory		
Following Curricula		- Bioeconomic Process Engineering, Focus	Management and	Controlling: Elective
	Compulsory			
		: Specialisation II. Civil Engineering: Elective (
	·	ction: Specialisation Product Development: Ele		
	·	ction: Specialisation Production: Elective Comp	-	
		ction: Specialisation Materials: Elective Compu	lisury	
	Water and Environmental Engineering: Core	e Quanneacion: Compuisory		

Course L1145: Safety, Reliab	ility and Risk Assessment
•	Seminar
Hrs/wk	2
CP	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Dr. Marco Ritzkowski
Language	DE
Cycle	WiSe
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.

Module M1024: Metho	ods of Product Development			
Courses				
Title		Тур	Hrs/wk	СР
Integrated Product Development II		Lecture	3	3
Integrated Product Development II	(L1255)	Project-/problem-based Learning	2	3
Module Responsible	Prof. Dieter Krause			
Admission Requirements	None			
Recommended Previous	Basic knowledge of Integrated product development and	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:			
	a symposis to about all toward of decision months adalogy.			
	 explain technical terms of design methodology, describe essential elements of construction mana 	and the same of th		
	describe essential elements of construction managements of describe current problems and the current state of	-	mont	
	describe current problems and the current state t	or research or integrated product develop	illelit.	
Skills	After passing the module students are able to:			
				- d b b d-
	select and apply proper construction methods for	or non-standardized solutions of problem	is as well as a	adapt new bounda
	conditions,	-i-b		
	solve product development problems with the ass			
	 choose and execute appropriate moderation tech 	niques.		
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 id 	eas.		
Autonomy	After passing the module students are able to:			
	give a structured feedback and accept a critical feedback.	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	55			
Assignment for the	Aircraft Systems Engineering: Core Qualification: Electiv	e Compulsory		
Following Curricula			nn: Elective Co	mnulsory
. cc.ming curricula	Aeronautics: Core Qualification: Elective Compulsory	2	2.000170 00	
	Mechatronics: Specialisation System Design: Elective Co	ompulsory		
	Mechatronics: Core Qualification: Elective Compulsory	,50.50. j		
	Product Development, Materials and Production: Special	lisation Product Development: Compulsor	·v	
	Product Development, Materials and Production: Special	· · · · · ·	,	
	Product Development, Materials and Production: Special			
	Theoretical Mechanical Engineering: Specialisation Prod		e Compulsorv	
		The second secon		

Production"	
Course L1254: Integrated Pr	oduct Development II
Тур	Lecture
Hrs/wk	3
СР	3
Workload in Hours	Independent Study Time 48, Study Time in Lecture 42
	Prof. Dieter Krause
Language	DE
Cycle	
	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,
	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	
Elterature	 Andreasen, M.M., Design for Assembly, Berlin, Springer 1985. Ashby, M. F.: Materials Selection in Mechanical Design, München, Spektrum 2007. Beckmann, H.: Supply Chain Management, Berlin, Springer 2004. Hartmann, M., Rieger, M., Funk, R., Rath, U.: Zielgerichtet moderieren. Ein Handbuch für Führungskräfte, Berater und Trainer, Weinheim, Beltz 2007. Pahl, G., Beitz, W.: Konstruktionslehre, Berlin, Springer 2006. Roth, K.H.: Konstruieren mit Konstruktionskatalogen, Band 1-3, Berlin, Springer 2000. Simpson, T.W., Siddique, Z., Jiao, R.J.: Product Platform and Product Family Design. Methods and Applications, New York,
	Springer 2013.

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

Module M1025: Fluidi	cs			
Courses				
Title Fluidics (L1256) Fluidics (L1371) Fluidics (L357)		Typ Lecture Project-/problem-based Learning	Hrs/wk 2 1	CP 3 2
Fluidics (L1257)	Prof. Dieter Krause	Recitation Section (large)	1	1
Module Responsible Admission Requirements	None			
Recommended Previous Knowledge	Good knowledge of mechanics (stereo statics, elastostatics	s, hydrostatics, kinematics and	kinetics), flui	d mechanics, and
Educational Objectives	After taking part successfully, students have reached the following	ing learning results		
	After passing the module students are able to explain structures and functionalities of hydrostatic, pneu explain the interaction of hydraulic components in hydrau explain open and closed loop control of hydraulic systems describe functioning and applications of hydrodynamic to and aggregates in plant technology After passing the module students are able to analyse and assess hydraulic and pneumatic components design and dimension hydraulic systems for mechanical a perform numerical simulations of hydraulic systems base select and adapt pump characteristic curves for hydraulic	ulic systems, s, prque converters, brakes and clut s and systems, applications, d on abstract problem definitions	ches as well as	centrifugal pumps
Personal Competence Social Competence	dimension hydrodynamic torque converters and brakes for the discussion of the module students are able to discuss and present functional context in groups, organise teamwork autonomously.	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				-
Course achievement		ydrostatischer Systeme		
Examination	Written exam	yarostatistner systeme		
Examination duration and scale Assignment for the Following Curricula	International Management and Engineering: Specialisation II. Pro Product Development, Materials and Production: Specialisation I	oduct Development and Production Product Development: Compulsor	on: Elective Con	npulsory
	Product Development, Materials and Production: Specialisation I Product Development, Materials and Production: Specialisation I Theoretical Mechanical Engineering: Specialisation Product Deve	Materials: Elective Compulsory	e Compulsory	

Production"	
Course L1256: Fluidics	
Тур	Lecture
Hrs/wk	2
СР	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
	Prof. Dieter Krause
Language	
Cycle	
Content	Lecture
	Hydrostatics
	physical fundamentals
	hydraulic fluids
	hydrostatic machines .
	• valves
	• components
	hydrostatic transmissions
	examples from industry
	Pneumatics
	generation of compressed air
	pneumatic motors
	Examples of use
	Hydrodynamics
	- Type of the state of the stat
	physical fundamentals
	hydraulic continous-flow machines
	hydrodynamic transmissions
	interoperation of motor and transmission
	Exercise
	Exercise
	Hydrostatics
	and the and desire of hydroutic discourse
	reading and design of hydractatic traction and working drives.
	dimensioning of hydrostatic traction and working drives performance calculation
	• performance calculation
	Hydrodynamics
	a laulation / dimensioning of budged-unania torque
	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
	Skript zur voncaung

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	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	

Courses Title Typ Hrs/wk CP Aircraft Cabin Systems (L1545) Aircraft Cabin Systems (L1545) Aircraft Cabin Systems (L1546) Prof. Ralf God Admission Requirements Recommended Previous Knowledge Nathematics Mechanics Thermodynamics Electrical Engineering Control Systems After taking part successfully, students have reached the following learning results Professional Competence Knowledge Students are able to:	
Title Aircraft Cabin Systems (L1545) Aircraft Cabin Systems (L1546) Module Responsible Admission Requirements Recommended Previous Knowledge Admission Cabin Systems After taking part successfully, students have reached the following learning results Typ Lecture Recitation Section (large) 1 2 A 4 A 2 A 6 A 6 A 6 A 7 A 7 A 7 A 8 A 8 A 8 A 8 A 8	
Title Aircraft Cabin Systems (L1545) Aircraft Cabin Systems (L1546) Module Responsible Admission Requirements Recommended Previous Knowledge Admics - Mathematics - Mechanics - Thermodynamics - Electrical Engineering - Control Systems After taking part successfully, students have reached the following learning results Typ Lecture 3 4 Activation Section (large) 1 2 Activation Section (large) 1 2 Activation Section (large) 4 2 Activation Section (large) 1 2 Activation Section (large) 2 4 Activation Section (large) 1 2 Activation Section (large) 2 4 Activation Section (large) 3 4 Activation Section (large) 4 4 Activation Section Section (large) 4 4 Activation Section Section Section (large) 4 4	
Aircraft Cabin Systems (L1545) Aircraft Cabin Systems (L1546) Module Responsible Prof. Ralf God Admission Requirements None Recommended Previous Knowledge in:	
Aircraft Cabin Systems (L1546) Module Responsible Prof. Ralf God Admission Requirements None Recommended Previous Knowledge in: - Mathematics - Mechanics - Thermodynamics - Electrical Engineering - Control Systems After taking part successfully, students have reached the following learning results	
Module Responsible Prof. Ralf God Admission Requirements None Recommended Previous Knowledge Basic knowledge in: • Mathematics • Mechanics • Thermodynamics • Electrical Engineering • Control Systems Educational Objectives After taking part successfully, students have reached the following learning results	
Admission Requirements Recommended Previous Knowledge Mathematics Mechanics Thermodynamics Electrical Engineering Control Systems After taking part successfully, students have reached the following learning results Professional Competence	
Recommended Previous Knowledge Mathematics Mechanics Thermodynamics Electrical Engineering Control Systems Educational Objectives After taking part successfully, students have reached the following learning results	
Knowledge	
Mechanics Thermodynamics Electrical Engineering Control Systems Educational Objectives After taking part successfully, students have reached the following learning results Professional Competence	
Thermodynamics Electrical Engineering Control Systems Educational Objectives Professional Competence After taking part successfully, students have reached the following learning results	
Electrical Engineering Control Systems Educational Objectives Professional Competence After taking part successfully, students have reached the following learning results	
Control Systems Educational Objectives	
Educational Objectives After taking part successfully, students have reached the following learning results Professional Competence	
Professional Competence	
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	
Chille Chudanta ara akla ka	
Skills 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 Affilia 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 basis of existing requirements	
discuss with experts in technical language	
explain system 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 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 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 Compulsory	
Following Curricula Aircraft Systems Engineering: Core Qualification: Compulsory	
International Management and Engineering: Specialisation II. Aviation Systems: 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 Materials: Elective Compulsory	
Theoretical Mechanical Engineering: Specialisation Aircraft Systems Engineering: Elective Compulsory	

Course L1545: Aircraft Cabin	Systems
Тур	Lecture
Hrs/wk	3
СР	4
Workload in Hours	Independent Study Time 78, Study Time in Lecture 42
Lecturer	Prof. Ralf God
Language	DE
Cycle	WiSe
Content	The objective of the lecture with the corresponding exercise is the acquisition of knowledge about aircraft cabin systems and cabin operations. A basic understanding of technological and systems engineering effort to maintain an artificial but comfortable and safe travel and working environment at cruising altitude is to be achieved.
	The course provides a comprehensive overview of current technology and cabin systems in modern passenger aircraft. The Fulfillment of requirements for the cabin as the central system of work are covered on the basis of the topics comfort, ergonomics, human factors, operational processes, maintenance and energy supply: Materials used in the cabin Ergonomics and human factors Cabin interior and non-electrical systems Cabin electrical systems and lights Cabin electronics, communication-, information- and IFE-systems Cabin and passenger process chains RFID Aircraft Parts Marking Energy sources and energy conversion
Literature	- Skript zur Vorlesung - Jenkinson, L.R., Simpkin, P., Rhodes, D.: Civil Jet Aircraft Design. London: Arnold, 1999 - Rossow, CC., Wolf, K., Horst, P. (Hrsg.): Handbuch der Luftfahrzeugtechnik. Carl Hanser Verlag, 2014 - Moir, I., Seabridge, A.: Aircraft Systems: Mechanical, Electrical and Avionics Subsystems Integration, Wiley 2008 - Davies, M.: The standard handbook for aeronautical and astronautical engineers. McGraw-Hill, 2003 - Kompendium der Flugmedizin. Verbesserte und ergänzte Neuauflage, Nachdruck April 2006. Fürstenfeldbruck, 2006 - Campbell, F.C.: Manufacturing Technology for Aerospace Structural Materials. Elsevier Ltd., 2006

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

Module M1342: Polyn	ners			
Courses				
Γitle		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	reached the following learning results		
Professional Competence				
Knowledge	Students can use the knowledge of plastics a	and define the necessary testing and analys	sis.	
	They can explain the complex relationships :	structure proporty 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			
Skiiis	ordaenes are capable of			
	- using standardized calculation methods	in a given context to mechanical proper	rties (modulus, strengt	th) to calculate and
	evaluate the different materials.			
	- selecting appropriate solutions for mechar	nical recycling problems and sizing example	stiffness, corrosion res	sistance.
	3.44 .4	5		
Personal Competence				
Social Competence	Students can			
	- arrive at funded work results in heterogeni	us groups and document them.		
	- provide appropriate feedback and handle for	eedback on their own performance constru	ctively.	
4	Charles have a halo ha			
Autonomy	Students are able to			
	- assess their own strengths and weaknesse:	S.		
	assess their own state of learning in specifi	is terms and to define further work stone or	this basis	
	- assess their own state of learning in specifi	ic terms and to define further work steps of	i una Dasis.	
	- assess possible consequences of their profe	essional activity.		
Workload in Hours	Independent Study Time 124, Study Time in	Lecture 56		
Credit points	6			
Course achievement				
Examination				
Examination duration and	180 min			
scale	200			
Assignment for the	Materials Science and Engineering: Specialis	ation Engineering Materials: Elective Comp	ulsorv	
Following Curricula	Materials Science: Specialisation Engineering			
3	Biomedical Engineering: Specialisation Impla			
	Biomedical Engineering: Specialisation Artific		ctive Compulsory	
	Biomedical Engineering: Specialisation Mana	agement and Business Administration: Elect	ive Compulsory	
	Biomedical Engineering: Specialisation Medic	cal Technology and Control Theory: Elective	e Compulsory	
	Product Development, Materials and Product	tion: Specialisation Production: Elective Con	npulsory	
	Product Development, Materials and Product	tion: Specialisation Materials: Elective Comp	oulsory	
	Product Development, Materials and Product	tion: Specialisation Product Development: E	Elective Compulsory	
	Theoretical Mechanical Engineering: Special	isation Materials Science: Elective Compuls	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 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	

