

## **Module Manual**

Master of Science (M.Sc.)

# Product Development, Materials and Production Dual study program

Cohort: Winter Term 2023

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#### **Program description**

#### **Content**

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

In addition to the foundational curriculum taught at TUHH, seminars on developing personal skills are integrated into the dual study programme, in the context of transfer between theory and practice. These seminars correspond to the modern professional requirements expected of an engineer, as well as promoting the link between the two places of learning.

The intensive dual courses at TUHH integrating practical experience consist of an academic-oriented and a practice-oriented element, which are completed at two places of learning. The academic-oriented element comprises study at TUHH. The practice-oriented element is coordinated with the study programme in terms of content and time, and consists of practical modules and phases spent in an affiliate company during periods when there are no lectures.

#### **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.

In addition, students acquire basic professional and personal skills as part of the dual study programme that enable them to enter professional practice at an early stage and to go on to further study. Students also gain practical work experience through the integrated practical modules. Graduates of the dual course have broad foundational knowledge, fundamental skills for academic work and relevant personal competences.

#### 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

#### **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.

By continually switching places of learnings throughout the dual study programme, it is possible for theory and practice to be interlinked. Students reflect theoretically on their individual professional practical experience, and apply the results of their reflection to new forms of practice. They also test theoretical elements of the course in a practical setting, and use their findings as a stimulus for theoretical debate.

#### **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)

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• 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)

The structural model of the dual study programme follows a module-differentiating approach. Given the practice-oriented element, the curriculum of the dual study programme is different compared to a standard Bachelor's course. Five practical modules are completed at the dual students' partner company as part of corresponding practical terms during lecture-free periods.

#### **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	<ul> <li>Students are able to find their way around selected special areas of management within the scope of business management.</li> <li>Students are able to explain basic theories, categories, and models in selected special areas of business management.</li> <li>Students are able to interrelate technical and management knowledge.</li> <li>Students are able to apply basic methods in selected areas of business management.</li> <li>Students are able to explain and give reasons for decision proposals on practical issues in areas of business management.</li> </ul>
Personal Competence Social Competence Autonomy	<ul> <li>Students are able to communicate in small interdisciplinary groups and to jointly develop solutions for complex problems</li> <li>Students are capable of acquiring necessary knowledge independently by means of research and preparation of material.</li> </ul>
Workload in Hours	Depends on choice of courses
Credit points	6

#### Courses

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

Module M0603: Nonli	near Structural Analysis				
Courses					
Title			Гур	Hrs/wk	CP
Nonlinear Structural Analysis (L027	7)		Lecture	3	4
Nonlinear Structural Analysis (L027			Recitation Section (small)	1	2
Module Responsible	Prof. Alexander Düster				
Admission Requirements	None				
Recommended Previous	Knowledge of partial differential equations is	recommended.			
Knowledge					
<b>Educational Objectives</b>	After taking part successfully, students have	reached the following	g learning results		
<b>Professional Competence</b>					
Knowledge	Students are able to				
	+ give an overview of the different nonlinear	r phenomena in struct	tural mechanics.		
	+ explain the mechanical background of non	nlinear phenomena in	structural mechanics.		
	+ to specify problems of nonlinear structura	al analysis, to identify	them in a given situation a	nd to explain the	eir mathematical and
	mechanical background.				
Skills	Students are able to				
Skins	+ model nonlinear structural problems.				
	+ select for a given nonlinear structural prob	blem a suitable compu	itational procedure.		
	+ apply finite element procedures for nonline				
	+ critically verify and judge results of nonline	-			
	+ to transfer their knowledge of nonlinear so		new problems.		
Personal Competence					
Social Competence	Students are able to				
	+ solve problems in heterogeneous groups.	.f			
	<ul><li>+ present and discuss their results in front o</li><li>+ give and accept professional constructive</li></ul>				
	+ give and accept professional constructive	CHUCISIII.			
Autonomy	Students are able to				
Autonomy	+ assess their knowledge by means of exerc	rises and E-Learning			
	+ acquaint themselves with the necessary k		earch oriented tasks		
	+ to transform the acquired knowledge to si		caren onemed tasks		
		, , , , ,			
Workload in Hours	Independent Study Time 124, Study Time in	Lecture 56			
Credit points					
Course achievement					
Examination	Written exam				
Examination duration and	120 min				
scale					
Assignment for the	Civil Engineering: Specialisation Structural En	3 3	. ,		
Following Curricula	Civil Engineering: Specialisation Computation		•	vulcory.	
	International Management and Engineering:	•	Engineering: Elective Comp	ouis01 y	
	Materials Science: Specialisation Modeling: E		con/		
	Mechatronics: Technical Complementary Cou		oui y		
	Mechatronics: Specialisation System Design: Mechatronics: Core Qualification: Elective Co				
	Product Development, Materials and Product		a: Flective Compulsory		
	Naval Architecture and Ocean Engineering: 0				
	Ship and Offshore Technology: Core Qualifica				
	Theoretical Mechanical Engineering: Speciali			irv	
				.,	

Course L0277: Nonlinear Str	uctural 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	

Module M0751: Vibra	tion Theory			
Courses				
Title		Тур	Hrs/wk	СР
Vibration Theory (L0701)		Integrated Lecture	4	6
Module Responsible	Prof. Norbert Hoffmann			
Admission Requirements	None			
Recommended Previous	Calculus			
Knowledge	Linear Algebra			
	Engineering Mechanics			
Educational Objectives	After taking part successfully, students have reached t	he following learning results		
Professional Competence	,, ,, ,			
Knowledge				
	Students are able to denote terms and concepts			
	Students know methods of modeling and simula		d parameter driven v	ibrations.
	Students know about concepts of linear and non     Students know about concepts of linear and home	·	_	
	<ul> <li>Students know basic tasks of vibration problems</li> </ul>	of discrete and continuous systems		
Skills		Theory and dayalan them from how		
	Students are able to denote methods of Vibratio     Students are able to apply and expand metho			ited and narameter
	driven vibrations.	as of modeling and simulation for	iree, forced, self-exc	ited and parameter
	Students are able to solve linear and nonlinear visits.	ribration problems.		
		·		
Personal Competence				
Social Competence	Students can analyze vibration problems, work of	on them, and reach working results	also in teams or grou	ips.
	Students are able to document the results of vib	ration studies also in groups.	-	
Autonomy	Students are able to individually analyze and so	ve vibration problems.		
	Students are able to approach individually research	rch tasks in Vibration Theory.		
Workload in Hours	Independent Study Time 124, Study Time in Lecture 50			
Credit points		,		
Course achievement				
Examination duration and				
scale				
Assignment for the	Energy Systems: Core Qualification: Elective Compulso	ry		
Following Curricula	1		ulsory	
	Mechanical Engineering and Management: Specialisation	on Mechatronics: Elective Compulso	ry	
	Mechatronics: Core Qualification: Compulsory			
	Biomedical Engineering: Specialisation Artificial Organs			
	Biomedical Engineering: Specialisation Implants and Er			
	Biomedical Engineering: Specialisation Medical Techno			
	Biomedical Engineering: Specialisation Management at		Compulsory	
	Product Development, Materials and Production: Core			
	Naval Architecture and Ocean Engineering: Core Qualif Theoretical Mechanical Engineering: Core Qualification	• •		
	medical Mechanical Engineering, Core Qualification	. Liective Compuisory		

Course L0701: Vibration The	ory
Тур	Integrated Lecture
Hrs/wk	4
СР	6
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56
Lecturer	Prof. Norbert Hoffmann
Language	DE/EN
Cycle	WiSe
Content	Linear and Nonlinear Single and Multiple Degree of Freedom Vibrations  Free vibration  Self-excited vibration  Parameter driven vibration  Forced vibration  Multi degree of freedom vibration  Continuum vibration  Irregular vibration
Literature	German - K. Magnus, K. Popp, W. Sextro: Schwingungen. Physikalische Grundlagen und mathematische Behandlung von Schwingungen.  English - K. Magnus: Vibrations.

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

Course L0023: Thermal Engergy Systems			
Тур	Lecture		
Hrs/wk	3		
СР	5		
Workload in Hours	Independent Study Time 108, Study Time in Lecture 42		
Lecturer	Prof. Arne Speerforck		
Language	DE		
Cycle	WiSe		
Content	1. Introduction		
	<ol> <li>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</li> <li>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</li> <li>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</li> <li>Laws and standards 5.1 Buildings 5.2 Industrial plants</li> </ol>		
Literature	<ul> <li>Schmitz, G.: Klimaanlagen, Skript zur Vorlesung</li> <li>VDI Wärmeatlas, 11. Auflage, Springer Verlag, Düsseldorf 2013</li> <li>Herwig, H.; Moschallski, A.: Wärmeübertragung, Vieweg+Teubner Verlag, Wiesbaden 2009</li> <li>Recknagel, H.; Sprenger, E.; Schrammek, ER.: Taschenbuch für Heizung- und Klimatechnik 2013/2014, 76. Auflage, Deutscher Industrieverlag, 2013</li> </ul>		

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

Module M0808: Finite	Elements Methods			
Courses				
Title		Тур	Hrs/wk	СР
Finite Element Methods (L0291)		Lecture	2	3
Finite Element Methods (L0804)		Recitation Section (large)	2	3
Module Responsible	Prof. Benedikt Kriegesmann			
Admission Requirements	None			
Recommended Previous	Mechanics I (Statics, Mechanics of Materials) and I	Mechanics II (Hydrostatics, Kinematics, Dyr	iamics)	
Knowledge	Mathematics I, II, III (in particular differential equa	tions)		
Educational Objectives	After taking part successfully, students have reach	ed the following learning results		
Professional Competence	3,000			
Knowledge	The students possess an in-depth knowledge re overview of the theoretical and methodical basis of		ent method and	are able to give an
Skills	The students are capable to handle engineering p		ments, assemblin	ng the corresponding
	system matrices, and solving the resulting system	of equations.		
Personal Competence				
Social Competence	Students can work in small groups on specific prob	elems to arrive at joint solutions.		
Autonomy	The students are able to independently solve of Problems can be identified and the results are critical control of the control		develop own finit	e element routines.
Workload in Hours	Independent Study Time 124, Study Time in Lectu	re 56		
Credit points				
Course achievement	Compulsory Bonus Form  No 20 % Midterm	Description		
Examination				
Examination duration and	120 min			
scale				
Assignment for the	Civil Engineering: Core Qualification: Compulsory			
Following Curricula	Energy Systems: Core Qualification: Elective Comp	pulsory		
	Aircraft Systems Engineering: Core Qualification: E	Elective Compulsory		
	International Management and Engineering: Speci	alisation II. Mechatronics: Elective Compuls	sory	
	International Management and Engineering: Speci	·	uction: Elective Co	ompulsory
	Aeronautics: Core Qualification: Elective Compulso	ry		
	Mechatronics: Core Qualification: Compulsory			
	Biomedical Engineering: Specialisation Implants an			
	Biomedical Engineering: Specialisation Manageme			
	Biomedical Engineering: Specialisation Medical Te	*		
	Biomedical Engineering: Specialisation Artificial Or Product Development, Materials and Production: C		соприіѕ0гу	
	Technomathematics: Specialisation III. Engineering	• •		
	Theoretical Mechanical Engineering: Core Qualification			
	Theoretical Mechanical Engineering, core Qualifica	acon. Compulsory		