Troduction				
Module M1170: Phenomena and Methods in Materials Science				
Courses				
Title		Тур	Hrs/wk	СР
Experimental Methods for the Char	acterization of Materials (L1580)	Lecture	2	2
Phase equilibria and transformation		Lecture	2	2
Übung zu Phänomene und Methode	en der Materialwissenschaft (L2991)	Recitation Section (large)	2	2
Module Responsible	Prof. Jörg Weißmüller			
Admission Requirements	None			
Recommended Previous	Basic knowledge in Materials Science, e.g. Wei	rkstoffwissenschaft I/II		
Knowledge				
Educational Objectives	After taking part successfully, students have re	eached the following learning results		
Professional Competence				
Knowledge	The students will be able to explain the prope	rties of advanced materials along with their	applications in tecl	nnology, in particular
	metallic, ceramic, polymeric, semiconductor, n	nodern composite materials (biomaterials) a	nd nanomaterials.	
Skille	The students will be able to select material	configurations according to the technical	noods and if nocos	seary to docion now
SKIIIS	materials considering architectural principles	•		
	modern materials science, which enables			
	applications.	them to select optimum materials com	ibiliations acpenal	ing on the teeninear
Personal Competence				
Social Competence	The students are able to present solutions to s	pecialists and to develop ideas further.		
Autonomy	The students are able to			
	assess their own strengths and weakness	sses.		
	gather new necessary expertise by their			
	, , ,			
Workload in Hours	Independent Study Time 96, Study Time in Lec	cture 84		
Credit points	6			
Course achievement	None			
Examination	Written exam			
Examination duration and	90 min			
scale				
Assignment for the	Chemical and Bioprocess Engineering: Speciali	isation General Process Engineering: Elective	Compulsory	
Following Curricula	Chemical and Bioprocess Engineering: Speciali	isation Chemical Process Engineering: Electi	e Compulsory	
	International Management and Engineering: Sp	pecialisation II. Product Development and Pr	oduction: Elective C	ompulsory
	Materials Science: Core Qualification: Compuls	•		
	Product Development, Materials and Productio	·		
	Product Development, Materials and Productio	·	lsory	
	Product Development, Materials and Productio	•		
	Theoretical Mechanical Engineering: Specialisa	tion 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
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 ass	ets		
Courses				
Title Fundamentals of Maintenance, Repair and Overhaul (MRO) (L3160)		Typ Lecture	Hrs/wk	CP 4
Fundamentals of Maintenance, Rep Module Responsible	ı	Recitation Section (large)	1	2
Admission Requirements	None			
	We recommend knowledge in the areas of gene	ral engineering sciences, aeronautics and a	ircraft systems e	ngineering. Technical
Knowledge	fields like mechanical engineering, mechatronic content.	cs and production engineering will be intro	oduced into the	relevant aeronautica
Educational Objectives	After taking part successfully, students have read	ched the following learning results		
Professional Competence				
Knowledge	The students are able to describe fundamental coapproaches for complex optimization problems.	orrelations for the sustainable operation of t	echnical assets a	nd to identify solutior
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 group environment of multiple stakeholders.	os with a clear focus on the approached	solutions by res	pecting the complex
Autonomy	The students are enabled to find solutions for determining factors independently.	or optimization problems and to take req	uired decision fo	r the assessment of
Workload in Hours	Independent Study Time 124, Study Time in Lect	ure 56		
Credit points	6			
Course achievement	None			
Examination	Oral exam			
Examination duration and	30 min			
scale				
Assignment for the	Aircraft Systems Engineering: Core Qualification:	Elective Compulsory		
Following Curricula	Aeronautics: Core Qualification: Elective Compuls	sory		
	Mechatronics: Specialisation Intelligent Systems	and Robotics: Elective Compulsory		
	Mechatronics: Specialisation System Design: Elec	tive Compulsory		
	Mechatronics: Core Qualification: Elective Compu	llsory		
	Product Development, Materials and Production:			
	Product Development, Materials and Production:	Specialisation Production: Elective Compuls	ory	
	Product Development, Materials and Production:	·	-	
	Theoretical Mechanical Engineering: Specialisation			′
	Theoretical Mechanical Engineering: Specialisation	on Aircraft 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 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 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 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 Learn	ing 3	3
Advanced Training Course SE-ZERT	(L2739) Project-/problem-based Learn	ing 2	3
Elements of Integrated Production	Systems (L0927) Project-/problem-based Learn	ing 2	3
Development Management for Mec	hatronics (L1512) Lecture	2	3
Fatigue & Damage Tolerance (L031	.0) Lecture	2	3
GSD - Generational Sheet-Metal De	velopment (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 Course	e (L1258) Project-/problem-based Learn	ing 3	3
Mechanisms, Systems and Processe	es of Materials Testing (L0950) Lecture	2	2
Microsystems Technology (L0724)	Lecture	2	4
Sustainable Industrial Production (L	.2863) Lecture	2	4
Productivity Management (L0928)	Project-/problem-based Learn	ing 2	2
Productivity Management (L0931)	Recitation Section (small)	1	1
Feedback Control in Medical Techno	ology (L0664) Lecture	2	3
Structural Mechanics of Fibre Reinfe	orced Composites (L1514) Lecture	2	3
System Simulation (L1820)	Lecture	2	2
System Simulation (L1821)	Recitation Section (large)	1	2
Technical Design (L1513)	Lecture	2	3
Materials Testing (L0949)	Lecture	2	2
Reliability in Engineering Dynamics	(L2994) Lecture	2	2
Reliability in Engineering Dynamics	(L2995) Recitation Section (small)	1	2
Reliability of Aircraft Systems (L074	19) Lecture	2	3
Module Responsible	Prof. Dieter Krause		
Admission Requirements	None		
Recommended Previous	None		
Knowledge			
Educational Objectives	After taking part successfully, students have reached the following learning results		
Professional Competence			
Knowledge			
	 Students are able to express their extended knowledge and discuss the connection of 	f different specia	al fields or application
	areas of product development, materials and production		
	Students are qualified to connect different special fields with each other		
Skills	 Students can apply specialized solution strategies and new scientific methods in selec 	ted areas	
	Students are able to transfer learned skills to new and unknown problems and can developed to the students are able to transfer learned skills to new and unknown problems and can developed to the students are able to transfer learned skills to new and unknown problems and can developed to the students are able to transfer learned skills to new and unknown problems and can developed to the students are able to transfer learned skills to new and unknown problems and can developed to the students are able to transfer learned skills to new and unknown problems and can developed to the students are able to transfer learned skills to new and unknown problems and can developed to the students are able to transfer learned skills to new and unknown problems and can developed to the students are able to transfer learned skills to new and unknown problems and can developed to the students are able to transfer learned skills to new and unknown problems and can developed to the students are able to transfer learned skills to new and unknown problems are able to the students are able to t		n annroachos
	• Students are able to transfer learned skills to new and unknown problems and can dev	relop own solutio	парргоаспеѕ
Personal Competence			
Casial Camanatanaa			
Social Competence	<u>-</u>		
Autonomy	Students are able to develop their knowledge and skills by autonomous election of countries.	ırses.	
Workload in Hours	Depends on choice of courses		
Credit points	12		
Assignment for the	Product Development, Materials and Production: Specialisation Product Development: Electiv	e Compulsory	
Following Curricula			
Following Curricula	Product Development, Materials and Production: Specialisation Production: Elective Compulsion Product Payallan Production		
	Product Development, Materials and Production: Specialisation Materials: Elective Compulsor	У	

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 De	esign 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,	Systems and Processes of Materials Testing
Тур	Lecture
Hrs/wk	2
СР	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Examination Form	Klausur
Examination duration and	90 Minuten
scale	
Lecturer	Dr. Jan Oke Peters
Language	DE
Cycle	SoSe
Content	Application, analysis and discussion of basic and advanced testing methods to ensure correct selection of applicable testing procedure for investigation of part/materials deficiencies Stress-strain relationships Strain gauge application Visko elastic behavior Tensile test (strain hardening, necking, strain rate) Compression test, bending test, torsion test Crack growth upon static loading (J-Integral) Crack growth upon cyclic loading (micro- und macro cracks) Effect of notches Creep testing (physical creep test, influence of stress and temperature, Larson Miller parameter) Wear testing Non destructive testing application for overhaul of jet engines
Literature	 E. Macherauch: Praktikum in Werkstoffkunde, Vieweg G. E. Dieter: Mechanical Metallurgy, McGraw-Hill R. Bürgel: Lehr- und Übungsbuch Festigkeitslehre, Vieweg R. Bürgel: Werkstoffe sícher beurteilen und richtig einsetzen, Vieweg

Course L0724: Microsystems	Technology
Тур	Lecture
Hrs/wk	2
СР	4
Workload in Hours	Independent Study Time 92, Study Time in Lecture 28
Examination Form	Mündliche Prüfung
Examination duration and	30 min
scale	
Lecturer	Prof. Hoc Khiem Trieu
Language	EN
Cycle	WiSe
Content	
Content	 Introduction (historical view, scientific and economic relevance, scaling laws) Semiconductor Technology Basics, Lithography (wafer fabrication, photolithography, improving resolution, next-generation lithography, nano-imprinting, molecular imprinting) Deposition Techniques (thermal oxidation, epitaxy, electroplating, PVD techniques: evaporation and sputtering; CVD techniques: APCVD, LPCVD, PECVD and LECVD; screen printing) Etching and Bulk Micromachining (definitions, wet chemical etching, isotropic etch with HNA, electrochemical etching, anisotropic etching with KOH/TMAH: theory, corner undercutting, measures for compensation and etch-stop techniques; plasma processes, dry etching: back sputtering, plasma etching, RIE, Bosch process, cryo process, XeF2 etching) Surface Micromachining and alternative Techniques (sacrificial etching, film stress, stiction: theory and counter measures; Origami microstructures, Epi-Poly, porous silicon, SOI, SCREAM process, LIGA, SUB, rapid prototyping) Thermal and Radiation Sensors (temperature measurement, self-generating sensors: Seebeck effect and thermopile; modulating sensors: thermo resistor, Pt-100, spreading resistance sensor, pn junction, NTC and PTC; thermal anemometer, mass flow sensor: thermo resistor, Pt-100, spreading resistance sensor, pn junction, NTC and PTC; thermal anemometer, 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; magnetor esistance, AMR and GMR, fluxgate magnetometer) Chemical and Bio Sensors (thermal gas
I thoughton	M. Madau Eundamontals of Microfabrication, CDC Proce, 2002
Literature	M. Madou: Fundamentals of Microfabrication, CRC Press, 2002 N. Schwesinger: Lehrbuch Mikrosystemtechnik, Oldenbourg Verlag, 2009 T. M. Adams, R. A. Layton: Introductory MEMS, Springer, 2010 G. Gerlach; W. Dötzel: Introduction to microsystem technology, Wiley, 2008
	O. Genden, W. Dozzer. Introduction to microsystem technology, whey, 2000

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, Tim Jansen
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	Independent Study Time 62, Study Time in Lecture 28
Examination Form	Mündliche Prüfung
Examination duration and	30 min
scale	
Lecturer	Prof. Benedikt Kriegesmann
Language	EN
Cycle	WiSe
Content	Classical laminate theory
	Rules of mixture
	Failure mechanisms and criteria of composites
	Boundary value problems of isotropic and anisotropic shells
	Stability of composite structures
	Optimization of laminated composites
	Modelling composites in FEM
	Numerical multiscale analysis of textile composites
	Progressive failure analysis
Literature	 Schürmann, H., "Konstruieren mit Faser-Kunststoff-Verbunden", Springer, Berlin, aktuelle Auflage. Wiedemann, J., "Leichtbau Band 1: Elemente", Springer, Berlin, Heidelberg, , aktuelle Auflage. Reddy, J.N., "Mechanics of Composite Laminated Plates and Shells", CRC Publishing, Boca Raton et al., current edition. Jones, R.M., "Mechanics of Composite Materials", Scripta Book Co., Washington, current edition. Timoshenko, S.P., Gere, J.M., "Theory of elastic stability", McGraw-Hill Book Company, Inc., New York, current edition. Turvey, G.J., Marshall, I.H., "Buckling and postbuckling of composite plates", Chapman and Hall, London, current edition. Herakovich, C.T., "Mechanics of fibrous composites", John Wiley and Sons, Inc., New York, current edition. Mittelstedt, C., Becker, W., "Strukturmechanik ebener Laminate", aktuelle Auflage.

Course L1820: System Simul	ation
Тур	Lecture
Hrs/wk	2
СР	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Examination Form	Mündliche Prüfung
Examination duration and	30 min
scale	
Lecturer	Dr. Stefan Wischhusen, 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	 Modelica Association: "Modelica Language Specification - Version 3.5", Linköping, Sweden, 2021. OpenModelica: OpenModelica 1.17.0, https://www.openmodelica.org (siehe Download), 2021. M. Tiller: "Modelica by Example", https://book.xogeny.com, 2014. M. Otter, H. Elmqvist, et al.: "Objektorientierte Modellierung Physikalischer Systeme", at- Automatisierungstechnik (german), Teil 1 - 17, Oldenbourg Verlag, 1999 - 2000. P. Fritzson: "Principles of Object-Oriented Modeling and Simulation with Modelica 3.3", Wiley-IEEE Press, New York, 2015. P. Fritzson: "Introduction to Modeling and Simulation of Technical and Physical Systems with Modelica", Wiley, New York, 2011.