Course L0291: Finite Element Methods	
Тур	Lecture
Hrs/wk	2
СР	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Prof. Benedikt Kriegesmann
Language	EN
Cycle	WiSe
Content	- General overview on modern engineering
	- Displacement method
	- Hybrid formulation
	- Isoparametric elements
	- Numerical integration
	- Solving systems of equations (statics, dynamics)
	- Eigenvalue problems
	- Non-linear systems
	- Applications
	- Programming of elements (Matlab, hands-on sessions)
	- Applications
Literature	Bathe, KJ. (2000): Finite-Elemente-Methoden. Springer Verlag, Berlin

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

Module M0846: Contr	rol Systems Theory and Design			
Courses				
Title		Тур	Hrs/wk	СР
Control Systems Theory and Design		Lecture	2	4
Control Systems Theory and Design	n (L0657)	Recitation Section (small)	2	2
Module Responsible	NN			
Admission Requirements				
	Introduction to Control Systems			
Knowledge				
Educational Objectives Professional Competence	After taking part successfully, students have	reached the following learning results		
Knowledge Skills	Students can explain how linear dynaresponse to initial states or external explains the system properties estimation, respectively They can explain the significance of a integration that they can explain observer-based state in they can explain observer-based state in they can explain the z-transform and integration that it is they can explain state space models are in they can explain the experimental ide is be solved by solving a normal equation. They can explain how a state space models are integrated by solving a normal equation.  Students can transform transfer function. They can assess controllability and observed they can design LQG controllers for mind they can carry out a controller design for a given sampling rate.	es controllability and observability, and their reminimal realisation e feedback and how it can be used to achieve to alti-input multi-output systems its relationship with the Laplace Transform and transfer function models of discrete-time syntification of ARX models of dynamic systems, a control of the constructed from a discrete-time in the constructed from a discrete-time in the constructed into state space models and vice verservability and construct minimal realisations	elationship to state racking and disturb /stems and how the ident mpulse response rsa	e feedback and state  pance rejection  ification problem car  which is appropriate
Personal Competence Social Competence Autonomy	They can carry out all these tasks us Simulink)  Students can work in small groups on specific Students can obtain information from provid when solving given problems.	ing standard software tools (Matlab Control 1	Toolbox, System Id	entification Toolbox,
	Independent Study Time 124, Study Time in I	Lecture 56		
Credit points	O .			
Course achievement				
Examination				
Examination duration and				
scale				
•	Electrical Engineering: Core Qualification: Cor	,		
Following Curricula	Energy Systems: Core Qualification: Elective Aircraft Systems Engineering: Core Qualificat	• •		
	Aeronautics: Core Qualification: Elective Com	• •		
		pecialisation Mechatronics: Elective Compulsor	v	
	Mechatronics: Core Qualification: Compulsory		,	
		ial Organs and Regenerative Medicine: Elective	e Compulsory	
	- · · ·	nts and Endoprostheses: Elective Compulsory		
		al Technology and Control Theory: Compulsory	,	
	Biomedical Engineering: Specialisation Manag	gement and Business Administration: Elective (	Compulsory	
	Biomedical Engineering: Specialisation Manage Product Development, Materials and Producti		Compulsory	

Course L0656: Control Systems Theory and Design		
Тур	Lecture	
Hrs/wk	2	
СР	4	
Workload in Hours	Independent Study Time 92, Study Time in Lecture 28	
Lecturer	NN	
Language	EN	
Cycle	WiSe	
Content	State space methods (single-input single-output)	
	• State chase models and transfer functions, state feedback	
	State space models and transfer functions, state feedback     Coordinate basis, similarity transformations	
	Solutions of state equations, matrix exponentials, Caley-Hamilton Theorem     Controllability and pale placement.	
	Controllability and pole placement     Chate action shows billing the properties.	
	State estimation, observability, Kalman decomposition	
	Observer-based state feedback control, reference tracking	
	Transmission zeros     Optional relationship was the second to the	
	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	NN
Language	EN
Cycle	WiSe
Content	See interlocking course
Literature	See interlocking course

Module M1150: Conti	nuum Mechanics			
Courses				
Title		Тур	Hrs/wk	СР
Continuum Mechanics (L1533) Continuum Mechanics Exercise (L1533)	534)	Lecture Recitation Section (small)	2	3
		Recitation Section (Smail)	2	3
Module Responsible	· · · · · · · · · · · · · · · · · · ·			
Admission Requirements		vincering Machanics Land Engineeri	ng Mochanics II :	at TUBE (forces and
	Basics of mechanics as taught, e.g., in the modules Eng moments, stress, linear strain, free-body principle, linear			
Kilowieuge	e.g., in the modules Mathematics I and Mathematics II at		gy), busies of file	thematics as taught,
-	After taking part successfully, students have reached the	following learning results		
Professional Competence				
Knowledge	In this module, students learn the fundamental conce			
	describe arbitrary deformations of continuous bodies (so			
	of the basic module Engineering Mechanics II (elastosta small deformations, simple geometries) of which are succ		opic, iiriear-eiasti	c material behavior,
	First, the students learn the necessary fundamentals of to	ensor calculus. Based on this, the de	scription of the d	eformations / strains
	of arbitrarily deformable bodies is dealt with. The studen	ts learn the mathematical formalism	for characterizing	g the stress state of
	a body and for formulating the balance equations for m	ass, momentum, energy and entrop	y in various forn	ns. Furthermore, the
	students know which constitutive assumptions have to be	e made for modeling the material bel	navior of a mecha	anical body.
Skille	The students can set up balance laws and apply basics	of deformation theory to specific as	nocts both in ar	onlind contoxts as in
Skiiis	research contexts.	or deformation theory to specific as	pects, both in ap	opiica contexts as iii
	research contexts.			
Personal Competence				
Social Competence	The students are able to develop solutions also for comp	lex problems of solid mechanics, to	present them to	specialists in written
	form and to develop ideas further.			
Autonomy	The students are able to assess their own strengths and			vn identify and solve
	problems in the area of continuum mechanics and acquir	e the knowledge required to this end		
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56			
Credit points	6			
Course achievement				
Examination				
Examination duration and	60 min			
scale		1		
-	Materials Science: Specialisation Modeling: Elective Comp	•		
Following Curricula	Mechanical Engineering and Management: Specialisation	. ,	Compulsor,	
	Biomedical Engineering: Specialisation Artificial Organs a	-	оттритьогу.	
	Biomedical Engineering: Specialisation Implants and Endi Biomedical Engineering: Specialisation Medical Technolog		nulsory	
	Biomedical Engineering: Specialisation Management and		-	
	Product Development, Materials and Production: Core Qu		, ,	
	Theoretical Mechanical Engineering: Core Qualification: E	· · ·		
	3 3	. ,		

Production		
Course L1533: Continuum Mo	echanics	
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	
Cycle	WiSe  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 III (Elastostatics) but extends them significantly. While in the lecture Engineering Mechanics III (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  • Motion of continuum  • Deformation of infinitesimal line, area and volume elements  • Material and spatial description  • Polar decomposition  • Spectral decomposition  • Objectivity  • Strain measures  • Time derivatives  • Partial / material time derivatives  • Dijective time rates  • Strain and deformation rates  • Transport theorems  • Balance equations (global and local form)  • Balance equations (global and local form)  • Balance erson state  • Surface traction vectors  • Cauchy's fundamental theorem	
	Stress tensors (Cauchy, 1. and 2. Piola-Kirchhoff, Kirchhoff stress tensor)  Balance of linear momentum  Balance of angular momentum  Balance of energy  Balance of entropy  Clausius-Duhem inequality  Constitutive laws  Constitutive assumptions  Fluids  Elastic solids  Hyperelasticity  Material symmetry  Elasto-plastic solids  Analysis  Initial-boundary value problems and their numerical solution	
Literature	R. Greve: Kontinuumsmechanik: Ein Grundkurs für Ingenieure und Physiker I-S. Liu: Continuum Mechanics, Springer	