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

Course L1513: Technical Design	
Тур	Lecture
Hrs/wk	2
СР	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Examination Form	Schriftliche Ausarbeitung
Examination duration and	10-15 Entwurfszeichnungen, Skizzen und ca. 5-10 A4-Dokumentationsseiten (Themen- und Entwurfsbegründung)
scale	
Lecturer	Prof. Werner Granzeier, 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 GmbH, Auto & Design,

Production	
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	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			
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	lausur		
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 L2995: Reliability in I			
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	ausur	
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 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	Mathematics			
	Mechanics			
	Thermodynamics			
	Electrical Engineering			
	Fluid mechanics			
	After taking part successfully, students have read	ched the following learning results		
Professional Competence				
Knowledge	Students are able to:			
	Assess challenges during the design of air	craft energy systems		
	Describe essential components and design	n points of hydraulic and electrical supply sys	stems	
	Give an overview of the functionality of air	r conditioning systems		
	Describe different system concepts for de-	-icing		
	Identify constraints for the electrification of	of aircraft systems, and evaluate possible co	ncepts and limitat	tions
	Describe architectures for fuel supply syst	ems and illustrate design examples		
	Explain possible approaches for the integr	ation of fuel cell systems and evaluate zero-	emission concept	S
Skills	Students are able to:			
	Design hydraulic and electric supply syste			
	Analyze the thermodynamic behavior of a	ir conditioning systems		
	Design ice protection systems	and the second s		
	 Apply possible electrification concepts to e Design fuel supply systems 	existing aircraft systems		
	Perform the design of a fuel cell system			
	Terrorm the design of a fact cell system			
Personal Competence				
Social Competence	Students are able to:			
	Perform system design in groups and pres	ent and discuss results		
	Present systems engineering problems an			
Autonomy	Students are able to:			
	Reflect on the content of lectures autonom			
	Apply methods learned in the course of ex	·		
	Identify complex system dependencies au	tonomously and abstract simplified models a	and design proces	sses
Workload in Hours	Independent Study Time 110, Study Time in Lect	ture 70		
Credit points	6			
Course achievement	None			
Examination	Written exam			
Examination duration and	165 Minutes			
scale				
Assignment for the	Energy Systems: Specialisation Energy Systems:	Elective Compulsory		
Following Curricula				
	International Management and Engineering: Spe	• •	pulsory	
	Product Development, Materials and Production:	Specialisation Product Development: Electiv	e Compulsory	
	Product Development, Materials and Production:	Specialisation Production: Elective Compulso	ory	
	Product Development, Materials and Production:	Specialisation Materials: Elective Compulsor	у	
	Theoretical Mechanical Engineering: Specialisation	on Aircraft Systems Engineering: Elective Co	mpulsory	
	•			

Course L0735: Aircraft Energy Systems		
Тур	Lecture	
Hrs/wk	3	
СР	4	
Workload in Hours	ndependent 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 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			3
Elements of Integrated Production	Systems (L0927) Project-/problem-based Learning	2	3
Development Management for Med	chatronics (L1512) Lecture	2	3
atigue & Damage Tolerance (L031	Lecture Lecture	2	3
ndustry 4.0 for engineers (L2012)	Lecture	2	3
nnovation and Product Manageme	nt (L2168) Seminar	2	3
ightweight Design Practical Cours	e (L1258) Project-/problem-based Learning	3	3
Mechanisms, Systems and Process	es of Materials Testing (L0950) Lecture	2	2
Microsystems Technology (L0724)	Lecture	2	4
Sustainable Industrial Production (I	Lecture Lecture	2	4
Productivity Management (L0928)	Project-/problem-based Learning	2	2
roductivity Management (L0931)	Recitation Section (small)	1	1
eedback Control in Medical Techn	ology (L0664) Lecture	2	3
Structural Mechanics of Fibre Reinf	forced Composites (L1514) Lecture	2	3
System Simulation (L1820)	Lecture	2	2
System Simulation (L1821)	Recitation Section (large)	1	2
echnical Design (L1513)	Lecture	2	3
Materials Testing (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 following learning results		
Professional Competence			
Knowledge			
	Charles and the same at the sa	1166	I Galda an analta
	Students are able to express their extended knowledge and discuss the connection of contents.	lifferent specia	l fields or applica
	 Students are able to express their extended knowledge and discuss the connection of of areas of product development, materials and production 	lifferent specia	l fields or applica
	Students are able to express their extended knowledge and discuss the connection of contents.	lifferent specia	I fields or applica
Skille	 Students are able to express their extended knowledge and discuss the connection of of areas of product development, materials and production 	lifferent specia	I fields or applica
Skills	 Students are able to express their extended knowledge and discuss the connection of of areas of product development, materials and production 	·	I fields or applica
Skills	 Students are able to express their extended knowledge and discuss the connection of of areas of product development, materials and production Students are qualified to connect different special fields with each other 	d areas	
Skills	Students are able to express their extended knowledge and discuss the connection of a areas of product development, materials and production Students are qualified to connect different special fields with each other Students can apply specialized solution strategies and new scientific methods in selected.	d areas	
Skills Personal Competence	Students are able to express their extended knowledge and discuss the connection of a areas of product development, materials and production Students are qualified to connect different special fields with each other Students can apply specialized solution strategies and new scientific methods in selected.	d areas	
	Students are able to express their extended knowledge and discuss the connection of a areas of product development, materials and production Students are qualified to connect different special fields with each other Students can apply specialized solution strategies and new scientific methods in selected.	d areas	
Personal Competence Social Competence	Students are able to express their extended knowledge and discuss the connection of a areas of product development, materials and production Students are qualified to connect different special fields with each other Students can apply specialized solution strategies and new scientific methods in selected.	d areas	
Personal Competence	Students are able to express their extended knowledge and discuss the connection of a areas of product development, materials and production Students are qualified to connect different special fields with each other Students can apply specialized solution strategies and new scientific methods in selected.	d areas op own solution	
Personal Competence Social Competence Autonomy	Students are able to express their extended knowledge and discuss the connection of a areas of product development, materials and production Students are qualified to connect different special fields with each other Students can apply specialized solution strategies and new scientific methods in selected. Students are able to transfer learned skills to new and unknown problems and can devel Students are able to develop their knowledge and skills by autonomous election of course.	d areas op own solution	
Personal Competence Social Competence Autonomy Workload in Hours	Students are able to express their extended knowledge and discuss the connection of a areas of product development, materials and production Students are qualified to connect different special fields with each other Students can apply specialized solution strategies and new scientific methods in selected. Students are able to transfer learned skills to new and unknown problems and can devel Students are able to develop their knowledge and skills by autonomous election of course. Depends on choice of courses	d areas op own solution	
Personal Competence Social Competence Autonomy Workload in Hours Credit points	Students are able to express their extended knowledge and discuss the connection of a areas of product development, materials and production Students are qualified to connect different special fields with each other Students can apply specialized solution strategies and new scientific methods in selected. Students are able to transfer learned skills to new and unknown problems and can devel Students are able to develop their knowledge and skills by autonomous election of courses.	d areas op own solution es.	
Personal Competence Social Competence Autonomy Workload in Hours	Students are able to express their extended knowledge and discuss the connection of a areas of product development, materials and production Students are qualified to connect different special fields with each other Students can apply specialized solution strategies and new scientific methods in selected. Students are able to transfer learned skills to new and unknown problems and can devel Students are able to develop their knowledge and skills by autonomous election of courses.	d areas op own solution es.	
Personal Competence Social Competence Autonomy Workload in Hours Credit points	Students are able to express their extended knowledge and discuss the connection of a areas of product development, materials and production Students are qualified to connect different special fields with each other Students can apply specialized solution strategies and new scientific methods in selected. Students are able to transfer learned skills to new and unknown problems and can devel Students are able to develop their knowledge and skills by autonomous election of courses.	d areas op own solution es. Compulsory	
Personal Competence Social Competence Autonomy Workload in Hours Credit points Assignment for the	Students are able to express their extended knowledge and discuss the connection of a areas of product development, materials and production Students are qualified to connect different special fields with each other Students can apply specialized solution strategies and new scientific methods in selected. Students are able to transfer learned skills to new and unknown problems and can devel Students are able to develop their knowledge and skills by autonomous election of courses. Depends on choice of courses.	d areas op own solution es. Compulsory	
Personal Competence Social Competence Autonomy Workload in Hours Credit points Assignment for the	Students are able to express their extended knowledge and discuss the connection of careas of product development, materials and production Students are qualified to connect different special fields with each other Students can apply specialized solution strategies and new scientific methods in selected. Students are able to transfer learned skills to new and unknown problems and can devel Students are able to develop their knowledge and skills by autonomous election of course. Depends on choice of courses Product Development, Materials and Production: Specialisation Product Development: Elective Product Development, Materials and Production: Specialisation Production: Elective Compulsory.	d areas op own solution es. Compulsory	n approaches

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

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

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

Course L1512: Development	Management for Mechatronics
Тур	Lecture
Hrs/wk	2
СР	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Examination Form	Mündliche Prüfung
Examination duration and	30 Minuten
scale	
Lecturer	NN, Dr. Johannes Nicolas Gebhardt
Language	DE
Cycle	SoSe
Content	 Processes and methods of product development - from idea to market launch identification of market and technology potentials development of a common product architecture Synchronized product development across all engineering disciplines product validation incl. customer view Steering and optimization of product development Design of processes for product development IT systems for product development Establishment of management standards Typical types of organization
Literature	 Bender: Embedded Systems - qualitätsorientierte Entwicklung Ehrlenspiel: Integrierte Produktentwicklung: Denkabläufe, Methodeneinsatz, Zusammenarbeit Gausemeier/Ebbesmeyer/Kallmeyer: Produktinnovation - Strategische Planung und Entwicklung der Produkte von morgen Haberfellner/de Weck/Fricke/Vössner: Systems Engineering: Grundlagen und Anwendung Lindemann: Methodische Entwicklung technischer Produkte: Methoden flexibel und situationsgerecht anwenden Pahl/Beitz: Konstruktionslehre: Grundlagen erfolgreicher Produktentwicklung. Methoden und Anwendung VDI-Richtlinie 2206: Entwicklungsmethodik für mechatronische Systeme

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

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

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

Typ Project-/problem-based Learning Hrs/wk 3 CP 3 Workload in Hours Independent Study Time 48, Study Time in Lecture 42 Examination Form Mündliche Prüfung Examination duration and scale Lecturer Prof. Dieter Krause DE/EN	
CP 3 Workload in Hours Independent Study Time 48, Study Time in Lecture 42 Examination Form Mündliche Prüfung Examination duration and scale Lecturer Prof. Dieter Krause Language DE/EN	
Workload in Hours Independent Study Time 48, Study Time in Lecture 42 Examination Form Mündliche Prüfung Examination duration and scale Lecturer Prof. Dieter Krause Language DE/EN	
Examination Form Mündliche Prüfung Examination duration and scale Lecturer Prof. Dieter Krause Language DE/EN	
Examination duration and scale Lecturer Prof. Dieter Krause Language DE/EN	
scale Lecturer Prof. Dieter Krause Language DE/EN	
Lecturer Prof. Dieter Krause Language DE/EN	
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 Ver	lag, 2012.
 Schulte, K., Fiedler, B., "Structure and Properties of Composite Materials", Hamburg, TUHH - TuTech Inno 2005. 	vation GmbH,

Course L0950: Mechanisms,	Systems and Processes of Materials Testing
Тур	Lecture
Hrs/wk	2
СР	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Examination Form	Klausur
Examination duration and	90 Minuten
scale	
Lecturer	Dr. Jan Oke Peters
Language	DE
Cycle	SoSe
Content	Application, analysis and discussion of basic and advanced testing methods to ensure correct selection of applicable testing procedure for investigation of part/materials deficiencies • Stress-strain relationships • Strain gauge application • Visko elastic behavior • Tensile test (strain hardening, necking, strain rate) • Compression test, bending test, torsion test • Crack growth upon static loading (J-Integral) • Crack growth upon cyclic loading (micro- und macro cracks) • Effect of notches • Creep testing (physical creep test, influence of stress and temperature, Larson Miller parameter) • Wear testing • Non destructive testing application for overhaul of jet engines
Literature	 E. Macherauch: Praktikum in Werkstoffkunde, Vieweg G. E. Dieter: Mechanical Metallurgy, McGraw-Hill R. Bürgel: Lehr- und Übungsbuch Festigkeitslehre, Vieweg R. Bürgel: Werkstoffe sícher beurteilen und richtig einsetzen, Vieweg

Course L0724: Microsystems	Technology
	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; accelerometer: piezoresistive, piezoelectric and capacitive; angular rate sensor: operating principle 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: plistor and thermal conductivity sensor; metal oxide semiconduct
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, industria activities were mostly oriented towards economic constraints, while social and environmental consequences were only hardly considered. As a result, today's global consumption rates of many resources and associated emissions often exceed the natura regeneration rate of our planet. In this respect, current industrial production can mostly be described as unsustainable. This is emphasized each year by the Earth Overshoot Day, which marks the day when humanity's ecological footprint exceeds the Earth's annual regenerative capacity.
	This lecture aims to provide the motivation, analytical methods as well as approaches for sustainable industrial production and to clarify the influence of the production phase in relation to the raw material, use and recycling phases in the entire life cycle of products. For this, the following topics will be highlighted:
	- Motivation for sustainable production, the 17 Sustainable Development Goals (SDGs) of the UN and their relevance fo tomorrow's manufacturing;
	- raw material vs. production phase vs. use phase vs. recycling/end-of-life phase: importance of the production phase for the environmental impact of manufactured products;
	- Typical energy- and resource-intensive processes in industrial production and innovative approaches to increase energy and resource efficiency;
	- Methodology for optimizing the energy and resource efficiency of industrial manufacturing chains with the three steps 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.
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	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, Tim Jansen
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
СР	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Examination Form	Mündliche Prüfung
Examination duration and	30 min
scale	
Lecturer	Prof. Benedikt Kriegesmann
Language	EN
Cycle	WiSe
Content	Classical laminate theory
	Rules of mixture
	Failure mechanisms and criteria of composites
	Boundary value problems of isotropic and anisotropic shells
	Stability of composite structures
	Optimization of laminated composites
	Modelling composites in FEM
	Numerical multiscale analysis of textile composites
	Progressive failure analysis
Literature	 Schürmann, H., "Konstruieren mit Faser-Kunststoff-Verbunden", Springer, Berlin, aktuelle Auflage. Wiedemann, J., "Leichtbau Band 1: Elemente", Springer, Berlin, Heidelberg, , aktuelle Auflage. Reddy, J.N., "Mechanics of Composite Laminated Plates and Shells", CRC Publishing, Boca Raton et al., current edition. Jones, R.M., "Mechanics of Composite Materials", Scripta Book Co., Washington, current edition. Timoshenko, S.P., Gere, J.M., "Theory of elastic stability", McGraw-Hill Book Company, Inc., New York, current edition. Turvey, G.J., Marshall, I.H., "Buckling and postbuckling of composite plates", Chapman and Hall, London, current edition. Herakovich, C.T., "Mechanics of fibrous composites", John Wiley and Sons, Inc., New York, current edition. Mittelstedt, C., Becker, W., "Strukturmechanik ebener Laminate", aktuelle Auflage.