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

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	

Module M1151: Mater	rials Modeling
Courses	
	Turn Herbula CD
<b>Fitle</b> Material Modeling (L1535)	Typ Hrs/wk CP Lecture 2 3
Material Modeling (L1536)	Recitation Section (small) 2 3
Module Responsible	Prof. Christian Cyron
Admission Requirements	
Recommended Previous	
Knowledge	moments, stress, linear strain, free-body principle, linear-elastic constitutive laws, strain energy); basics of mathematics as taught
	e.g., in the modules Mathematics I and Mathematics II at TUHH
Educational Objectives	After taking part successfully, students have reached the following learning results
Professional Competence	Arter taking part successfully, staucites have reactical the following learning results
•	The students understand the theoretical foundations of anisotropic elasticity, viscoelasticity and elasto-plasticity in the realm of
	three-dimensional (linear) continuum mechanics. In the area of anisotropic elasticity, they know the concept of material symmetr
	and its application in orthotropic, transversely isotropic and isotropic materials. They understand the concept of stiffness and
	compliance and how both can be characterized by appropriate parameters. Moreover, the students understand viscoelasticity bot
	in the time and frequency domain using the concepts of relaxation modulus, creep modulus, storage modulus and loss modulus. I
	the area of elasto-plasticity, the students know the concept of yield stress or (in higher dimensions) yield surface and of plasti
	potential. Additionally, the know the concepts of ideal plasticity, hardening and weakening. Moreover, they know von-Mise
	plasticity as a specific model of elasto-plasticity.
Skills	The students can independently identify and solve problems in the area of materials modeling and acquire the knowledge to do so
	This holds in particular for the area fo anisotropically elastic, viscoelastic and elasto-plastic material behavior. In these areas, the
	students can independently develop models for complex material behavior. To this end, they have the ability to read and understand relevant literature and identify the relevant results reported there. Moreover, they can implement models which the
	developed or found in the literature in computational software (e.g., based on the finite element method) and use it for practical
	calculations.
Personal Competence	
Social Competence	The students are able to develop constitutive models for materials and present them to specialists. Moreover, they have the abilit
	to discuss challenging problems of materials modeling with experts using the proper terminoloy, to identify and ask critical
	questions in such discussions and to identify and discuss potential caveats in models presented to them.
Autonomy	The students have the ability to independently develop abstract models that allow them to classify observed phenomena within a
	more general abstract framework and to predict their further evolution. Moreover, the students understand the advantages by
	also limitations of mathematical models and can thus independently decide when and to which extent they make sense as a basi
	for decisions.
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56
Credit points	6
Course achievement	
Examination	
Examination duration and	60 min
scale	
Assignment for the	
Following Curricula	
	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
	Product Development, Materials and Production: Core Qualification: Elective Compulsory
	, , , , , , , , , , , , , , , , , , , ,
	Theoretical Mechanical Engineering: Specialisation Simulation Technology: Elective Compulsory
	Theoretical Mechanical Engineering: Specialisation Simulation Technology: Elective Compulsory Theoretical Mechanical Engineering: Specialisation Materials Science: Elective Compulsory

Course L1535: Material Modeling	
Тур	Lecture
Hrs/wk	2
СР	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Prof. Christian Cyron
Language	DE
Cycle	WiSe
Content	One of the most important questions when modeling mechanical systems in practice is how to model the behavior of the materials of their different components. In addition to simple isotropic elasticity in particular the following phenomena play key roles
	- anisotropy (material behavior depending on direction, e.g., in fiber-reinforced materials) - plasticity (permanent deformation due to one-time overload, e.g., in metal forming) - viscoelasticity (absorption of energy, e.g., in dampers) - creep (slow deformation under permanent load, e.g., in pipes)
	This lecture briefly introduces the theoretical foundations and mathematical modeling of the above phenomena. It is complemented by exercises where simple examples problems are solved by calculations and where the implementation of the content of the lecture in computer simulations is explained. It will also briefly discussed how important material parameters can be determined from experimental data.
Literature	Empfohlene Literatur / Recommended literature:  1) Dietmar Gross, Werner Hauger, Peter Wriggers, Technische Mechanik 4, Springer 2018, DOI: 10.1007/978-3-662-55694-8  2) Peter Haupt, Continuum Mechanics and Theory of Materials, Springer 2002, DOI: 10.1007/978-3-662-04775-0

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

Module M1173: Applie	ed Statistics			
Courses				
Title	Тур		Hrs/wk	СР
Applied Statistics (L1584)	Lecture		2	3
Applied Statistics (L1586)	Project-/r	problem-based Learning	2	2
Applied Statistics (L1585)	Recitatio	n Section (small)	1	1
Module Responsible	Prof. Michael Morlock			
<b>Admission Requirements</b>	None			
Recommended Previous	Basic knowledge of statistical methods			
Knowledge				
<b>Educational Objectives</b>	After taking part successfully, students have reached the following learning	ng results		
Professional Competence				
Knowledge	Students can explain the statistical methods and the conditions of their us	se.		
Skills	Students are able to use the statistics program to solve statistics problem	s and to interpret and d	lepict the resu	lts
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: El	ective Compulsory		
Following Curricula	Mechatronics: Specialisation Intelligent Systems and Robotics: Elective Co	ompulsory		
	Mechatronics: Specialisation System Design: Elective Compulsory			
	Mechatronics: Core Qualification: Elective Compulsory			
	Biomedical Engineering: Core Qualification: Compulsory			
	Product Development, Materials and Production: Core Qualification: Electi	ve Compulsory		
	Theoretical Mechanical Engineering: Specialisation Bio- and Medical Techn	nology: Elective Compul	sory	

Course L1504, Applied Statio	Alexander
Course L1584: Applied Statis	
	Lecture
Hrs/wk	
СР	
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Prof. Michael Morlock
Language	DE/EN
Cycle	WiSe
Content	The goal is to introduce students to the basic statistical methods and their application to simple problems. The topics include:
	Chi square test
	Simple regression and correlation
	Multiple regression and correlation
	One way analysis of variance
	Two way analysis of variance
	Discriminant analysis
	Analysis of categorial data
	Chossing the appropriate statistical method
	Determining critical sample sizes
Literature	Applied Regression Analysis and Multivariable Methods, 3rd Edition, David G. Kleinbaum Emory University, Lawrence L. Kupper
	University of North Carolina at Chapel Hill, Keith E. Muller University of North Carolina at Chapel Hill, Azhar Nizam Emory University,
	Published by Duxbury Press, CB © 1998, ISBN/ISSN: 0-534-20910-6

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

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

Module M1204: Mode	lling and Optimization in Dynamics			
Courses				
<b>Title</b> Flexible Multibody Systems (L1632)	)	<b>Typ</b> Lecture	Hrs/wk	<b>CP</b> 3
Optimization of dynamical systems	(L1633)	Lecture	2	3
Module Responsible	Prof. Robert Seifried			
Admission Requirements	None			
Recommended Previous Knowledge	Mathematics I, II, III     Mechanics I, II, III, IV     Simulation of dynamical Systems			
<b>Educational Objectives</b>	After taking part successfully, students have reached th	e following learning results		
Professional Competence Knowledge	Students demonstrate basic knowledge and understar multibody systems and methods for optimizing dynamic Students are able			ex rigid and flexib
SKIIIS	+ to think holistically + to independently, securly and critically analyze and systems + to describe dynamics problems mathematically + to optimize dynamics problems	optimize basic problems of	the dynamics of rigid an	d flexible multibo
Personal Competence Social Competence	Students are able to + solve problems in heterogeneous groups and to docur	ment the corresponding resul	ts.	
Autonomy	Students are able to  + assess their knowledge by means of exercises.  + acquaint themselves with the necessary knowledge to	o solve research oriented task	KS.	
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56			
Credit points				
Course achievement				
Examination				
Examination duration and				
scale				
Assignment for the Following Curricula	Aircraft Systems Engineering: Core Qualification: Electiv Aeronautics: Core Qualification: Elective Compulsory Mechatronics: Specialisation Intelligent Systems and Roi Mechatronics: Specialisation System Design: Elective Co Mechatronics: Core Qualification: Elective Compulsory Product Development, Materials and Production: Core Q	botics: Elective Compulsory	ory	
	Theoretical Mechanical Engineering: Core Qualification:			

Course L1632: Flexible Multi	body 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 M1759: Linkir	ng theory and practice (dual study program, Master's degree)
Module Responsible	Dr. Henning Haschke
Admission Requirements	None
Recommended Previous Knowledge	Successful completion of practical modules as part of the dual Bachelor's course     Module "interlinking theory and practice as part of the dual Master's course"
Educational Objectives	After taking part successfully, students have reached the following learning results
<b>Professional Competence</b>	
Knowledge	Dual students
	can describe and classify selected classic and current theories, concepts and methods
	related to project management and
	change and transformation management
	and apply them to specific situations, processes and plans in a personal, professional context.
Skills	Dual students
	<ul> <li> anticipate typical difficulties, positive and negative effects, as well as success and failure factors in the engineering sector, evaluate them and consider promising strategies and courses of action.</li> <li> develop specialised technical and conceptual skills to solve complex tasks and problems in their professional field of activity/work.</li> </ul>
Personal Competence	
Social Competence	Dual students
	<ul> <li> can responsibly lead interdisciplinary teams within the framework of complex tasks and problems.</li> <li> engage in sector-specific and cross-sectoral discussions with experts, stakeholders and staff, representing their approaches, points of view and work results.</li> </ul>
Autonomy	Dual students
	<ul> <li> define, reflect and evaluate goals and measures for complex application-oriented projects and change processes.</li> <li> shape their professional area of responsibility independently and sustainably.</li> <li> take responsibility for their actions and for the results of their work.</li> </ul>
Workload in Hours	Independent Study Time 96, Study Time in Lecture 84
Credit points	6
Course achievement	None
Examination	Written elaboration
Examination duration and	Studienbegleitende und semesterübergreifende Dokumentation: Die Leistungspunkte für das Modul werden durch die Anfertigung
scale	eines digitalen Lern- und Entwicklungsberichtes (E-Portfolio) erworben. Dabei handelt es sich um eine fortlaufende Dokumentation
	und Reflexion der Lernerfahrungen und der Kompetenzentwicklung im Bereich der Personalen Kompetenz.

Tvp	Seminar
Hrs/wk	
CP	
Workload in Hours	Independent Study Time 48, Study Time in Lecture 42
Lecturer	Dr. Henning Haschke, Heiko Sieben
Language	DE
Cycle	WiSe/SoSe
Content	<ul> <li>Theories and methods of project management</li> <li>Innovation management</li> <li>Agile project management</li> <li>Fundamentals of classic and agile methods</li> <li>Hybrid use of classic and agile methods</li> <li>Roles, perspectives and stakeholders throughout the project</li> <li>Initiating and coordinating complex engineering projects</li> <li>Principles of moderation, team management, team leadership, conflict management</li> <li>Communication structures: in-house, cross-company</li> <li>Public information policy</li> <li>Promoting commitment and empowerment</li> <li>Sharing experience with specialists and managers from the engineering sector</li> <li>Documenting and reflecting on learning experiences</li> </ul>
Literature	Seminarapparat

Course L2891: Responsible Change and Transformation Management in Engineering (for Dual Study Program)		
Тур	Seminar	
Hrs/wk	3	
СР	3	
Workload in Hours	Independent Study Time 48, Study Time in Lecture 42	
Lecturer	Dr. Henning Haschke, Heiko Sieben	
Language	DE	
Cycle	WiSe/SoSe	
Content	<ul> <li>Basic concepts, opportunities and limits of organisational change</li> <li>Models and methods of organisational design and development</li> <li>Strategic orientation and change, and their short-, medium- and long-term consequences for individuals, organisations and society as a whole</li> <li>Roles, perspectives and stakeholders in change processes</li> <li>Initiating and coordinating change measures in engineering</li> <li>Phase models of organisational change (Lewin, Kotter, etc.)</li> <li>Change-oriented information policy and dealing with resistance and uncertainty</li> <li>Promoting commitment and empowerment</li> <li>Successfully handling change and transformation: personally, as an employee, as a manager (personal, professional, organisational)</li> <li>Company-level and globally (systemic)</li> <li>Sharing experience with specialists and managers from the engineering sector</li> <li>Documenting and reflecting on learning experiences</li> </ul>	
Literature	Seminarapparat	

Module M1756: Pract	ical module 1 (dual study program, Master's degree)
Courses	
Title	Typ Hrs/wk CP
Practical term 1 (dual study progra	
Module Responsible	
Admission Requirements Recommended Previous	None
Knowledge	Successful completion of a compatible dual B.Sc. at TU Hamburg or comparable practical work experience and competences
	in the area of interlinking theory and practice
	Course D from the module on interlinking theory and practice as part of the dual Master's course
Educational Objectives	After taking part successfully, students have reached the following learning results
Professional Competence	
Knowledge	Dual students
	<ul> <li> combine their knowledge of facts, principles, theories and methods gained from previous study content with acquired practical knowledge - in particular their knowledge of practical professional procedures and approaches, in the current field of activity in engineering.</li> <li> have a critical understanding of the practical applications of their engineering subject.</li> </ul>
Skills	Dual students
	<ul> <li> apply technical theoretical knowledge to complex, interdisciplinary problems within the company, and evaluate the associated work processes and results, taking into account different possible courses of action.</li> <li> implement the university's application recommendations with regard to their current tasks.</li> <li> develop solutions as well as procedures and approaches in their field of activity and area of responsibility.</li> </ul>
Personal Competence	
Social Competence	Dual students
	<ul> <li> work responsibly in project teams within their working area and proactively deal with problems within their team.</li> <li> represent complex engineering viewpoints, facts, problems and solution approaches in discussions with internal and external stakeholders.</li> </ul>
Autonomy	Dual students
	<ul> <li> define goals for their own learning and working processes as engineers.</li> <li> reflect on learning and work processes in their area of responsibility.</li> <li> reflect on the relevance of subject modules specialisations and specialisation for work as an engineer, and also implement the university's application recommendations and the associated challenges to positively transfer knowledge between theory and practice.</li> </ul>
Workload in Hours	Independent Study Time 300, Study Time in Lecture 0
Credit points	10
Credit points Course achievement	10 None
Credit points  Course achievement  Examination	10 None Written elaboration
Credit points Course achievement	None Written elaboration Documentation accompanying studies and across semesters: Module credit points are earned by completing a digital learning and
Credit points Course achievement Examination Examination duration and scale Assignment for the	None  Written elaboration  Documentation accompanying studies and across semesters: Module credit points are earned by completing a digital learning and development report (e-portfolio). This documents and reflects individual learning experiences and skills development relating to interlinking theory and practice, as well as professional practice. In addition, the partner company provides proof to the dual@TUHH Coordination Office that the dual student has completed the practical phase.  Civil Engineering: Core Qualification: Compulsory
Credit points  Course achievement  Examination  Examination duration and  scale	None  Written elaboration  Documentation accompanying studies and across semesters: Module credit points are earned by completing a digital learning and development report (e-portfolio). This documents and reflects individual learning experiences and skills development relating to interlinking theory and practice, as well as professional practice. In addition, the partner company provides proof to the dual@TUHH Coordination Office that the dual student has completed the practical phase.  Civil Engineering: Core Qualification: Compulsory Bioprocess Engineering: Core Qualification: Compulsory
Credit points Course achievement Examination Examination duration and scale Assignment for the	None  Written elaboration  Documentation accompanying studies and across semesters: Module credit points are earned by completing a digital learning and development report (e-portfolio). This documents and reflects individual learning experiences and skills development relating to interlinking theory and practice, as well as professional practice. In addition, the partner company provides proof to the dual@TUHH Coordination Office that the dual student has completed the practical phase.  Civil Engineering: Core Qualification: Compulsory Bioprocess Engineering: Core Qualification: Compulsory Chemical and Bioprocess Engineering: Core Qualification: Compulsory
Credit points Course achievement Examination Examination duration and scale Assignment for the	None  Written elaboration  Documentation accompanying studies and across semesters: Module credit points are earned by completing a digital learning and development report (e-portfolio). This documents and reflects individual learning experiences and skills development relating to interlinking theory and practice, as well as professional practice. In addition, the partner company provides proof to the dual@TUHH Coordination Office that the dual student has completed the practical phase.  Civil Engineering: Core Qualification: Compulsory Bioprocess Engineering: Core Qualification: Compulsory
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Credit points  Course achievement  Examination  Examination duration and  scale  Assignment for the	None  Written elaboration  Documentation accompanying studies and across semesters: Module credit points are earned by completing a digital learning and development report (e-portfolio). This documents and reflects individual learning experiences and skills development relating to interlinking theory and practice, as well as professional practice. In addition, the partner company provides proof to the dual@TUHH Coordination Office that the dual student has completed the practical phase.  Civil Engineering: Core Qualification: Compulsory Bioprocess Engineering: Core Qualification: Compulsory Chemical and Bioprocess Engineering: Core Qualification: Compulsory Computer Science: Core Qualification: Compulsory Electrical Engineering: Core Qualification: Compulsory Energy Systems: Core Qualification: Compulsory Environmental Engineering: Core Qualification: Compulsory Aircraft Systems Engineering: Core Qualification: Compulsory
Credit points  Course achievement  Examination  Examination duration and  scale  Assignment for the	None  Written elaboration  Documentation accompanying studies and across semesters: Module credit points are earned by completing a digital learning and development report (e-portfolio). This documents and reflects individual learning experiences and skills development relating to interlinking theory and practice, as well as professional practice. In addition, the partner company provides proof to the dual@TUHH Coordination Office that the dual student has completed the practical phase.  Civil Engineering: Core Qualification: Compulsory Bioprocess Engineering: Core Qualification: Compulsory Chemical and Bioprocess Engineering: Core Qualification: Compulsory Computer Science: Core Qualification: Compulsory Electrical Engineering: Core Qualification: Compulsory Energy Systems: Core Qualification: Compulsory Environmental Engineering: Core Qualification: Compulsory Aircraft Systems Engineering: Core Qualification: Compulsory Computer Science in Engineering: Core Qualification: Compulsory
Credit points  Course achievement  Examination  Examination duration and  scale  Assignment for the	None  Written elaboration  Documentation accompanying studies and across semesters: Module credit points are earned by completing a digital learning and development report (e-portfolio). This documents and reflects individual learning experiences and skills development relating to interlinking theory and practice, as well as professional practice. In addition, the partner company provides proof to the dual@TUHH Coordination Office that the dual student has completed the practical phase.  Civil Engineering: Core Qualification: Compulsory Bioprocess Engineering: Core Qualification: Compulsory Chemical and Bioprocess Engineering: Core Qualification: Compulsory Computer Science: Core Qualification: Compulsory Electrical Engineering: Core Qualification: Compulsory Energy Systems: Core Qualification: Compulsory Environmental Engineering: Core Qualification: Compulsory Aircraft Systems Engineering: Core Qualification: Compulsory
Credit points Course achievement Examination Examination duration and scale Assignment for the	None  Written elaboration  Documentation accompanying studies and across semesters: Module credit points are earned by completing a digital learning and development report (e-portfolio). This documents and reflects individual learning experiences and skills development relating to interlinking theory and practice, as well as professional practice. In addition, the partner company provides proof to the dual@TUHH Coordination Office that the dual student has completed the practical phase.  Civil Engineering: Core Qualification: Compulsory Bioprocess Engineering: Core Qualification: Compulsory Chemical and Bioprocess Engineering: Core Qualification: Compulsory Computer Science: Core Qualification: Compulsory Electrical Engineering: Core Qualification: Compulsory Energy Systems: Core Qualification: Compulsory Environmental Engineering: Core Qualification: Compulsory Aircraft Systems Engineering: Core Qualification: Compulsory Computer Science in Engineering: Core Qualification: Compulsory Information and Communication Systems: Core Qualification: Compulsory
Credit points Course achievement Examination Examination duration and scale Assignment for the	None  Written elaboration  Documentation accompanying studies and across semesters: Module credit points are earned by completing a digital learning and development report (e-portfolio). This documents and reflects individual learning experiences and skills development relating to interlinking theory and practice, as well as professional practice. In addition, the partner company provides proof to the dual@TUHH Coordination Office that the dual student has completed the practical phase.  Civil Engineering: Core Qualification: Compulsory Bioprocess Engineering: Core Qualification: Compulsory Chemical and Bioprocess Engineering: Core Qualification: Compulsory Electrical Engineering: Core Qualification: Compulsory Energy Systems: Core Qualification: Compulsory Environmental Engineering: Core Qualification: Compulsory Aircraft Systems Engineering: Core Qualification: Compulsory Computer Science in Engineering: Core Qualification: Compulsory Information and Communication Systems: Core Qualification: Compulsory Informational Management and Engineering: Core Qualification: Compulsory Logistics, Infrastructure and Mobility: Core Qualification: Compulsory Aeronautics: Core Qualification: Compulsory
Credit points Course achievement Examination Examination duration and scale Assignment for the	None  Written elaboration  Documentation accompanying studies and across semesters: Module credit points are earned by completing a digital learning and development report (e-portfolio). This documents and reflects individual learning experiences and skills development relating to interlinking theory and practice, as well as professional practice. In addition, the partner company provides proof to the dual@TUHH Coordination Office that the dual student has completed the practical phase.  Civil Engineering: Core Qualification: Compulsory Bioprocess Engineering: Core Qualification: Compulsory Chemical and Bioprocess Engineering: Core Qualification: Compulsory Computer Science: Core Qualification: Compulsory Electrical Engineering: Core Qualification: Compulsory Energy Systems: Core Qualification: Compulsory Environmental Engineering: Core Qualification: Compulsory Aircraft Systems Engineering: Core Qualification: Compulsory Information and Communication Systems: Core Qualification: Compulsory International Management and Engineering: Core Qualification: Compulsory Logistics, Infrastructure and Mobility: Core Qualification: Compulsory Aeronautics: Core Qualification: Compulsory Materials Science and Engineering: Core Qualification: Compulsory
Credit points Course achievement Examination Examination duration and scale Assignment for the	None  Written elaboration  Documentation accompanying studies and across semesters: Module credit points are earned by completing a digital learning and development report (e-portfolio). This documents and reflects individual learning experiences and skills development relating to interlinking theory and practice, as well as professional practice. In addition, the partner company provides proof to the dual@TUHH Coordination Office that the dual student has completed the practical phase.  Civil Engineering: Core Qualification: Compulsory Bioprocess Engineering: Core Qualification: Compulsory Chemical and Bioprocess Engineering: Core Qualification: Compulsory Computer Science: Core Qualification: Compulsory Electrical Engineering: Core Qualification: Compulsory Energy Systems: Core Qualification: Compulsory Environmental Engineering: Core Qualification: Compulsory Aircraft Systems Engineering: Core Qualification: Compulsory Information and Communication Systems: Core Qualification: Compulsory Information and Communication Systems: Core Qualification: Compulsory Logistics, Infrastructure and Mobility: Core Qualification: Compulsory Aeronautics: Core Qualification: Compulsory Materials Science and Engineering: Core Qualification: Compulsory Materials Science: Core Qualification: Compulsory
Credit points Course achievement Examination Examination duration and scale Assignment for the	None  Written elaboration  Documentation accompanying studies and across semesters: Module credit points are earned by completing a digital learning and development report (e-portfolio). This documents and reflects individual learning experiences and skills development relating to interlinking theory and practice, as well as professional practice. In addition, the partner company provides proof to the dual@TUHH Coordination Office that the dual student has completed the practical phase.  Civil Engineering: Core Qualification: Compulsory Bioprocess Engineering: Core Qualification: Compulsory Chemical and Bioprocess Engineering: Core Qualification: Compulsory Computer Science: Core Qualification: Compulsory Electrical Engineering: Core Qualification: Compulsory Energy Systems: Core Qualification: Compulsory Environmental Engineering: Core Qualification: Compulsory Aircraft Systems Engineering: Core Qualification: Compulsory Information and Communication Systems: Core Qualification: Compulsory International Management and Engineering: Core Qualification: Compulsory Logistics, Infrastructure and Mobility: Core Qualification: Compulsory Aeronautics: Core Qualification: Compulsory Materials Science and Engineering: Core Qualification: Compulsory
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Credit points Course achievement Examination Examination duration and scale Assignment for the	None Written elaboration Documentation accompanying studies and across semesters: Module credit points are earned by completing a digital learning and development report (e-portfolio). This documents and reflects individual learning experiences and skills development relating to interlinking theory and practice, as well as professional practice. In addition, the partner company provides proof to the dual@TUHH Coordination Office that the dual student has completed the practical phase.  Civil Engineering: Core Qualification: Compulsory Bioprocess Engineering: Core Qualification: Compulsory Computer Science: Core Qualification: Compulsory Electrical Engineering: Core Qualification: Compulsory Energy Systems: Core Qualification: Compulsory Environmental Engineering: Core Qualification: Compulsory Aircraft Systems Engineering: Core Qualification: Compulsory Information and Communication Systems: Core Qualification: Compulsory Information and Communication Systems: Core Qualification: Compulsory Logistics, Infrastructure and Mobility: Core Qualification: Compulsory Materials Science and Engineering: Core Qualification: Compulsory Materials Science: Core Qualification: Compulsory Materials Science: Core Qualification: Compulsory Mechatronics: Core Qualification: Compulsory Biomedical Engineering and Management: Core Qualification: Compulsory Mechatronics: Core Qualification: Compulsory Microelectronics and Microsystems: Core Qualification: Compulsory Microelectronics and Microsystems: Core Qualification: Compulsory
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Credit points Course achievement Examination Examination duration and scale Assignment for the	None Written elaboration Documentation accompanying studies and across semesters: Module credit points are earned by completing a digital learning and development report (e-portfolio). This documents and reflects individual learning experiences and skills development relating to interlinking theory and practice, as well as professional practice. In addition, the partner company provides proof to the dual@TUHH Coordination Office that the dual student has completed the practical phase.  Civil Engineering: Core Qualification: Compulsory Bioprocess Engineering: Core Qualification: Compulsory Computer Science: Core Qualification: Compulsory Electrical Engineering: Core Qualification: Compulsory Energy Systems: Core Qualification: Compulsory Environmental Engineering: Core Qualification: Compulsory Aircraft Systems Engineering: Core Qualification: Compulsory Information and Communication Systems: Core Qualification: Compulsory Information and Communication Systems: Core Qualification: Compulsory Logistics, Infrastructure and Mobility: Core Qualification: Compulsory Materials Science and Engineering: Core Qualification: Compulsory Materials Science: Core Qualification: Compulsory Materials Science: Core Qualification: Compulsory Mechatronics: Core Qualification: Compulsory Biomedical Engineering and Management: Core Qualification: Compulsory Mechatronics: Core Qualification: Compulsory Microelectronics and Microsystems: Core Qualification: Compulsory Microelectronics and Microsystems: Core Qualification: Compulsory
Credit points Course achievement Examination Examination duration and scale Assignment for the	None Written elaboration Documentation accompanying studies and across semesters: Module credit points are earned by completing a digital learning and development report (e-portfolio). This documents and reflects individual learning experiences and skills development relating to interlinking theory and practice, as well as professional practice. In addition, the partner company provides proof to the dual@TUHH Coordination Office that the dual student has completed the practical phase.  Civil Engineering: Core Qualification: Compulsory Bioprocess Engineering: Core Qualification: Compulsory Chemical and Bioprocess Engineering: Core Qualification: Compulsory Computer Science: Core Qualification: Compulsory Electrical Engineering: Core Qualification: Compulsory Energy Systems: Core Qualification: Compulsory Environmental Engineering: Core Qualification: Compulsory Aircraft Systems Engineering: Core Qualification: Compulsory Computer Science in Engineering: Core Qualification: Compulsory Information and Communication Systems: Gore Qualification: Compulsory Information and Communication Systems: Gore Qualification: Compulsory International Management and Engineering: Core Qualification: Compulsory Aeronautics: Core Qualification: Compulsory Materials Science and Engineering: Core Qualification: Compulsory Materials Science: Core Qualification: Compulsory Mechanical Engineering and Management: Core Qualification: Compulsory Biomedical Engineering: Core Qualification: Compulsory Biomedical Engineering: Core Qualification: Compulsory Microelectronics and Microsystems: Core Qualification: Compulsory Product Development, Materials and Production: Core Qualification: Compulsory Renewable Energies: Core Qualification: Compulsory
Credit points  Course achievement  Examination  Examination duration and  scale  Assignment for the	None Written elaboration  Documentation accompanying studies and across semesters: Module credit points are earned by completing a digital learning and development report (e-portfolio). This documents and reflects individual learning experiences and skills development relating to interlinking theory and practice, as well as professional practice. In addition, the partner company provides proof to the dual@TUHH Coordination Office that the dual student has completed the practical phase.  Civil Engineering: Core Qualification: Compulsory Bioprocess Engineering: Core Qualification: Compulsory Chemical and Bioprocess Engineering: Core Qualification: Compulsory Computer Science: Core Qualification: Compulsory Electrical Engineering: Core Qualification: Compulsory Energy Systems: Core Qualification: Compulsory Environmental Engineering: Core Qualification: Compulsory Aircraft Systems Engineering: Core Qualification: Compulsory Computer Science in Engineering: Core Qualification: Compulsory Informational Management and Engineering: Core Qualification: Compulsory Informational Management and Engineering: Core Qualification: Compulsory Aeronautics: Core Qualification: Compulsory Materials Science and Engineering: Core Qualification: Compulsory Materials Science: Core Qualification: Compulsory Mechaironics: Core Qualification: Compulsory Mechaironics: Core Qualification: Compulsory Mechaironics: Core Qualification: Compulsory Biomedical Engineering and Management: Core Qualification: Compulsory Microelectronics and Microsystems: Core Qualification: Compulsory Microelectronics and Microsystems: Core Qualification: Compulsory Microelectronics and Microsystems: Core Qualification: Compulsory Nordical Engineering: Core Qualification: Compulsory Naval Architecture and Ocean Engineering: Core Qualification: Compulsory