Course L1820: System Simul	ation
Тур	Lecture
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Examination Form	Mündliche Prüfung
Examination duration and	30 min
scale	
Lecturer	Dr. Stefan Wischhusen, 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 L1821: System Simulation	
Тур	Recitation Section (large)
Hrs/wk	1
СР	2
Workload in Hours	Independent Study Time 46, Study Time in Lecture 14
Examination Form	Mündliche Prüfung
Examination duration and	30 min
scale	
Lecturer	Dr. Stefan Wischhusen, Dr. Johannes Brunnemann
Language	DE
Cycle	WiSe
Content	See interlocking course
Literature	See interlocking course

Course L1513: Technical Design	
Тур	Lecture
Hrs/wk	2
СР	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Examination Form	Schriftliche Ausarbeitung
Examination duration and	10-15 Entwurfszeichnungen, Skizzen und ca. 5-10 A4-Dokumentationsseiten (Themen- und Entwurfsbegründung)
scale	
Lecturer	Prof. Werner Granzeier, 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 GmbH, Auto & Design,

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	AERO International,
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	(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			
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	Prof. Benedikt Kriegesmann, Dr. Eric Groß	
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	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 M1193: Cabin	Systems Engineering			
Ploudie Pillipp. Cabiii	Systems Engineering			
Courses				
Title		Тур	Hrs/wk	СР
	nology in cabin electronics and avionics (L1557)	Lecture	2	2
Computer and communication tech	nology in cabin electronics and avionics (L1558)	Recitation Section (small)	1	1
Model-Based Systems Engineering ((MBSE) with SysML/UML (L1551)	Project-/problem-based Learnin	g 3	3
Module Responsible	Prof. Ralf God			
Admission Requirements	None			
Recommended Previous	Basic knowledge in:			
Knowledge	Mathematics			
	Mechanics			
	Thermodynamics			
	Electrical Engineering			
	Control Systems			
	I			
	Previous knowledge in:			
	Systems Engineering			
Educational Objectives	After taking part successfully, students have reache	ed the following learning results		
Professional Competence				
Knowledge	Students are able to:			
	• describe the structure and operation of computer	architectures		
	• explain the structure and operation of digital com	munication Networks		
	• explain architectures of cabin electronics, integral	ted modular avionics (IMA) and Aircraft Dat	a Communication	on Network (ADCN)
	• understand the approach of Model-Based Syste	ems Engineering (MBSE) in the design of	hardware and s	oftware-based cabi
	systems			
Skills	Students are able to:			
	 understand, operate and maintain a Minicomputer build up a network communication and communicate with other network participants 			
	• connect a minicomputer with a cabin management system (A380 CIDS) and communicate over a AFDX®-Network			
	model system functions by means of formal languages SysML/UML and generate software code from the models			
	execute software code on a minicomputer			
Personal Competence				
-	Students are able to:			
	form teams of two or small groups for the practical	al work		
	work out partial results themselves and combine to		า	
	represent and contribute their own solution	and an overland solution		
	take over the guidance of 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		
	6			
Course achievement				
Examination	Written exam			
Examination duration and	120 minutes			
scale				
Assignment for the	Aircraft Systems Engineering: Core Qualification: Ele	ective Compulsory		
Following Curricula	International Management and Engineering: Special	lisation II. Aviation Systems: Elective Comp	ulsory	
	Decident Decidence of Materials and Decidentias Co	ecialisation Product Development: Elective	Compulsory	
	Product Development, Materials and Production: Sp			
, and the second	Product Development, Materials and Production: Sp Product Development, Materials and Production: Sp			
, and the second		pecialisation Production: Elective Compulsor	У	

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

Tvn	Recitation Section (small)
Hrs/wk	
CP	
	Independent Study Time 16, Study Time in Lecture 14
	Prof. Ralf God
Language	
Cycle	
	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 softwar
	mechanical and electronic system components nowadays requires a basic understanding of cabin electronics and avionics.
	The course teaches the basics of design and functionality of computers and data networks. Subsequently it focuses on curre
	principles and applications in integrated modular avionics (IMA), aircraft data communication networks (ADCN), cabin electroni
	and cabin networks:
	History of computer and network technology
	Layer model in computer technology
	Computer architectures (PC, IPC, Embedded Systems)
	BIOS, UEFI and operating system (OS)
	Programming languages (machine code and high-level languages)
	Applications and Application Programming Interfaces
	External interfaces (serial, USB, Ethernet)
	Layer model in network technology
	Network topologies
	Network components
	Bus access procedures
	Integrated Modular Avionics (IMA) and Aircraft Data Communication Networks (ADCN)
	Cabin electronics and cabin networks
Literature	- Skript zur Vorlesung
	- Schnabel, P.: Computertechnik-Fibel: Grundlagen Computertechnik, Mikroprozessortechnik, Halbleiterspeicher, Schnittstellen u
	Peripherie. Books on Demand; 1. Auflage, 2003
	- Schnabel, P.: Netzwerktechnik-Fibel: Grundlagen, Übertragungstechnik und Protokolle, Anwendungen und Dienste, Sicherhe
	Books on Demand; 1. Auflage, 2004
	- Wüst, K.: Mikroprozessortechnik: Grundlagen, Architekturen und Programmierung von Mikroprozessoren, Mikrocontrollern u
	Signalprozessoren. 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 M0630: Robot	tics and Navigation in Medicine			
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		,		
Knowledge	principles of math (algebra, analysis/calculu			
	principles of programming, e.g., in Java or C polid B or Mohlah plails	.++		
	solid R or Matlab skills			
Educational Objectives	After taking part successfully, students have reach	ned the following learning results		
Professional Competence				
Knowledge	The students can explain kinematics and trackin	g systems in clinical contexts and illustra	ite systems and	their components in
	detail. Systems can be evaluated with respect t	o collision detection and safety and regi	ulations. Student	s can assess typical
	systems regarding design and limitations.			
Chille	The students are able to design and such as a dis-		-lilli	_
SKIIIS	The students are able to design and evaluate navi	gation systems and robotic systems for me	dical applications	·.
Personal Competence				
Social Competence	The students are able to grasp practical tasks in	groups, develop solution strategies indep	endently, define	work processes and
	work on them collaboratively.			
	The students are able to collaboratively organize	their work processes and software soluti	ons using virtual	communication and
	software management tools.			
	The students can critically reflect on the results	s of other groups, make constructive sug	gestions for imp	provement, and also
	incorporate them into their own work.			
A coho m a man c	The students can access their level of Impulades	a and independently control their learning		this basis as well as
Autonomy	The students can assess their level of knowledg			
	document their work results. They can critically endocument to the other groups.	valuate the results achieved and present t	пені ін ан аррго	priate argumentative
	infamel to the other groups.			
Workload in Hours	Independent Study Time 110, Study Time in Lectu	re 70		
Credit points	6			
Course achievement	Compulsory Bonus Form	Description		
	Yes 10 % Written elaboration			
Francisco 41	Yes 10 % Presentation			
Examination	Written exam			
Examination duration and	90 minutes			
Scale	Computer Science: Specialisation II: Intelligence Er	oginooring: Floctive Compulsory		
Assignment for the		, ,		
Following Curricula	Electrical Engineering: Specialisation Medical Tech International Management and Engineering: Special		Compulsory	
	International Management and Engineering: Special International Management and Engineering: Special			Compulsory
	Mechatronics: Specialisation Intelligent Systems a	y y	orogy. Liective	Compaisory
	Biomedical Engineering: Specialisation Artificial Or		Compulsory	
	Biomedical Engineering: Specialisation Implants ar		compaisor y	
	Biomedical Engineering: Specialisation Medical Technology		pulsory	
	Biomedical Engineering: Specialisation Medical Tele	,		
	Product Development, Materials and Production: S			
	Product Development, Materials and Production: S Product Development, Materials and Production: S		, ,	
	Product Development, Materials and Production: S Product Development, Materials and Production: S	•	-	
	Theoretical Mechanical Engineering: Specialisation			
	medieded mechanical Engineering, Specialisation	1 210 and medical reclinology, Elective Con	ipuisoi y	

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

Module M1161: Turbo	omachinery			
Courses				
Title		Тур	Hrs/wk	СР
Turbomachines (L1562)		Lecture	3	4
Turbomachines (L1563)		Recitation Section (large)	1	2
Module Responsible	Prof. Markus Schatz			
Admission Requirements	None			
Recommended Previous	Technical Thermodynamics I, II, Fluid Dynamics, Heat Transf	er		
Knowledge				
Educational Objectives	After taking part successfully, students have reached the fol	lowing learning results		
Professional Competence				
Knowledge	The students can			
	distinguish the physical phenomena of conversion of a con	eneray.		
	understand the different mathematic modelling of tur			
	calculate and evaluate turbomachinery.	•		
Skills	The students are able to			
	- understand the physics of Turbomachinery,			
	- solve excersises self-consistent.			
Personal Competence				
Social Competence	The students are able to			
,				
	 discuss in small groups and develop an approach. 			
Autonomy	The students are able to			
	 develop a complex problem self-consistent, 			
	 analyse the results in a critical way, 			
	 have an qualified exchange with other students. 			
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56			
Credit points				
Course achievement				
Examination				
Examination duration and	90 min			
scale				
Assignment for the	Energy Systems: Specialisation Energy Systems: Elective Co	mpulsory		
Following Curricula	1			
-	Product Development, Materials and Production: Specialisati	on Product Development: Elective	Compulsory	
	Product Development, Materials and Production: Specialisati	on Production: Elective Compulso	ry	
	Product Development, Materials and Production: Specialisati	on Materials: Elective Compulsory	,	
	Theoretical Mechanical Engineering: Specialisation Energy S	ystems: Elective Compulsory		
	Theoretical Mechanical Engineering: Specialisation Energy S	ystems: Elective Compulsory		

Course L1562: Turbomachine	25
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 M0764: Flight Control Systems Striber Strib	P
Title Flight Control Systems (L0736) Flight Control Systems (L0740) Module Responsible Admission Requirements Knowledge - mathematics - mechanics - ithermo dynamics - electronics - fluid mechanics - control theory Educational Objectives Knowledge Knowledge After taking part successfully, students have reached the following learning results Professional Competence Knowledge Knowledge Knowledge Students are able to Skills Students are able to	P
Flight Control Systems (L0736) Flight Control Systems (L0740) Module Responsible Admission Requirements Recommended Previous Knowledge I therm dynamics electronics electronics fliuid mechanics control theory After taking part successfully, students have reached the following learning results Professional Competence Knowledge Knowledge Students are able to Akills Students are able to Skills Students are able to	P
Recitation Systems (LO740) Prof. Frank Thielecke Prof. Frank Thielecke Admission Requirements None Prof. Frank Thielecke Admission Requirements None Prof. Frank Thielecke Prof. Frank Thielecke Prof. Frank Thielecke Thielecke Thielecke Prof. Frank Thielecke	
Module Responsible Prof. Frank Thielecke Admission Requirements None Recommended Previous Knowledge i mathematics i mechanics i thermo dynamics electronics fluid mechanics control theory Educational Objectives After taking part successfully, students have reached the following learning results Professional Competence Knowledge Knowledge Students are able to describe the structure and the functioning of primary flight control systems as well as actuation-, avionic-, hig of aircrafts in general along with corresponding properties and applications. give an overview over the functioning and the structure of landing gear systems explain different configurations and designs and their origins Skills Students are able to	
Admission Requirements Recommended Previous Knowledge • mathematics • mechanics • thermo dynamics • electronics • fluid mechanics • control theory Educational Objectives After taking part successfully, students have reached the following learning results Professional Competence Knowledge Students are able to • describe the structure and the functioning of primary flight control systems as well as actuation-, avionic-, hig of aircrafts in general along with corresponding properties and applications. • give an overview over the functioning and the structure of landing gears and landing gear systems • explain different configurations and designs and their origins Students are able to	
Recommended Previous Knowledge	
Knowledge	
 mathematics mechanics thermo dynamics electronics fluid mechanics control theory Educational Objectives After taking part successfully, students have reached the following learning results Professional Competence Knowledge Students are able to describe the structure and the functioning of primary flight control systems as well as actuation-, avionic-, hig of aircrafts in general along with corresponding properties and applications. give an overview over the functioning and the structure of landing gears and landing gear systems explain different configurations and designs and their origins Skills 	
mechanics thermo dynamics electronics fluid mechanics control theory After taking part successfully, students have reached the following learning results Professional Competence Knowledge Students are able to describe the structure and the functioning of primary flight control systems as well as actuation-, avionic-, hig of aircrafts in general along with corresponding properties and applications. give an overview over the functioning and the structure of landing gears and landing gear systems explain different configurations and designs and their origins Skills Students are able to	
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electronics fluid mechanics control theory After taking part successfully, students have reached the following learning results Professional Competence Knowledge Students are able to describe the structure and the functioning of primary flight control systems as well as actuation-, avionic-, hig of aircrafts in general along with corresponding properties and applications. give an overview over the functioning and the structure of landing gears and landing gear systems explain different configurations and designs and their origins Skills Students are able to	
fluid mechanics	
Educational Objectives After taking part successfully, students have reached the following learning results Professional Competence Knowledge Students are able to describe the structure and the functioning of primary flight control systems as well as actuation-, avionic-, hig of aircrafts in general along with corresponding properties and applications. give an overview over the functioning and the structure of landing gears and landing gear systems explain different configurations and designs and their origins Skills Students are able to	
Professional Competence Knowledge Students are able to • describe the structure and the functioning of primary flight control systems as well as actuation-, avionic-, hig of aircrafts in general along with corresponding properties and applications. • give an overview over the functioning and the structure of landing gears and landing gear systems • explain different configurations and designs and their origins Skills Students are able to	
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of aircrafts in general along with corresponding properties and applications. • give an overview over the functioning and the structure of landing gears and landing gear systems • explain different configurations and designs and their origins Skills Students are able to	ah lift systems
 give an overview over the functioning and the structure of landing gears and landing gear systems explain different configurations and designs and their origins Skills Students are able to	
Skills Students are able to	
size primary flight control actuation systems	
Size primary riight contain decade on 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 is interest time in private to any	
Develop joint solutions in mixed teams Present and explain developed solutions in front of other students.	
 Present and explain developed solutions in front of other students Discuss developed solutions with experts 	
Discuss developed solutions with experts	
Autonomy Students are able to:	
 derive requirements and perform appropriate yet simplified design processes for aircraft systems from comple 	ley issues and
circumstances in a self-reliant manner	iev issues alla
apply new skills and methods in the context of exercises in a self-reliant manner	
- apply new skins and meanous in the context of exercises in a sen-reliant manner	
Workload in Hours Independent Study Time 110, Study Time in Lecture 70	
Credit points 6	
Course achievement None	
Examination Written exam	
Examination duration and 165 Minutes	
scale	
Assignment for the Aircraft Systems Engineering: Core Qualification: Compulsory	
Following Curricula International Management and Engineering: Specialisation II. Aviation Systems: Elective Compulsory	
Product Development, Materials and Production: Specialisation Product Development: Elective Compulsory	
Product Development, Materials and Production: Specialisation Production: Elective Compulsory	
Product Development, Materials and Production: Specialisation Materials: Elective Compulsory	
Theoretical Mechanical Engineering: Specialisation Aircraft Systems Engineering: Elective Compulsory	