Course L2887: Practical term	n 1 (dual study program, Master's degree)
Тур	
Hrs/wk	0
СР	10
Workload in Hours	Independent Study Time 300, Study Time in Lecture 0
Lecturer	Dr. Henning Haschke
Language	DE
Cycle	WiSe/SoSe
Content	Company onboarding process
	<ul> <li>Assigning a professional field of activity as an engineer (B.Sc.) and associated fields of work</li> <li>Establishing responsibilities and authorisation of the dual student within the company as an engineer (B.Sc.)</li> <li>Working independently in a team and on selected projects - across departments and, if applicable, across companies</li> <li>Scheduling the current practical module with a clear correlation to work structures</li> <li>Scheduling the examination phase/subsequent study semester</li> <li>Operational knowledge and skills</li> <li>Company-specific: Responsibility as an engineer (B.Sc.) in their own area of work, coordinating team and project work, dealing with complex contexts and unsolved problems, developing and implementing innovative solutions</li> <li>Subject specialisation (corresponding to the chosen course [M.Sc.]) in the field of activity</li> <li>Systemic skills</li> <li>Implementing the university's application recommendations (theory-practice transfer) in corresponding work and task areas across the company</li> </ul>
	Sharing/reflecting on learning
	Creating an e-portfolio     Importance of course contents (M.Sc.) when working as an engineer     Importance of development and innovation when working as an engineer
Literature	<ul> <li>Studierendenhandbuch</li> <li>Betriebliche Dokumente</li> <li>Hochschulseitige Handlungsempfehlungen zum Theorie-Praxis-Transfer</li> </ul>

Module M0604: High-	Order FEM					
Courses						
Title				Тур	Hrs/wk	СР
High-Order FEM (L0280)				Lecture	3	4
High-Order FEM (L0281)				Recitation Section (large)	1	2
Module Responsible	Prof. Alexander Düster					
Admission Requirements	None					
Recommended Previous	Knowledge of partial di	fferential equations i	s recommended.			
Knowledge						
<b>Educational Objectives</b>	After taking part succes	ssfully, students have	e reached the follow	ing learning results		
Professional Competence						
Knowledge	Students are able to					
	+ give an overview of t	he different (h, p, hp	) finite element prod	cedures.		
	+ explain high-order fir	nite element procedu	ires.			
	+ specify problems of	finite element proc	edures, to identify	them in a given situation a	nd to explain thei	r mathematical and
	mechanical background	d.				
Skille	Students are able to					
Skilis	+ apply high-order finit	e elements to proble	ems of structural med	chanics		
		•		finite element procedure.		
	+ critically judge result			mile ciemene procedure.		
	+ transfer their knowle	-		problems.		
		-9		F		
Personal Competence						
Social Competence	Students are able to					
	+ solve problems in heterogeneous groups.					
	+ present and discuss t					
	+ give and accept professional constructive criticism.					
Autonomy	Students are able to					
	+ assess their knowled	ge by means of exer	cises and E-Learning	J.		
	+ acquaint themselves	with the necessary k	knowledge to solve r	esearch oriented tasks.		
	+ acquaint themselves with the necessary knowledge to solve research oriented tasks. + to transform the acquired knowledge to similar problems.					
Mandaland In Harris	In deal of Charles Time	- 124 Church Time in	- Lt			
Workload in Hours		ie 124, Study Time in	i Lecture 56			
Credit points		Form	Description			
Course achievement		Presentation	Forschendes	Lernen		
Examination						
Examination duration and						
scale						
	Civil Engineering: Speci	ialisation Computation	nal Engineering: Ele	active Compulsory		
Following Curricula				oduct Development and Proc	uction: Elective Co	ompulsory
. cc.mig curricula	Materials Science: Spec		•	·		,,
	•	_		ct Development and Producti	on: Elective Comn	ulsory
	Mechatronics: Technica					,
				ion: Elective Compulsory		
	Naval Architecture and					
	Technomathematics: S	3 3	-	, ,		
	Theoretical Mechanical					

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	ndependent Study Time 46, Study Time in Lecture 14		
Lecturer	Prof. Alexander Düster		
Language	EN		
Cycle	SoSe		
Content	See interlocking course		
Literature	See interlocking course		

Module M0805: Technical Acoustics I (Acoustic Waves, Noise Protection, Psycho Acoustics )				
Courses				
Title		Тур	Hrs/wk	СР
Technical Acoustics I (Acoustic Way	ves, Noise Protection, Psycho Acoustics ) (L0516)	Lecture	2	3
Technical Acoustics I (Acoustic Way	ves, Noise Protection, Psycho Acoustics ) (L0518)	Recitation Section (large)	2	3
Module Responsible	Prof. Benedikt Kriegesmann			
Admission Requirements	None			
Recommended Previous	Mechanics I (Statics, Mechanics of Materials) and Mech	anics II (Hydrostatics, Kinematics, Dyna	amics)	
Knowledge	Mathematics I, II, III (in particular differential equations	)		
Educational Objectives	After taking part successfully, students have reached t	ne following learning results		
Professional Competence				
Knowledge	The students possess an in-depth knowledge in acous	tics regarding acoustic waves, noise	protection, and p	sycho acoustics and
	are able to give an overview of the corresponding theo	retical and methodical basis.		
Skills	The students are capable to handle engineering	problems in acoustics by theory-ba	ased application	of the demanding
	methodologies and measurement procedures treated v	vithin the module.		_
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			
Credit points				
Course achievement				
Examination	Written exam			
Examination duration and	90 min			
scale				
Assignment for the	Aircraft Systems Engineering: Core Qualification: Electi	ve Compulsory		
Following Curricula	International Management and Engineering: Specialisa	ion II. Aviation Systems: Elective Com	oulsory	
	Aeronautics: Core Qualification: Elective Compulsory			
	Mechatronics: Core Qualification: Elective Compulsory			
	Product Development, Materials and Production: Core	Qualification: Elective Compulsory		
	Technomathematics: Specialisation III. Engineering Sci	ence: Elective Compulsory		
	Theoretical Mechanical Engineering: Specialisation Pro-	•		
	Theoretical Mechanical Engineering: Specialisation Sim	ulation Technology: Elective Compulso	ry	

Course L0516: Technical Acoustics I (Acoustic Waves, Noise Protection, Psycho Acoustics )		
Тур	Lecture	
Hrs/wk	2	
СР	3	
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28	
Lecturer	Drlng. 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	
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	
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# Module Manual M.Sc. "Product Development, Materials and Production"

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

Module M1164: Pract	ical Course Product Development,	Materials and Production		
Courses				
<b>Fitle</b> Practical Course Product Developm	ent, Materials and Production (L1566)	<b>Typ</b> Practical Course	Hrs/wk	<b>CP</b> 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			
	<ul> <li>Lectures: Structural Metallic Materials, Metal</li> </ul>	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			
	<ul> <li>Lectures: Forming and Cutting Technology, N</li> </ul>	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			
	<ul> <li>represent more complex context of different</li> </ul>	fields of study.		
	<ul> <li>describe functionality of modern measurement</li> </ul>		nnologies.	
	-			
Skills	Students are capable of			
	<ul> <li>applying theoretical knowledge for practical</li> </ul>			
	applying provided experimental methods for		of study.	
	analyzing and evaluating experimental resul			
	applying modern measurement instrumenta	cions.		
Personal Competence	Charleste			
Social Competence	Students can			
	<ul> <li>carry out and document experimental work i</li> </ul>	n groups.		
	<ul> <li>present and discuss experimental results in</li> </ul>	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.			
	<ul> <li>assess own strengths and weaknesses.</li> </ul>			
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 Course Product Development, Materials and Production		
Тур	Practical Course	
Hrs/wk	6	
СР	6	
Workload in Hours	Independent Study Time 96, Study Time in Lecture 84	
Lecturer	Prof. Jan Hendrik Dege, Prof. Bodo Fiedler, Prof. Claus Emmelmann, Prof. Dieter Krause, Prof. Gerold Schneider, Prof. Hermann	
	Lödding, Prof. Jörg Weißmüller, Prof. Josef Schlattmann, Prof. Michael Morlock, Prof. Thorsten Schüppstuhl	
Language	DE	
Cycle	SoSe	
Content	Product Development:	
	<ul> <li>Modal analysis - experimental and computational</li> <li>Appropriate design in engineering</li> <li>Characterization of rubbery-elastic materials</li> <li>Stick-Slip-Analysis at friction and wear test station</li> <li>Materials:         <ul> <li>Property profiles of steel</li> <li>Actuators for modern fuel injection systems - synthesis and properties</li> <li>Processing, properties and structure of thermoplastic polymers and its composites</li> <li>Tribology in joints</li> </ul> </li> </ul>	
	Optimization of welding process parameters for hybrid plasma laser welding     Evaluation of stock removal processes     Analysis of basic laws in production logistics     Analysis of positioning behaviour and trajectory accuracy of industrial robots	
Literature	Nach Themenstellung / depending on topic	

Module M0752: Nonlin	near Dynamics			
Courses				
Title		Тур	Hrs/wk	СР
Nonlinear Dynamics (L0702)		Integrated Lecture	4	6
Module Responsible	Prof. Norbert Hoffmann			
Admission Requirements	None			
Recommended Previous				
Knowledge	Calculus			
	Linear Algebra			
	Engineering Mechanics			
Educational Objectives	After taking part successfully, students have reached	the following learning results		
Professional Competence				
Knowledge				
	Students are able to reflect existing terms and .	concepts in Nonlinear Dynamics and	to develop and rese	arch new terms and
	concepts.	de of modeling and analysis for nonli		
	Students are able to denote and expand metho	us of modeling and analysis for nonli	near dynamicai syst	ems.
Skills		d and a second of Namilia and Domania		
	Students are able to apply existing methods and     Students are able to develop nevel methods and	•	Lavatana	
	Students are able to develop novel methods an	a procedures for nonlinear dynamica	i systems.	
Personal Competence				
Social Competence				
	Students can analyze problems of nonlinear dyr     Students can achieve solution procedures for procedures for procedures.	- ·	ome also in groups	
	• Students can achieve solution procedures for pr	oblems of nonlinear dynamical syste	erris also ili groups.	
Autonomy	Charles to a ship to a second by the state of the state o		adiodal a Un	
	<ul> <li>Students are able to approach given research tasks on the basis of given methods individually.</li> <li>Students are able to identify and follow up novel research tasks by themselves.</li> </ul>			
	Students are able to identify and follow up hove	research tasks by themselves.		
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	2 Hours			
scale				
Assignment for the	Aircraft Systems Engineering: Core Qualification: Elect	ive Compulsory		
Following Curricula	International Management and Engineering: Specialisa	ation II. Mechatronics: Elective Comp	ulsory	
	Aeronautics: Core Qualification: Elective Compulsory			
	Mechanical Engineering and Management: Specialisati	on Mechatronics: Elective Compulso	ry	
	Mechatronics: Core Qualification: Elective Compulsory		0 1	
	Biomedical Engineering: Specialisation Artificial Organ		re Compulsory	
	Biomedical Engineering: Specialisation Implants and E		mpulsony	
	Biomedical Engineering: Specialisation Medical Techno Biomedical Engineering: Specialisation Management a			
	Product Development, Materials and Production: Core		Compuisory	
	Theoretical Mechanical Engineering: Core Qualification	• •		
		Liceare companion y		

Course L0702: Nonlinear Dyr	ourse L0702: Nonlinear Dynamics		
Тур	egrated Lecture		
Hrs/wk	4		
СР	6		
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56		
Lecturer	Prof. Norbert Hoffmann		
Language	DE/EN		
Cycle	SoSe		
Content	Fundamentals of Nonlinear Dynamics		
	One dimensional problems  Linear Stability  Local Bifurcations  Synchronisation  Two dimensional problems  Limit Cycles Global Bifurcations  Chaos  Lorenz Equations Fractals and Strange Attractors Predictability and Horizons		
Literature	Steven Strogatz: Nonlinear Dynamics and Chaos.		