Course L0736: Flight Control	Systems
Тур	Lecture
Hrs/wk	3
СР	4
Workload in Hours	Independent Study Time 78, Study Time in Lecture 42
Lecturer	Prof. Frank Thielecke
Language	DE
Cycle	SoSe
Content	 Actuation (Principles of actuators; electro-mechanical actuators; modeling, analysis and sizing of position control systems; hydro-mechanic actuation systems) Flight Control Systems (control surfaces, hinge moments; requirements of stability and controllability, actuation power; principles of reversible and irreversible flight control systems; servo actuation systems) Landing Gear Systems (Configurations and geometries; analysis of landing gear systems with respect to damper dynamics, dynamics of the breaking aircraft and power consumption; design and analysis of breaking systems with respect to energy and heat; anti-skit systems) Fuel Systems (Architectures; aviation fuels; system components; fueling system; tank inerting system; fuel management; trim tank) De- and Anti-Ice Systems: (Atmospheric icing conditions; principles of de- and anti-ice systems)
Literature	 Moir, Seabridge: Aircraft Systems Torenbek: Synthesis of Subsonic Airplane Design Curry: Aircraft Landing Gear Design: Principles and Practices

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	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 required Calculate the parameters of imaging systems using the mathematical or physical equations; Determine the influence of different system components on the spatial and temporal resolution of imaging systems Explain the importance of different imaging systems for a number of clinical applications;
	Select a suitable imaging system for an application.
Personal Competence	
Social Competence	
Autonomy	Students can:
	Understand which physical effects are used in medical imaging;
	Decide independently for which clinical issue a measuring system can be used.
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56
Credit points	6
Course achievement	None
Examination	Written exam
Examination duration and	90 min
scale	
Assignment for the	Electrical Engineering: Specialisation Medical Technology: Elective Compulsory
Following Curricula	
	Product Development, Materials and Production: Specialisation Product Development: Elective Compulsory
	Product Development, Materials and Production: Specialisation Production: Elective Compulsory
	Product Development, Materials and Production: Specialisation Materials: Elective Compulsory
	Theoretical Mechanical Engineering: Specialisation Bio- and Medical Technology: Elective Compulsory

Course L0819: Medical 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.

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

Course L1661: Mechanical Be	ehaviour of Brittle Materials
Тур	Lecture
Hrs/wk	2
СР	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Prof. Gerold Schneider
Language	DE/EN
Cycle	SoSe
Content	Theoretical Strength
	Of a perfect crystalline material, theoretical critical shear stress
	Real strength of brittle materials
	Energy release reate, stress intensity factor, fracture criterion
	Scattering of strength of brittle materials
	Defect distribution, strength distribution, Weibull distribution
	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
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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	DE/EN
Cycle	SoSe
Content	This class will cover the principles of dislocation theory from a physical metallurgy perspective, providing a fundamental understanding of the relations between the strength and of crystalline solids and distributions of defects.
	We will review the concept of dislocations, defining terminology used, and providing an overview of important concepts (e.g. linear elasticity, stress-strain relations, and stress transformations) for theory development. We will develop the theory of dislocation plasticity through derived stress-strain fields, associated self-energies, and the induced forces on dislocations due to internal and externally applied stresses. Dislocation structure will be discussed, including core models, stacking faults, and dislocation arrays (including grain boundary descriptions). Mechanisms of dislocation multiplication and strengthening will be covered along with general principles of creep and strain rate sensitivity. Final topics will include non-FCC dislocations, emphasizing the differences in structure and corresponding implications on dislocation mobility and macroscopic mechanical behavior; and dislocations in finite volumes.
Literature	Vorlesungsskript Aktuelle Publikationen Bücher: Introduction to Dislocations, by D. Hull and D.J. Bacon Theory of Dislocations, by J.P. Hirth and J. Lothe Physical Metallurgy, by Peter Hassen

Production"				
lodule M1156: Syste	ms Engineering			
ourses				
itle		Тур	Hrs/wk	СР
stems Engineering (L1547)		Lecture	3	4
stems 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, n		f complex System	ıs
	describe innovation processes and the need for tec			
	explain the aircraft development process and the p	**		
	explain the system development process, including ideatify any irranspatal and this are and took proceed.			
	 identify environmental conditions and test procedu value the methodology of requirements-based engine 		nonts onginooring	(MRDE)
	value the methodology of requirements-based engi	neering (KBL) and model-based requirer	nents engineering	g (MDKL)
Skills	Students are able to:			
	\bullet plan the process for the development of complex S	ystems		
	organize the development phases and development	t Tasks		
	assign required business activities and technical Ta	sks		
	apply systems engineering methods and tools			
Personal Competence				
Social Competence	Students are able to:			
	• understand and accept their tasks within a develop	ment team		
	• be comfortable with their role their tasks within the	overall process		
	• understand and serve their suppliers and customer	s in large projects		
	\bullet assume responsibility for people and technology in	the development of safety-critical system	ms	
Autonomy	Students are able to:			
Autonomy	 interact and communicate in a development team 	with division of tasks		
	independently research and identify certification sp			
	formulate requirements on their own			
	create test plans on their own and accompany certification.	fication processes		
Workload in Hours	Independent Study Time 124, Study Time in Lecture	56		
Credit points				
Course achievement				
Examination	Written exam			
Examination duration and	120 Minutes			
scale				
Assignment for the	Aircraft Systems Engineering: Core Qualification: Con	' '		
Following Curricula	International Management and Engineering: Specialis	•	-	
	International Management and Engineering: Specialis	·	iction: Elective Co	mpulsory
	Mechatronics: Specialisation System Design: Elective	Compulsory		
	, ,	Debation, Flactive Committees		
	Mechatronics: Specialisation Intelligent Systems and	• •	lsory	
	Mechatronics: Specialisation Intelligent Systems and Product Development, Materials and Production: Spec	cialisation Product Development: Compu		
	Mechatronics: Specialisation Intelligent Systems and	cialisation Product Development: Compu cialisation Production: Elective Compulso	ory	

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 Engi	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 M0840: Optin	nal and Robust Control			
Courses				
Title		Typ	Hrs/wk	СР
Optimal and Robust Control (L0658)	Typ Lecture	2	3
Optimal and Robust Control (L0659		Recitation Section (small)	2	3
Module Responsible	Prof. Herbert Werner			
Admission Requirements	None			
Recommended Previous				
Knowledge	Classical control (frequency response, root locus	s)		
	State space methods			
	 Linear algebra, singular value decomposition 			
Educational Objectives	After taking part successfully, students have reached	the following learning results		
Professional Competence				
Knowledge				
	 Students can explain the significance of the ma 			
	They can explain the duality between optimal st			
	They can explain how the H2 and H-infinity norr			
	They can explain how an LQG design problem c			
	They can explain how model uncertainty can be They can explain how board on the small rei			
	 They can explain how - based on the small gai an uncertain plant. 	ii theorem - a robust controller can gu	arantee stability	and performance to
	They understand how analysis and synthesis co	nditions on feedback loops can be repr	esented as linear	matrix inequalities
	They understand now undrysis and synthesis co		coenica ao inicar	matrix meqaanees.
Skills	 Students are capable of designing and tuning L0 	OG controllers for multivariable plant m	indels	
	They are capable of representing a H2 or H-infil			and of using standard
	software tools for solving it.	,g p	,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,	
	They are capable of translating time and frequency.	ency domain specifications for control	loops into const	raints on closed-loop
	sensitivity functions, and of carrying out a mixe		•	
	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 s 	ynthesis conditions as linear matrix inc	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	6			
Course achievement	None			
Examination	Oral exam			
Examination duration and	30 min			
scale				
Assignment for the	Electrical Engineering: Specialisation Control and Powe	er Systems Engineering: Elective Comp	ulsony	
Following Curricula	Energy Systems: Core Qualification: Elective Compulso		uisoiy	
Tonowing curricula	Aircraft Systems Engineering: Core Qualification: Elect	•		
	Mechatronics: Specialisation Intelligent Systems and R	• •		
	Mechatronics: Specialisation Intelligent Systems and Mechatronics: Specialisation System Design: Elective (
	Biomedical Engineering: Specialisation Artificial Organ		Compulsorv	
	Biomedical Engineering: Specialisation Implants and E	-	,	
	Biomedical Engineering: Specialisation Medical Techno		pulsory	
	Biomedical Engineering: Specialisation Management a	,		
	Product Development, Materials and Production: Speci			
	Product Development, Materials and Production: Speci			
	Product Development, Materials and Production: Speci	alisation Materials: Elective Compulsor	у	
	Theoretical Mechanical Engineering: Core Qualification	: Elective Compulsory		

Course L0658: Optimal and Robust Control		
Тур	Lecture	
Hrs/wk	2	
СР	3	
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28	
Lecturer	Prof. Herbert Werner	
Language	EN	
Cycle	SoSe	
Content	 Optimal regulator problem with finite time horizon, Riccati differential equation Time-varying and steady state solutions, algebraic Riccati equation, Hamiltonian system Kalman's identity, phase margin of LQR controllers, spectral factorization Optimal state estimation, Kalman filter, LQG control Generalized plant, review of LQG control Signal and system norms, computing H2 and H∞ norms Singular value plots, input and output directions Mixed sensitivity design, H∞ loop shaping, choice of weighting filters Case study: design example flight control Linear matrix inequalities, design specifications as LMI constraints (H2, H∞ and pole region) Controller synthesis by solving LMI problems, multi-objective design Robust control of uncertain systems, small gain theorem, representation of parameter uncertainty 	
Literature	 Werner, H., Lecture Notes: "Optimale und Robuste Regelung" Boyd, S., L. El Ghaoui, E. Feron and V. Balakrishnan "Linear Matrix Inequalities in Systems and Control", SIAM, Philadelphia, PA, 1994 Skogestad, S. and I. Postlewhaite "Multivariable Feedback Control", John Wiley, Chichester, England, 1996 Strang, G. "Linear Algebra and its Applications", Harcourt Brace Jovanovic, Orlando, FA, 1988 Zhou, K. and J. Doyle "Essentials of Robust Control", Prentice Hall International, Upper Saddle River, NJ, 1998 	