Module M1339: Desig	n optimization and probabilistic app	roaches in structural analy	rsis	
Courses				
= :	tic Approaches in Structural Analysis (L1873) tic Approaches in Structural Analysis (L1874)	<b>Typ</b> Lecture Recitation Section (large)	Hrs/wk 2 2	<b>CP</b> 3 3
Module Responsible	Prof. Benedikt Kriegesmann			
Admission Requirements	None			
Recommended Previous Knowledge	Technical mechanics     Higher math			
<b>Educational Objectives</b>	After taking part successfully, students have reached	the following learning results		
Professional Competence Knowledge	Design optimization     Gradient based methods     Genetic algorithms     Optimization with constraints     Topology optimization     Reliability analysis     Stochastic basics     Monte Carlo methods     Semi-analytic approaches     robust design optimization     Robustness measures     Coupling of design optimization and relia	ability analysis		
Skills	Application of optimization algorithms and prob     Programming with Matlab     Implementation of algorithms     Debugging	pabilistic methods in the design of struct	ures	
Personal Competence Social Competence	Team work Oral explanation of the the work			
Autonomy	Application of methods learned in the framework     Familiarizing with source code provided     Description of approaches and results	rk of a home work		
Workload in Hours	Independent Study Time 124, Study Time in Lecture 5	56		
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: Elect Aeronautics: Core Qualification: Elective Compulsory Product Development, Materials and Production: Core Theoretical Mechanical Engineering: Core Qualification	Qualification: Elective Compulsory		

Course L1873: Design Optimization and Probabilistic Approaches in Structural Analysis				
Тур	Lecture			
Hrs/wk	2			
CP	3			
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28			
Lecturer	Prof. Benedikt Kriegesmann			
Language	DE			
Cycle	SoSe			
Content	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 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		
Literature	siehe Vorlesung		

Hrs/wk CP 0 10  course the dual Master's course fults  gained from previous study content with acquired anal procedures and approaches, in the current field
0 10  course the dual Master's course tults  gained from previous study content with acquire
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ineering subject.
r problems within the company, and evaluate the sible courses of action. to their current tasks.  their field of activity and area of responsibility les).
t teams and proactively deal with problems with
rs.
specialisation for work as an engineer, and al- ciated challenges to positively transfer knowledg
into are carned by completing a digital learning as
ints are earned by completing a digital learning ar ning experiences and skills development relating tion, the partner company provides proof to the
cal phase.
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Тур		
Hrs/wk	0	
CP		
	Independent Study Time 300, Study Time in Lecture 0	
	Dr. Henning Haschke	
Language		
	WiSe/SoSe	
Content	Company onboarding process	
	<ul> <li>Assigning a professional field of activity as an engineer (B.Sc.) and associated fields of work</li> </ul>	
	• Establishing responsibilities and authorisation of the dual student within the company as an engineer (B.Sc.)	
	• Taking personal responsibility within a team and on selected projects - across departments and, if applicable, acr	
	companies	
	<ul> <li>Scheduling the current practical module with a clear correlation to work structures</li> </ul>	
	Scheduling the examination phase/subsequent study semester	
	erational knowledge and skills	
	• Company-specific: Responsibility as an engineer (B.Sc.) in their own area of work, coordinating team and projections.	
	dealing with complex contexts and unsolved problems, developing and implementing innovative solutions	
	• Subject specialisation (corresponding to the chosen course [M.Sc.]) in the field of activity	
	Systemic skills	
	<ul> <li>Implementing the university's application recommendations (theory-practice transfer) in corresponding work and task as across the company</li> </ul>	
	Sharing/reflecting on learning	
	Updating their e-portfolio	
	Importance of course contents (M.Sc.) when working as an engineer	
	Importance of development and innovation when working as an engineer	
Literature	Studierendenhandbuch	
	Betriebliche Dokumente	
	Hochschulseitige Anwendungsempfehlungen zum Theorie-Praxis-Transfer	

Module M0806: Technical Acoustics II (Room Acoustics, Computational Methods)					
Courses					
Title		Тур	Hrs/wk	СР	
Technical Acoustics II (Room Acous	tics, Computational Methods) (L0519)	Lecture	2	3	
Technical Acoustics II (Room Acous	tics, Computational Methods) (L0521)	Recitation Section (large)	2	3	
Module Responsible	Prof. Benedikt Kriegesmann				
Admission Requirements	None				
Recommended Previous	Technical Acoustics I (Acoustic Waves, Noise Protection	on, Psycho Acoustics)			
Knowledge	Mechanics I (Statics, Mechanics of Materials) and Mec	hanics II (Hydrostatics, Kinematics, Dyna	amics)		
	Mathematics I, II, III (in particular differential equation	s)			
Educational Objectives	After taking part successfully, students have reached	the following learning results			
Professional Competence					
Knowledge	The students possess an in-depth knowledge in acou	ustics regarding room acoustics and cor	mputational metl	nods and are able to	
	give an overview of the corresponding theoretical and methodical basis.				
Sville	The students are canable to handle engineering	problems in acquetics by theory-ha	sed application	of the demanding	
Skiiis	The students are capable to handle engineering problems in acoustics by theory-based application of the demanding computational methods and procedures treated within the module.				
Personal Competence					
Social Competence	Students can work in small groups on specific problen	ns to arrive at joint solutions.			
Autonomy	The students are able to independently solve challe	nging acoustical problems in the areas	treated within t	the module. Possible	
	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 5	56			
Credit points	6				
Course achievement	None				
Examination	Oral exam				
Examination duration and					
scale					
Assignment for the	Aircraft Systems Engineering: Core Qualification: Elect	tive Compulsory			
Following Curricula	Aeronautics: Core Qualification: Elective Compulsory				
	Mechatronics: Specialisation System Design: Elective	Compulsory			
	Mechatronics: Core Qualification: Elective Compulsory	•			
	Product Development, Materials and Production: Core	Qualification: Elective Compulsory			
	Theoretical Mechanical Engineering: Specialisation Product Development and Production: Elective Compulsory				
	Theoretical Mechanical Engineering: Specialisation Sir	mulation Technology: Elective Compulso	ry		

Course I 0510. Technical Acc	ushira II / Dagus Assushira Cammuhahianal Makhada)
	ustics II (Room Acoustics, Computational Methods)
	Lecture
Hrs/wk	
СР	
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	DrIng. Sören Keuchel
Language	EN EN
Cycle	WiSe
Content	- Room acoustics
	- Sound absorber
	- Standard computations
	- Statistical Energy Approaches
	- Statistical Energy Approaches - Finite Element Methods
	- Boundary Element Methods
	- Geometrical acoustics
	- Special formulations
	Special formations
	- 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			
<b>Educational Objectives</b>	After taking part successfully, students have reached the following learning results		
Professional Competence			
Knowledge	<ul> <li>Students can explain the project as well as their autonomously gained knowledge and relate it to current issues of their field of study.</li> <li>They can explain the basic scientific methods they have worked with.</li> </ul>		
Skills	The students are able to autonomously solve a limited scientific task under the guidance of an experienced researcher. They can justify and explain their approach for problem solving; they can draw conclusions from their results, and then can find new ways and methods for their work. Students are capable of comparing and assessing alternative approaches with their own with regard to given criteria.		
Personal Competence			
Social Competence	The students are able to condense the relevance and the structure of the project work, the work procedure and the sub-problems for the presentation and discussion in front of a bigger group. They can lead the discussion and give a feedback on the project to		
Autonomy	their peers and supervisors.  The students are capable of independently planning and documenting the work steps and procedures while considering the given deadlines. This includes the ability to accurately procure the newest scientific information. Furthermore, they can obtain feedback from experts with regard to the progress of the work, and to accomplish results on the state of the art in science and technology.		
Workload in Hours	Independent Study Time 360, Study Time in Lecture 0		
Credit points	12		
Course achievement	None		
Examination	Study work		
Examination duration and	according to FSPO		
scale			
Assignment for the Following Curricula	Product Development, Materials and Production: Core Qualification: Compulsory		

Module M1758: Practi	ical module 3 (dual study pro	ogram, Master's degree)		
Courses				
itle		Тур	Hrs/wk	СР
ractical term 3 (dual study progra			0	10
Module Responsible  Admission Requirements	None			
Recommended Previous	Notice			
Knowledge		module 2 as part of the dual Master's course inking theory and practice as part of the dua	l Master's course	
Educational Objectives	After taking part successfully, students ha	ave reached the following learning results		
Professional Competence	3,1	3 3		
Knowledge	Dual students			
	strategy-oriented practical knowled	and specialised engineering knowledge acquige gained from their current field of work ar f the practical applications of their enginee	nd area of responsibility.	
Skills	Dual students			
	evaluate the associated work proce     implement the university's applic     develop new solutions as well as     when facing frequently changing re	al skills to solve complex, sometimes interdisesses and results, taking into account difference cation recommendations with regard to their sprocedures and approaches to implement equirements and unpredictable changes (system of the complex control of the complex control of the complex control of the cont	nt possible courses of ac current tasks. operational projects and temic skills).	tion. d assignments - eve
Personal Competence				
Social Competence	Dual students			
Autonomy	their team.  • can promote the professional dev  • represent complex and interdisc	rtmental and interdisciplinary project teams velopment of others in a targeted manner. ciplinary engineering viewpoints, facts, prob ders and develop these further together.		
	company and the public.  • reflect on the relevance of are	resses in their area of responsibility.  -oriented tasks, projects and innovation planeas of specialisation and research for wor dations and the associated challenges to provide the state of the state	k as an engineer, and	also implement th
Workload in Hours	Independent Study Time 300, Study Time	in Lecture 0		
Credit points	10			
Course achievement	None			
Examination	Written elaboration			
	development report (e-portfolio). This doc interlinking theory and practice, as wel	d across semesters: Module credit points are cuments and reflects individual learning ex III as professional practice. In addition, th	periences and skills dev ne partner company pr	relopment relating t
Assignment for the		dual student has completed the practical pha	ise.	
Following Curricula		•		
	Chemical and Bioprocess Engineering: Cor	• •		
	Computer Science: Core Qualification: Con	mpulsory		
	Electrical Engineering: Core Qualification:	Compulsory		
	Energy Systems: Core Qualification: Comp			
	Environmental Engineering: Core Qualifica	• •		
	Aircraft Systems Engineering: Core Qualific			
	Computer Science in Engineering: Core Qu Information and Communication Systems:	· ·		
	International Management and Engineerin			
	Logistics, Infrastructure and Mobility: Core			
	Aeronautics: Core Qualification: Compulso	• •		
	4	Qualification: Compulsory		
	Materials Science and Engineering: Core Q	Qualification. Compulsory		
	Materials Science: Core Qualification: Com	npulsory		
	Materials Science: Core Qualification: Com Mechanical Engineering and Management:	npulsory :: Core Qualification: Compulsory		
	Materials Science: Core Qualification: Com Mechanical Engineering and Management: Mechatronics: Core Qualification: Compuls	npulsory :: Core Qualification: Compulsory sory		
	Materials Science: Core Qualification: Com Mechanical Engineering and Management:	npulsory :: Core Qualification: Compulsory sory n: Compulsory		