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

Module M1343: Struc	ture and properties of fibre-poly	mer-composites		
Courses				
Title		Тур	Hrs/wk	СР
Structure and properties of fibre-po	lymer-composites (L1894)	Lecture	2	3
Structure and properties of fibre-po		Project-/problem-based Lea	=	2
Structure and properties of fibre-po	lymer-composites (L2613)	Recitation Section (large)	1	1
Module Responsible				
Admission Requirements	None			
	Basics: chemistry / physics / materials science			
Knowledge				
Educational Objectives	After taking part successfully, students have re	ached the following learning results		
Professional Competence				
Knowledge	Students can use the knowledge of fiber-rein necessary testing and analysis.	forced composites (FRP) and its constituent	s to play (fiber / m	atrix) and define the
	They can explain the complex relationships str	ucture-property relationship and		
	the interactions of chamical structure of the	nolymore their processing with the diff	orant fiber types	including to ovolain
	the interactions of chemical structure of the neighboring contexts (e.g. sustainability, environment)		erent liber types,	including to explain
Skills	Students are capable of			
	 using standardized calculation methods 	in a given context to mechanical properti	es (modulus, stren	gth) to calculate and
	evaluate the different materials.			
	 approximate sizing using the network th 	eory of the structural elements implement a	ind evaluate.	
	 selecting appropriate solutions for mech 	anical recycling problems and sizing examp	le stiffness, corrosio	on resistance.
Personal Competence				
Social Competence	Students can			
Social competence	Stadents can			
	 arrive at funded work results in heterogether. 	enius groups and document them.		
	 provide appropriate feedback and handl 	e feedback on their own performance constr	uctively.	
	5			
Autonomy	Students are able to			
	- assess their own strengths and weaknesses.			
	- assess their own state of learning in specific t	erms and to define further work steps on th	is basis.	
	- assess possible consequences of their profess	ional activity.		
		. 70		
Workload in Hours	Independent Study Time 110, Study Time in Le	cture 70		
Credit points	6			
Course achievement				
Examination	Written exam			
Examination duration and	90 min			
scale				
-	Energy Systems: Core Qualification: Elective Co	•		
Following Curricula	Aircraft Systems Engineering: Core Qualificatio	, ,	alianta et et e	S
	International Management and Engineering: Sp	·	oduction: Elective C	compulsory
	Materials Science: Specialisation Engineering N	· ·		
	Mechanical Engineering and Management: Con	, ,	tivo Compulsor	
	Product Development, Materials and Production	·		
	Product Development, Materials and Production Product Development, Materials and Production	·	15U1 Y	
	Renewable Energies: Specialisation Bioenergy Renewable Energies: Specialisation Wind Energ			
	Renewable Energies: Specialisation Wind Energies: Renewable Energies: Specialisation Solar Energies:			
	Theoretical Mechanical Engineering: Specialisa			
	soredear meenanical Engineering. Specialisa	raterials science. Elective Compulsory		

Course L1894: Structure and	properties of fibre-polymer-composites
Тур	Lecture
Hrs/wk	2
СР	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Prof. Bodo Fiedler
Language	EN
Cycle	SoSe
Content	- Microstructure and properties of the matrix and reinforcing materials and their interaction
	- Development of composite materials
	- Mechanical and physical properties
	- Mechanics of Composite Materials
	- Laminate theory
	- Test methods
	- Non destructive testing
	- Failure mechanisms
	- Theoretical models for the prediction of properties
	- Application
Literature	Hall, Clyne: Introduction to Composite materials, Cambridge University Press
Literature	Daniel, Ishai: Engineering Mechanics of Composites Materials, Oxford University Press
	Mallick: Fibre-Reinforced Composites, Marcel Deckker, New York
	Manick: Fibre-Reinforced Composites, Marcel Deckker, New York

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

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

Module M1344: Proce	ssing of fibre-polymer-composites			
Courses				
Title		Тур	Hrs/wk	СР
Processing of fibre-polymer-compos		Lecture	2	3
From Molecule to Composites Part (L1516)	Project-/problem-based Learning	2	3
Module Responsible	Prof. Bodo Fiedler			
Admission Requirements	None			
Recommended Previous	Knowledge in the basics of chemistry / physics / materia	als science		
Knowledge				
Educational Objectives	After taking part successfully, students have reached th	e following learning results		
Professional Competence				
Knowledge	Students are able to give a summary of the technical of	- ·	•	•
	relationships. They are capable of describing and con		-	appropriate technical
	language. They can explain the typical process of solvir	g practical problems and present relate	d results.	
Skills	Students can use the knowledge of fiber-reinforced cor	nposites (FRP) and its constituents (fiber	/ matrix) and	define the necessary
	testing and analysis.			
	The same and the same law should be same lab.	and the second		
	They can explain the complex structure-property relation	inship and		
	the interactions of chemical structure of the polymers, their processing with the different fiber types, including to explain			
	neighboring contexts (e.g. sustainability, environmenta	protection).		
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	•		
	audience. Students have the ability to develop alternat	ive approaches to an engineering probl	em independe	ently or in groups and
	discuss advantages as well as drawbacks.			
Autonomy				
	gaps in as well as extent their knowledge using the liter	•	•	-
	meaningfully extend given problems and pragmatically		solutions and o	concepts.
	Independent Study Time 124, Study Time in Lecture 56			
Credit points Course achievement	6 None			
	None			
	Written exam			
Examination duration and scale	90 min			
	Materials Sciences Specialisation Engineering Materials	Elective Compulsory		
Following Curricula	Materials Science: Specialisation Engineering Materials: Mechanical Engineering and Management: Specialisatio	• •		
ronowing curricula	Product Development, Materials and Production: Specials		`omnulsory	
	Product Development, Materials and Production: Specia	•		
	Product Development, Materials and Production: Special			
	Theoretical Mechanical Engineering: Specialisation Mate			
		paisory		

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

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

Module M1174: Autor	nation Technology and Systems			
Plodule Pill/4. Autor	nation reciniology and Systems			
Courses				
Гitle		Тур	Hrs/wk	СР
automation Technology and System	ns (L2329)	Lecture	4	4
utomation Technology and Syster		Project-/problem-based Learning		1
utomation Technology and Syster	ns (L2330)	Recitation Section (small)	1	1
Module Responsible	Prof. Thorsten Schüppstuhl			
Admission Requirements	None			
	without major course assessment			
Knowledge				
	After taking part successfully, students have reached	the following learning results		
Professional Competence				
Knowledge	Students			
	 know the characteristic components of an auto 	mation systems and have good understar	iding of their in	teraction
	 know methods for a systematical analysis of au 	atomation tasks and are able to use them		
	have special competences in industrial robot be	ased automation systems		
Skills	Students are able to			
	analyze complex Automation tasks			
	develop application based concepts and solution			
	design subsystems and integrate into one system	em		
	investigate and evaluate safety of machinery			
	create simple programs for robots and program	nmable logic controllers		
	design of circuit for pneumatic applications			
Personal Competence				
Social Competence	Students are able to			
	- find solutions for automation and handling tasks in g	roups		
	- develop solutions in a production environment with		represent decis	sions.
Autonomy	Students are able to	quamica personnei ar cecimical fever ana	represent deep	,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,
Autonomy	Students are able to			
	 analyze automation tasks independently 			
	 generate programs for robots and programmal 	ole logic devices autonomously		
	 develop solutions for practice oriented tasks of 	automation independently		
	 design safety concepts for automation applicat 	ions		
	 assess consequences of their professional action 	ons and responsibilities		
Workload in Hours	Independent Study Time 96, Study Time in Lecture 84	1		
Credit points	6			
Course achievement	None			
Examination	Written exam			
Examination duration and				
scale				
Assignment for the	International Management and Engineering: Specialis	ation II. Product Development and Product	tion: Elective Co	ompulsory
Following Curricula		·		· ·
•	Product Development, Materials and Production: Spec	·		
	Product Development, Materials and Production: Spec			
	Theoretical Mechanical Engineering: Specialisation Pro		ve Compulsorv	

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 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 M1878: Susta	inable energy from wind and water	r		
Courses				
Title Sustainability Management (L0007) Hydro Power Use (L0013) Wind Turbine Plants (L0011)		Typ Lecture Lecture Lecture	Hrs/wk 2 1 2	CP 1 1 3
Wind Energy Use - Focus Offshore (Lecture	1	1
	Dr. Marvin Scherzinger			
Admission Requirements	None			
Recommended Previous Knowledge	Module: Technical Thermodynamics I, Module: Technical Thermodynamics II,			
	Module: Fundamentals of Fluid Mechanics			
Educational Objectives	After taking part successfully, students have reach	ed the following learning results		
Professional Competence Knowledge	By ending this module students can explain in detail knowledge of wind turbines with a particular focus of wind energy use in offshore conditions and can critical comment these aspects in consideration of current developments. Furthermore, they are able to describe fundamentally the use of water power to generate electricity. The students reproduce and explain the basic procedure in the implementation of renewable energy projects in countries outside Europe.			
	Through active discussions of various topics with application of the theoretical background and are t			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-specific	cly and multidisciplinary within a se	eminar.	
Autonomy	Students can independently exploit sources in the lecture and to acquire the particular knowledge about		ecture material to clear	the contents of the
Workload in Hours	Independent Study Time 96, Study Time in Lecture	84		
Credit points	6			
Course achievement		Description Schriftliche Ausarbeitung (inkl. Vor	trag) in Nachhaltigkeitsm	nanagement
Examination	Written exam			
Examination duration and	150 min			
scale				
-	Civil Engineering: Specialisation Structural Enginee Civil Engineering: Specialisation Geotechnical Engine Civil Engineering: Specialisation Coastal Engineerin International Management and Engineering: Special International Management and Engineering: Special Product Development, Materials and Production: Special Product Development, Materials and Production: Special Product Development, Materials and Production: Specialisation Engineering: Specialisation Process Engineering: Specialisation Environmental	neering: Elective Compulsory g: Elective Compulsory g: Elective Compulsory alisation II. Energy and Environment alisation II. Renewable Energy: Elect accialisation Production: Elective Co accialisation Product Development: accialisation Materials: Elective Compulsory Energy Systems: Elective Compulsory	tive Compulsory ompulsory Elective Compulsory onpulsory ory	Compulsory
	Water and Environmental Engineering: Specialisation Water and Environmental Engineering: Specialisation	on Environment: Compulsory		

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

Course L0013: Hydro Power I	Use
Тур	Lecture
Hrs/wk	1
СР	1
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14
Lecturer	Prof. Stefan Achleitner
Language	DE
Cycle	SoSe
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

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

Module M1888: Enviro	onmental protection manage	ment		
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 ha	eve reached the following learning results		
Professional Competence				
Knowledge				
Skills				
Personal Competence				
Social Competence				
Autonomy				
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 min			
scale				
Assignment for the	Civil Engineering: Specialisation Water and	d Traffic: Elective Compulsory		
Following Curricula	Bioprocess Engineering: Specialisation (C - Bioeconomic Process Engineering, Focus	Management and	Controlling: Elective
	Compulsory			
	Environmental Engineering: Specialisation	Energy and Resources: Elective Compulsory		
	International Management and Engineerin	ng: Specialisation II. Energy and Environmental E	ingineering: Elective	Compulsory
	·	uction: Specialisation Product Development: Ele	, ,	
	·	uction: Specialisation Production: Elective Comp	-	
	•	uction: Specialisation Materials: Elective Compu	lsory	
	Renewable Energies: Specialisation Bioene	** *		
		onmental Process Engineering: Elective Compuls	ory	
	Water and Environmental Engineering: Sp	' '		
	Water and Environmental Engineering: Sp	ecialisation 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 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	Typ Recitation Section (large)		
Hrs/wk	2		
СР	3		
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28		
Lecturer	of. Arne Speerforck, Dr. Johannes Brunnemann		
Language	DE		
Cycle	WiSe		
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						2	2	
Module Responsible	Dr. Martin Gomse							
Admission Requirements	None							
Recommended Previous	Fundamentals of elec	trical engine	eering					
Knowledge	Broad knowledge of n	nochanics						
	broad knowledge of th	nechanics						
	Fundamentals of cont	rol theory						
Educational Objectives	After taking part succ	essfully, stu	idents have re	eached the followi	ng learning results			
Professional Competence								
Knowledge	Students are able to o	describe fun	damental pro	perties of robots a	and solution approaches for mult	tiple problems	in robotics.	
Skills	Students are able to o	derive and s	olve equation	s of motion for va	rious manipulators.			
	Students can generat	e trajectorie	es in various c	oordinate systems	S.			
	Students can design I	inear and n	artially nonlin	ear controllers for	robotic manipulators.			
	Students can design i	inear and pe	arcially Horilli	ear controllers for	Tobotic mampulators.			
Personal Competence								
Social Competence	Students are able to v	work goal-or	iented in sma	II mixed groups.				
Autonomy	Students are able to r	ecognize ar	nd improve kn	owledge deficits i	ndependently.			
	With instructor assista	With instructor assistance, students are able to evaluate their own 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	Form		Description				
	Yes None	,	theoretical		n PBL-Einheiten sowie Erreic	chen des Ge	samtziels und der	
		practical v	vork	jeweiligen Se	ssion-Ziele			
Examination Examination duration and	120 min							
examination duration and scale	120 min							
	Aircraft Systems Engi	neering: Co	re Qualificatio	n: Flective Comp	ılsory			
Following Curricula		-			oduct Development and Producti	on: Elective Co	ompulsory	
3	_				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	ualification:	Compulsory					
	Product Development	, Materials a	and Productio	n: Specialisation P	roduct Development: Elective C	ompulsory		
	· ·			•	roduction: Elective Compulsory			
	l				Naterials: Elective Compulsory			
					elopment and Production: Electiv			
	Theoretical Mechanica	aı Engineeri	ng: Specialisa	tion Robotics and	Computer Science: Elective Cor	npulsory		

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

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

Troduction						
Module M0771: Flight	: Physics					
Courses						
Title		Тур	Hrs/wk	СР		
Aerodynamics and Flight Mechanics	s I (L0727)	Lecture	3	3		
Flight Mechanics II (L0730)	Lecture	2	2			
Flight Mechanics II (L0731)		Recitation Section (large)	1	1		
Module Responsible	Prof. Frank Thielecke					
Admission Requirements	None					
Recommended Previous	Basic knowledge in:					
Knowledge	a Makhamatica					
	Mathematics Mechanics					
	Thermodynamics					
	Aviation					
	Aviation					
Educational Objectives	After taking part successfully, students have reached the	following learning results				
Professional Competence						
Knowledge	Students are able to					
	Describe the fundamental equations of aerodynam	nics for compressible incompressible	and frictional flo	nw.		
	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					
	-					
Skills	Students are able to					
	Perform flight mechanic simulations					
	 Derive flight mechanic relations from virtual and re 	eal flight test data				
Personal Competence						
	Students are able to:					
30ciai competence	Students are able to.					
	Perform simulations in groups and discuss results					
	Evaluate flight test data in groups, discuss and present the results					
Autonomy	Students are able to:					
Hatohomy						
	Process teaching content independently					
	 Prepare, work out and process simulation models i 					
	 Apply teaching content on virtual and real flight te 	st data				
Workload in Hours	Independent Study Time 96, Study Time in Lecture 84					
Credit points						
Course achievement						
Examination						
Examination duration and						
scale						
Assignment for the	Aircraft Systems Engineering: Core Qualification: Compul	sory				
Following Curricula	International Management and Engineering: Specialisation	•	pulsory			
•	Aeronautics: Core Qualification: Compulsory	-	- -			
	Product Development, Materials and Production: Specialis	sation Product Development: Elective	e Compulsory			
	Product Development, Materials and Production: Specialis	•				
	Product Development, Materials and Production: Specialis	•	•			
	Theoretical Mechanical Engineering: Specialisation Aircra	·	-			
	. 5 . 5 . 5 . 5 . 5 . 5 . 5 . 5 . 5 . 5	. 5 . 5 . 5 . 2 . 2 . 2 . 2 . 2 . 2 . 2	. ,			

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

ourse L0730: Flight Mechan	nics II			
Тур	ecture			
Hrs/wk				
СР	2			
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28			
Lecturer	Prof. Frank Thielecke			
Language	DE			
Cycle	SoSe			
Content	stationary asymmetric flight dynamics of lateral movement methods of flight simulation eyperimental methods of flight mechanics model validation using system identification wind tunnel techniques			
Literature	 Schlichting, H.; Truckenbrodt, E.: Aerodynamik des Flugzeuges I und II Etkin, B.: Dynamics of Atmospheric Flight Sachs/Hafer: Flugmechanik Brockhaus: Flugregelung J.D. Anderson: Introduction to flight 			

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

Module M0815: Produ	ict Planning			
Courses				
Title		Тур	Hrs/wk	СР
Product Planning (L0851)		Lecture	3	3
Product Planning Seminar (L0853)		Project-/problem-based Learning	2	3
Module Responsible	Prof. Cornelius Herstatt			
Admission Requirements	None			
Recommended Previous	Good basic-knowledge of Business Administration			
Knowledge				
	After taking part successfully, students have reached the fo	ollowing learning results		
Professional Competence	6			
Knowledge	Students will gain insights into:			
	Product Planning			
	 Process 			
	 Methods 			
	Design thinking			
	 Process 			
	 Methods 			
	User integration			
Skills	Students will gain deep insights into:			
	Product Planning			
	 Process-related aspects 			
	 Organisational-related aspects 			
	 Human-Ressource related aspects 			
	 Working-tools, methods and instruments 			
	0			
Personal Competence				
Social Competence				
•	Interact within a team			
	Raise awareness for globabl issues			
Autonomy				
	Gain access to knowledge sources			
	Interpret complex cases Develop presentation skills			
	Develop presentation skills			
Workload in Hours	Independent Study Time 110, Study Time in Lecture 70			
Credit points	6			
Course achievement	Compulsory Bonus Form Description	on		
	Yes 20 % Subject theoretical and			
	practical work			
Examination				
Examination duration and scale	90 minutes			
Assignment for the	Global Innovation Management: Core Qualification: Compul-	con/		
Following Curricula	International Management and Engineering: Specialisation	•	nnulsory	
. oowing curricula	Mechanical Engineering and Management: Specialisation M		puisoi y	
	Product Development, Materials and Production: Specialisation in		ompulsorv	
	Product Development, Materials and Production: Specialisate	'		
	Product Development, Materials and Production: Specialisat	, ,		
	Theoretical Mechanical Engineering: Specialisation Product		e Compulsory	

Course L0851: Product Planning				
Тур	Lecture			
Hrs/wk	3			
СР	3			
Workload in Hours	Independent Study Time 48, Study Time in Lecture 42			
Lecturer	Prof. Cornelius Herstatt			
Language	EN			
Cycle	WiSe			
Content	Product Planning Process			
	This integrated lecture is designed to understand major issues, activities and tools in the context of systematic product planning, a key activity for managing the front-end of innovation, i.e.: Systematic scanning of markets for innovation opportunities Understanding strengths/weakness and specific core competences of a firm as platforms for innovation Exploring relevant sources for innovation (customers, suppliers, Lead Users, etc.) Developing ideas for radical innovation, relying on the creativeness of employees, using techniques to stimulate creativity and creating a stimulating environment Transferring ideas for innovation into feasible concepts which have a high market attractively Voluntary presentations in the third hour (articles / case studies) - Guest lectures by researchers - Lecture on Sustainability with frequent reference to current research - Permanent reference to current research Examination: In addition to the written exam at the end of the module, students have to attend the PBL-exercises and prepare presentations in groups in order to pass the module. Additionally, students have the opportunity to present research papers on a voluntary base. With these presentations it is possible to gain a bonus of max. 20% for the exam. However, the bonus is only valid if the exam is passed without the bonus.			
Literature	Ulrich, K./Eppinger, S.: Product Design and Development, 2nd. Edition, McGraw-Hill 2010			

Course L0853: Product Planning Seminar				
Тур	Project-/problem-based Learning			
Hrs/wk	2			
СР	3			
Workload in Hours	dependent 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".			

ction Planning & Control an	d Digital Enterprise			
	Тур	Hrs/wk	СР	
	Lecture	2	2	
0929)	Lecture	2	2	
0930)	Recitation Section (small)	1	1	
933)	Recitation Section (small)	1	1	
Prof. Hermann Lödding				
None				
Fundamentals of Production and Quality	Management			
After taking part successfully, students h	nave reached the following learning results			
Students can explain the contents of the module in detail and take a critical position to them.				
·				
statements are expanse or encouring and applying models and methods from the modale to madural problems.				
Students can develop joint solutions in mixed teams and present them to others				
-				
Independent Study Time 96, Study Time	in Lecture 84			
None				
Written exam				
180 Minuten				
International Management and Engineeri	ing: Specialisation II. Product Development and Prod	uction: Elective Co	ompulsory	
Logistics, Infrastructure and Mobility: Spe	ecialisation Production and Logistics: Elective Compu	ılsory		
Biomedical Engineering: Specialisation A	rtificial Organs and Regenerative Medicine: Elective	Compulsory		
Biomedical Engineering: Specialisation Implants and Endoprostheses: Elective Compulsory				
Biomedical Engineering: Specialisation M	ledical Technology and Control Theory: Elective Com	pulsory		
Biomedical Engineering: Specialisation M	lanagement and Business Administration: Compulso	ry		
Product Development, Materials and Prod	duction: Specialisation Product Development: Electiv	e Compulsory		
Product Development, Materials and Prod	duction: Specialisation Production: Compulsory			
Product Development, Materials and Prod	duction: Specialisation Materials: Elective Compulsor	У		
Theoretical Mechanical Engineering: Spec	cialisation Product Development and Production: Ele	ctive Compulsory		
	20929) 20930) 20930) 20933) Prof. Hermann Lödding None Fundamentals of Production and Quality After taking part successfully, students in Students can explain the contents of the Students are capable of choosing and ap Students can develop joint solutions in in Independent Study Time 96, Study Time 6 None Written exam 180 Minuten International Management and Engineer Logistics, Infrastructure and Mobility: Spe Biomedical Engineering: Specialisation A Biomedical Engineering: Specialisation In Biomedical Engineering: Specialisation M Biomedical Engineering: Specialisation M Product Development, Materials and Pro Product Development, Materials and Pro Product Development, Materials and Pro	Lecture 1929) Lecture 1930) Recitation Section (small) 1933) Recitation Section (small) 1943 None 1954 Fundamentals of Production and Quality Management After taking part successfully, students have reached the following learning results Students can explain the contents of the module in detail and take a critical position to them Students are capable of choosing and applying models and methods from the module to industriate are capable of choosing and applying models and methods from the module to industriate are capable of choosing and applying models and present them to others. Independent Study Time 96, Study Time in Lecture 84 6 None Written exam 180 Minuten International Management and Engineering: Specialisation III. Product Development and Prod Logistics, Infrastructure and Mobility: Specialisation Production and Logistics: Elective Compusionedical Engineering: Specialisation Medical Technology and Control Theory: Elective Compusionedical Engineering: Specialisation Medical Technology and Control Theory: Elective Compusionedical Engineering: Specialisation Management and Business Administration: Compulsor Product Development, Materials and Production: Specialisation Product Development: Elective Product Development, Materials and Production: Specialisation Materials: Elective Compulsor	Typ Hrs/wk Lecture 2 1929) Lecture 2 1930) Recitation Section (small) 1 1933) Recitation Section (small) 1 1 Prof. Hermann Lödding None Fundamentals of Production and Quality Management After taking part successfully, students have reached the following learning results Students can explain the contents of the module in detail and take a critical position to them. Students are capable of choosing and applying models and methods from the module to industrial problems. Students can develop joint solutions in mixed teams and present them to others. - Independent Study Time 96, Study Time in Lecture 84 6 None Written exam 180 Minuten International Management and Engineering: Specialisation II. Product Development and Production: Elective Congulsory Biomedical Engineering: Specialisation Artificial Organs and Regenerative Medicine: Elective Compulsory Biomedical Engineering: Specialisation Implants and Endoprostheses: Elective Compulsory Biomedical Engineering: Specialisation Management and Business Administration: Compulsory Biomedical Engineering: Specialisation Management and Business Administration: Compulsory Product Development, Materials and Production: Specialisation Product Development: Elective 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	ecitation 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	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 concepts.			
Personal Competence				
Social Competence				
,	Students can gain knowledge of the subje	ct area from given sources and transform it	to new guestions. 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	s Management and	Controlling: Elective
	Compulsory	Consisting II Civil Engineering 51	Commulació :	
		: Specialisation II. Civil Engineering: Elective (
	·	ction: Specialisation Product Development: Election: Specialisation Production: Elective Com		
	·	ction: Specialisation Production: Elective Compaction: Specialisation Materials: Elective Compa		
	Water and Environmental Engineering: Core		u1301 y	
	water and Environmental Engineering. Core	e Quamicación. Compuisory		

Course L1145: Safety, Reliability 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			
	ngergy production with algae			
	nvironmental 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: Meth	ods of Product Development			
Courses				
Title		Тур	Hrs/wk	СР
Integrated Product Development II	(L1254)	Lecture	3	3
Integrated Product Development II	(L1255)	Project-/problem-based Learning	2	3
Module Responsible	Prof. Dieter Krause			
Admission Requirements	None			
Recommended Previous	Basic knowledge of Integrated product development	and applying CAE systems		
Knowledge				
Educational Objectives	After taking part successfully, students have reached	d the following learning results		
Professional Competence				
Knowledge	After passing the module students are able to:			
	explain technical terms of design methodolog describe essential elements of construction m			
	describe essential elements of construction in describe current problems and the current sta	-	amont	
	describe current problems and the current sta	ate of research of integrated product develop	oment.	
Skills	After passing the module students are able to:			
	select and apply proper construction method	de for non standardized solutions of problem	as as well as	adant now houndar
	conditions,	as for non-standardized solutions of problem	is as well as	adapt new bodinda
	 solve product development problems with the 	a assistance of a workshop based approach		
	choose and execute appropriate moderation t			
	- choose and execute appropriate moderation to	ecciniques.		
Personal Competence				
Social Competence	After passing the module students are able to:			
	prepare and lead team meetings and modera	tion processes		
	work in teams on complex tasks,	tion processes,		
	 represent problems and solutions and advance 	e ideas.		
	·			
Autonomy	After passing the module students are able to:			
	give a structured feedback and accept a critic	cal feedback.		
	implement the accepted feedback autonomou			
	' '			
Workload in Hours	Independent Study Time 110, Study Time in Lecture	70		
Credit points	6			
Course achievement	None			
Examination	Oral exam			
Examination duration and	30 Minuten			
scale				
Assignment for the	Aircraft Systems Engineering: Core Qualification: Ele	ective Compulsory		
Following Curricula	International Management and Engineering: Speciali	isation II. Product Development and Producti	on: Elective Co	ompulsory
	Aeronautics: Core Qualification: Elective Compulsory			
	Mechatronics: Specialisation System Design: Elective	e Compulsory		
	Mechatronics: Core Qualification: Elective Compulsor			
	Product Development, Materials and Production: Spe	·	ry	
	Product Development, Materials and Production: Spe			
	Product Development, Materials and Production: Spe			
	Theoretical Mechanical Engineering: Specialisation P	Product Development and Production: Elective	e Compulsory	

Production"					
Course L1254: Integrated Pro	oduct Development II				
Тур	Lecture				
Hrs/wk	3				
CP	3				
Workload in Hours	Independent Study Time 48, Study Time in Lecture 42				
Lecturer	Prof. Dieter Krause				
Language	DE				
Cycle	WiSe				
Content	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,				
	nstruction management				
	CE mark, declaration of conformity including risk assessment,				
	Patents, patent rights, patent monitoring Project representative graphs and exceletion principles.				
	Project management (cost, time, quality) and escalation principles, Development management for mechatronics.				
	Development management for mechatronics, Tochnical 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, Springer 2013. 				

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

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	Recitation Section (large)	1	1
Admission Requirements	None			
Recommended Previous Knowledge		s, hydrostatics, kinematics and	kinetics), flui	d mechanics, and
Educational Objectives	After taking part successfully, students have reached the follow	ring learning results		
	After passing the module students are able to explain structures and functionalities of hydrostatic, pnet explain the interaction of hydraulic components in hydra explain open and closed loop control of hydraulic system describe functioning and applications of hydrodynamic transland aggregates in plant technology After passing the module students are able to analyse and assess hydraulic and pneumatic component design and dimension hydraulic systems for mechanical perform numerical simulations of hydraulic systems base select and adapt pump characteristic curves for hydraulic	ulic systems, is, orque converters, brakes and clut s and systems, applications, ed on abstract problem definitions	ches as well as	centrifugal pumps
Personal Competence Social Competence	 dimension hydrodynamic torque converters and brakes f After passing the module students are able to discuss and present functional context in groups, organise teamwork autonomously. 	•		
Autonomy	After passing the module students are able to • obtain necessary knowledge for the simulation.			
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56			
Credit points				-
Course achievement	Compulsory Bonus Form Description Yes None Attestation Simulation h	avdrostatischer Systeme		
Examination	Yes None Attestation Simulation P Written exam	nydrostatischer Systeme		
Examination duration and scale Assignment for the Following Curricula		roduct Development and Production	on: Elective Con	npulsory
	Product Development, Materials and Production: Specialisation Product Development, Materials and Production: Specialisation Theoretical Mechanical Engineering: Specialisation Product Dev	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 CONTRACTOR OF THE CONTRACTO				
Cycle					
Content	Lecture				
	Hydrostatics				
	a physical for dam while				
	physical fundamentals hydraville fluida				
	 hydraulic fluids hydrostatic machines 				
	• valves				
	• components				
	hydrostatic transmissions				
	examples from industry				
	Countries from madaty				
	Pneumatics				
	generation of compressed air				
	preumatic motors				
	Examples of use				
	- Examples of disc				
	Hydrodynamics				
	physical fundamentals				
	hydraulic continous-flow machines				
	hydrodynamic transmissions				
	interoperation of motor and transmission				
	ercise				
	Irostatics				
	nydiostates				
	reading and design of hydraulic diagrams				
	 dimensioning of hydrostatic traction and working drives 				
	performance calculation				
	ydrodynamics				
	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 weighting of simulation properties.				
	variation of simulation parameters using simulations for system dimensioning and entimisation.				
	using simulations for system dimensioning and optimisation (narthy) solf organised teamwork				
	(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 De				
	Beitz, W., Grote, KH.: Dubbel - Taschenbuch für den Maschinenbau, Springer-Verlag, Berlin, aktuelle Auflage				
	Skript zur Vorlesung				

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

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

Production			
Module M1155: Aircra	aft Cabin Systems		
Courses			
Title	Тур	Hrs/wk	СР
Aircraft Cabin Systems (L1545)	Lecture	3	4
Aircraft Cabin Systems (L1546)	Recitation Section (large)	1	2
Module Responsible	Prof. Ralf God		
Admission Requirements	None		
Recommended Previous	Basic knowledge in:		
Knowledge	• Mathematics		
	Mechanics		
	Thermodynamics		
	Electrical Engineering		
	Control Systems		
Educational Objectives	s After taking part successfully, students have reached the following learning results		
Professional Competence			
	e 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 operating systems and emergency Systems		
	assess the challenges human factors integration in a cabin environment		
C1 "	Strudente ava abla ta		
SKIIIS	s Students are able to:		
	 design a cabin layout for a given business model of an Airline design cabin systems for safe operations 		
	design cabin systems for safe operations design emergency systems for safe man-machine interaction		
	solve comfort needs and entertainment requirements in the cabin		
	Solve connot needs and entertainment requirements in the casin		
Personal Competence			
Social Competence	Students are able to:		
	• comprehend existing system solutions and explain them on the basis of existing requirement	nts	
	discuss with experts in technical language		
	explain system functions		
	classify the criticality of functions		
	describe systems as is		
Autonomy	Students are able to:		
	independently reflect on lecture content and expert presentations		
	independently develop more in-depth content		
	recognize further areas of knowledge		
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56		
Credit points			
Course achievement			
Examination duration and			
scale			
Assignment for the		ılsory	
-		11301 y	
i Snowing Curricula	International Management and Engineering: Specialisation II. Aviation Systems: Elective Comp	nulsory	
	Aeronautics: Core Qualification: Compulsory	741301 y	
	Product Development, Materials and Production: Specialisation Product Development: Elective	e Compulsorv	
	Product Development, Materials and Production: Specialisation Production: Elective Compulso		
	Product Development, Materials and Production: Specialisation Materials: Elective Compulsor		
	Theoretical Mechanical Engineering: Specialisation Aircraft Systems Engineering: Elective Cor		
	, , , , , , , , , , , , , , , , , , , ,	-	

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	citation Section (large)		
Hrs/wk	1		
СР	2		
Workload in Hours	Independent Study Time 46, Study Time in Lecture 14		
Lecturer	Prof. Ralf God		
Language	DE		
Cycle	WiSe		
Content	See interlocking course		
Literature	See interlocking course		

Module M1183: Laser	Systems and Methods of	Manufacturing Design and A	Analysis	
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, studen	nts have reached the following learning res	sults	
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 Develop	pment: Elective Compulsory	
Following Curricula	Product Development, Materials and	Production: Specialisation Production: Con	npulsory	
	Product Development, Materials and	Production: Specialisation Materials: Election	ive Compulsory	
	Theoretical Mechanical Engineering:	Specialisation Product Development and P	roduction: Elective Compulsory	y

Course L1612: Laser Systems	s and Process Technologies
Тур	Lecture
Hrs/wk	2
СР	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Prof. Claus Emmelmann
Language	EN
Cycle	WiSe
Content	 Fundamentals of laser technology Laser beam sources: CO2-, Nd:YAG-, Fiber- and Diodelasers Laser system technology: beam forming, beam guidance systems, beam motion and beam control Laser-based manufacturing technologies: generation, marking, cutting, joining, surface treatment Quality assurance and economical aspects of laser material processing Markets and Applications of laser technology Student group exercises
Literature	 Hügel, H., T. Graf: Laser in der Fertigung: Strahlquellen, Systeme, Fertigungsverfahren, 3. Aufl., Vieweg + Teubner Wiesbaden 2014. Eichler, J., Eichler. H. J.: Laser: Bauformen, Strahlführung, Anwendungen, 7. Aufl., Springer-Verlag Berlin Heidelberg 2010. Steen W. M.; Mazumder J.: Laser material processing, 4th Edition, Springer-Verlag London 2010. J.C. Ion: Laser processing of engineering materials: principles, procedure and industrial applications, Elsevier Butterworth-Heinemann 2005. Gebhardt, A.: Understanding additive manufacturing, München [u.a.] Hanser 2011

Course L0876: Methods for Analysing Production Processes		
Тур	Lecture	
Hrs/wk	2	
СР	3	
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28	
Lecturer	Prof. Wolfgang Hintze	
Language	DE	
Cycle	WiSe	
Content	 Modelling and simulation of maching and forming processes Numerical simulation of forces, temperatures, deformation in machining Analysis of vibration problems in maching (chatter, modal analysis,) Knowledge based process planning Design of experiments Machinability of nonmetallic materials Analysis of interaction between maching process and machine tool systems with regard to process stability and quality Simulation of maching processes by virtual reality methods 	
Literature	Tönshoff, H.K.; Denkena, B.; Spanen Grundlagen, Springer (2004) Klocke, F.; König, W.; Fertigungsverfahren Umformen, Springer (2006) Weck, M.; Werkzeugmaschinen Fertigungssysteme 3, Springer (2001) Weck, M.; Werkzeugmaschinen Fertigungssysteme 5, Springer (2001)	

Courses				
		Tun	Hrs/wk	СР
Title Structure and Properties of Polymers (L0389)		Typ Lecture	2 nrs/wk	3
Processing and design with polyme		Lecture	2	3
Module Responsible	Dr. Hans Wittich			
Admission Requirements	None			
Recommended Previous	Basics: chemistry / physics / material science			
Knowledge				
Educational Objectives	After taking part successfully, students have r	eached the following learning results		
Professional Competence				
Knowledge	Students can use the knowledge of plastics ar	nd define the necessary testing and analy	/sis.	
	They can explain the complex relationships st	ructure-property relationship and		
	the interactions of chemical structure of the p	olymore including to oxplain poighboring	a contoxts (o.g. sustaina	ability anyiranmant
	protection).	orymers, including to explain heighboring	g contexts (e.g. sustaine	ability, environment
Skills	Students are capable of			
	- using standardized calculation methods in evaluate the different materials.	a given context to mechanical prope	erties (modulus, streng	yth) to calculate a
	- selecting appropriate solutions for mechanic	cal recycling problems and sizing exampl	e stiffness, corrosion re	sistance.
Personal Competence				
Social Competence	Students can			
	- arrive at funded work results in heterogenius	groups and document them.		
	- provide appropriate feedback and handle fee	edback on their own performance constru	uctively.	
Autonomy	Chudanha aya abla ha			
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 o	n this basis.	
	- assess possible consequences of their profes	sional activity.		
Workload in Hours	Independent Study Time 124, Study Time in L	ecture 56		
Credit points	6			
Course achievement	None			
Examination	Written exam			
Examination duration and	180 min			
scale				
Assignment for the	Materials Science and Engineering: Specialisat	tion Engineering Materials: Elective Com	pulsory	
Following Curricula	Materials Science: Specialisation Engineering	Materials: Elective Compulsory		
-	Biomedical Engineering: Specialisation Implan	ts and Endoprostheses: Compulsory		
	Biomedical Engineering: Specialisation Artificia	al Organs and Regenerative Medicine: El	ective Compulsory	
	Biomedical Engineering: Specialisation Manag			
	Biomedical Engineering: Specialisation Medica			
	Product Development, Materials and Production	on: Specialisation Production: Elective Co	mpulsory	
	Product Development, Materials and Production	on: Specialisation Materials: Elective Com	pulsory	
	Product Development, Materials and Production	on: Specialisation Product Development:	Elective Compulsory	
	Theoretical Mechanical Engineering: Specialisa	ation Materials Science, Flostive Compul		

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		
Courses				
Title		Тур	Hrs/wk	СР
Experimental Methods for the Char	acterization of Materials (L1580)	Lecture	2	2
Phase equilibria and transformation	ns (L1579)	Lecture	2	2
Übung zu Phänomene und Methode	en der Materialwissenschaft (L2991)	Recitation Section (large)	2	2
Module Responsible	Prof. Jörg Weißmüller			
Admission Requirements	None			
Recommended Previous	Basic knowledge in Materials Science, e.g. 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	ties of advanced materials along with thei	r applications in tec	nnology, in particular
J.	metallic, ceramic, polymeric, semiconductor, m			5,7
Skille	The students will be able to select material of	configurations according to the technical	needs and if neces	ssary to design new
Skills	materials considering architectural principles			
	modern materials science, which enables t			
	applications.	nem to select optimum materials co.	iibiiidaaaiib deperidi	ing on the teerninear
	аррисалоны			
Personal Competence				
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			
	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: Electiv	e Compulsory	
Following Curricula	Chemical and Bioprocess Engineering: Specialis	ation Chemical Process Engineering: Electi	ve Compulsory	
	International Management and Engineering: Sp	ecialisation II. Product Development and Pr	oduction: Elective C	ompulsory
	Materials Science: Core Qualification: Compulso	ry		
	Product Development, Materials and Production	: Specialisation Product Development: Elec	ctive Compulsory	
	Product Development, Materials and Production	: Specialisation Production: Elective Comp	ulsory	
	Product Development, Materials and Production	: Specialisation Materials: Compulsory		
	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 asse	ets		
Courses				
Title		Тур	Hrs/wk	СР
Fundamentals of Maintenance, Rep Fundamentals of Maintenance, Rep		Lecture Recitation Section (large)	3 1	4 2
Module Responsible	Prof. Gerko Wende			
Admission Requirements	None			
Recommended Previous	We recommend knowledge in the areas of gener	ral engineering sciences, aeronautics and a	ircraft systems e	ngineering. Technica
Knowledge	fields like mechanical engineering, mechatronic content.	s and production engineering will be intr	oduced into the	relevant aeronautica
Educational Objectives	After taking part successfully, students have read	thed the following learning results		
Professional Competence				
Knowledge	The students are able to describe fundamental coapproaches for complex optimization problems.	orrelations for the sustainable operation of t	echnical assets a	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 group environment of multiple stakeholders.	os with a clear focus on the approached	solutions by res	pecting the complex
Autonomy	The students are enabled to find solutions fo determining factors independently.	r optimization problems and to take req	uired decision fo	r the assessment o
Workload in Hours	Independent Study Time 124, Study Time in Lect	ure 56		
Credit points	6			
Course achievement	None			
Examination	Oral exam			
Examination duration and	30 min			
scale				
Assignment for the	Aircraft Systems Engineering: Core Qualification:	Elective Compulsory		
Following Curricula	Aeronautics: Core Qualification: Elective Compuls	sory		
	Mechatronics: Specialisation Intelligent Systems a	and Robotics: Elective Compulsory		
	Mechatronics: Specialisation System Design: Elec	tive Compulsory		
	Mechatronics: Core Qualification: Elective Compu	Isory		
	Product Development, Materials and Production:	Specialisation Product Development: Elective	e Compulsory	
	Product Development, Materials and Production:	Specialisation Production: Elective Compuls	ory	
	Product Development, Materials and Production:	·	-	
	Theoretical Mechanical Engineering: Specialisation	n Product Development and Production: Ele	ective Compulsory	/
	Theoretical Mechanical Engineering: Specialisation	on Aircraft 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	•

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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

Thesis

Module Responsible Professoren der TUHH Admission Requirements Professoren der TUHH Admission Requirements • According to General Regulations \$21 (1):	Module M-002: Maste	r Thesis
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Mechatronics: 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	