Product Development, Materials and Production: Core Qualification: Compulsory

Renewable Energies: Core Qualification: Compulsory

Naval Architecture and Ocean Engineering: Core Qualification: Compulsory Theoretical Mechanical Engineering: Core Qualification: Compulsory

Process Engineering: Core Qualification: Compulsory

Water and Environmental Engineering: Core Qualification: Compulsory

Course L2889: Practical term	n 3 (dual study program, Master's degree)
Тур	
Hrs/wk	0
СР	10
Workload in Hours	Independent Study Time 300, Study Time in Lecture 0
Lecturer	Dr. Henning Haschke
Language	DE
Cycle	WiSe/SoSe
Content	Company onboarding process
	<ul> <li>Assigning a future professional field of activity as an engineer (M.Sc.) and associated fields of work</li> <li>Extending responsibilities and authorisation of the dual student within the company up to the intended first assignment after completing their studies</li> <li>Working responsibly in a team; project responsibility within own area - as well as across divisions and companies if necessary</li> <li>Scheduling the final practical module with a clear correlation to work structures</li> <li>Internal agreement on a potential topic or innovation project for the Master's dissertation</li> <li>Planning the Master's dissertation within the company in cooperation with TU Hamburg</li> <li>Scheduling the examination phase/subsequent study semester</li> </ul> Operational knowledge and skills
	<ul> <li>Company-specific: dealing with change, project and team development, responsibility as an engineer in their future field of work (M.Sc.), dealing with complex contexts, frequent and unpredictable changes, developing and implementing innovative solutions</li> <li>Specialising in one field of work (final dissertation)</li> <li>Systemic skills</li> <li>Implementing the university's application recommendations (theory-practice transfer) in corresponding work and task areas across the company</li> <li>Sharing/reflecting on learning</li> <li>E-portfolio</li> <li>Relevance of study content and personal specialisation when working as an engineer</li> <li>Relevance of research and innovation when working as an engineer</li> </ul>
Literature	Studierendenhandbuch     betriebliche Dokumente     Hochschulseitige Anwendungsempfehlungen zum Theorie-Praxis-Transfer

### **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.

γ	tung edge of technology, calculate and actively pro			
Module M0763: Aircra	aft Energy Systems			
Courses				
Title		Тур	Hrs/wk	СР
Aircraft Energy Systems (L0735)		Lecture	3	4
Aircraft Energy Systems (L0739)		Recitation Section (large)	2	2
Module Responsible	Prof. Frank Thielecke			
Admission Requirements	None			
<b>Recommended Previous</b>	Basic knowledge in:			
Knowledge	Mathematics			
	Mechanics			
	Thermodynamics			
	Electrical Engineering			
	Fluid mechanics			
Educational Objections	After the literary many transport of the second of the sec	black-Hamilton I amelian manufa		
Educational Objectives	After taking part successfully, students have reached	the following learning results		
Professional Competence	Chudanta ava abla ta			
Knowieage	Students are able to:			
	<ul> <li>Assess challenges during the design of aircraft</li> </ul>	energy systems		
	Describe essential components and design poir	ts of hydraulic and electrical supply sys	stems	
	Give an overview of the functionality of air cond	litioning systems		
	Describe different system concepts for de-icing			
	Identify constraints for the electrification of airce      Describe architecture for fuel cumply authors.		ncepts and limita	tions
	Describe architectures for fuel supply systems a     Explain possible approaches for the integration	- ·	omission consont	
	Explain possible approaches for the integration	of fuel cell systems and evaluate zero-	emission concept	.5
Skills	Students are able to:			
	Design hydraulic and electric supply systems of	aircrafts		
	Analyze the thermodynamic behavior of air con			
	Design ice protection systems			
	Apply possible electrification concepts to existing	ng aircraft systems		
	Design fuel supply systems			
	<ul> <li>Perform the design of a fuel cell system</li> </ul>			
Borconal Compatonco				
Personal Competence	Students are able to:			
30Clai Competence	Students are able to.			
	<ul> <li>Perform system design in groups and present a</li> </ul>	nd discuss results		
	Present systems engineering problems and disc	cuss solutions with experts		
Autonomy	Students are able to:			
	Deflect on the content of lectures cutonomical			
	<ul> <li>Reflect on the content of lectures autonomously</li> <li>Apply methods learned in the course of exercis</li> </ul>			
	Identify complex system dependencies autonor	•	nd design proces	sses
	,			
Workload in Hours	Independent Study Time 110, Study Time in Lecture 7	0		
Credit points	6			
Course achievement	None			
Examination	Written exam			
Examination duration and	165 Minutes			
scale				
Assignment for the	Energy Systems: Specialisation Energy Systems: Elect	' '		
Following Curricula	Aircraft Systems Engineering: Core Qualification: Com		oulcon.	
	International Management and Engineering: Specialisa	ation ii. Aviation Systems: Elective Com	puisory	
	Aeronautics: Core Qualification: Compulsory Product Development, Materials and Production: Spec	ialisation Product Development: Floctive	- Compulsory	
	Product Development, Materials and Production: Spec	·		
	Product Development, Materials and Production: Spec			
	Theoretical Mechanical Engineering: Specialisation Air	·		
		, , , , , , , , , , , , , , , , , , ,	,,	

Course L0735: Aircraft Energ	y Systems
Тур	Lecture
Hrs/wk	3
СР	4
Workload in Hours	Independent Study Time 78, Study Time in Lecture 42
Lecturer	Prof. Frank Thielecke
Language	DE
Cycle	WiSe
Content	<ul> <li>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)</li> <li>Electric Energy Systems (Generators; constant-speed-drives; DC and AC converters; electrical power distribution; bus systems; monitoring; load analysis)</li> <li>High Lift Systems (Principles; investigation of loads and system actuation power; principles and sizing of actuation and positioning systems; safety requirements and devices)</li> <li>Environmental Control Systems (Thermodynamic analysis; expansion and compression cooling systems; control strategies; cabin pressure control systems)</li> </ul>
Literature	<ul> <li>Moir, Seabridge: Aircraft Systems</li> <li>Green: Aircraft Hydraulic Systems</li> <li>Torenbek: Synthesis of Subsonic Airplane Design</li> <li>SAE1991: ARP; Air Conditioning Systems for Subsonic Airplanes</li> </ul>

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

Module M1024: Metho	ods of Product Development			
Courses				
Title		Тур	Hrs/wk	СР
Methods of Product Development (	L1254)	Lecture	3	3
Methods of Product Development (	L1255)	Project-/problem-based Learning	2	3
Module Responsible	Prof. Dieter Krause			
Admission Requirements	None			
<b>Recommended Previous</b>	Basic knowledge of Integrated product development and	applying CAE systems		
Knowledge				
<b>Educational Objectives</b>	After taking part successfully, students have reached the	e following learning results		
Professional Competence				
Knowledge	After passing the module students are able to:			
	explain technical terms of design methodology,			
	describe essential elements of construction mana			
	<ul> <li>describe current problems and the current state of</li> </ul>	r research of integrated product develop	ment.	
Skills	After passing the module students are able to:			
	select and apply proper construction methods fo	r non-standardized solutions of problem	is as well as a	adapt new bounda
	conditions,			
	solve product development problems with the ass			
	choose and execute appropriate moderation technique.	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,			
	<ul> <li>represent problems and solutions and advance identifications.</li> </ul>	eas.		
Autonomy	After passing the module students are able to:			
	give a structured feedback and accept a critical fe	edback,		
	<ul> <li>implement the accepted feedback autonomous.</li> </ul>			
Workload in Hours	Independent Study Time 110, Study Time in Lecture 70			
Credit points	6			
Course achievement				
Examination				
Examination duration and	30 Minuten			
scale	50 Pilliatell			
Assignment for the	Aircraft Systems Engineering: Core Qualification: Elective	Compulsory		
Following Curricula	International Management and Engineering: Specialisation		an: Elective Co	mpulcory
Following Curricula	Aeronautics: Core Qualification: Elective Compulsory	on in Froduct Development and Froduction	JII. LIECTIVE CO	лприізої ў
	Mechatronics: Specialisation System Design: Elective Co	mpulsory		
	Mechatronics: Specialisation System Design: Elective Co Mechatronics: Core Qualification: Elective Compulsory	привогу		
	Product Development, Materials and Production: Special	sation Product Development: Compulsor	7/	
	Product Development, Materials and Production: Special	·	J	
	Product Development, Materials and Production: Special			
	Theoretical Mechanical Engineering: Specialisation Production		e Compulsory	
		act bevelopment and Froduction. Liectiv	c compulsory	

Course L1254: Methods of Pr	roduct Development
	Lecture
Hrs/wk	
CP	
Language	
Cycle	
Content	The lecture extends and enhances the learned content of the module "Integrated Product Development and lightweight design" and is based on the knowledge and skills acquired there.  Topics of the course include in particular:  Methods of product development, Presentation techniques, Industrial Design, Design for variety Modularization methods, Design catalogs, Adapted QFD matrix, Systematic material selection, Assembly oriented design,  Construction management CE mark, declaration of conformity including risk assessment, Patents, patent rights, patent monitoring Project management (cost, time, quality) and escalation principles, Development management for mechatronics, Technical Supply Chain Management.  Exercise (PBL)  In the exercise the content presented in the lecture "Integrated Product Development II" and methods of product development and design management will be enhanced.
	Students learn an independently moderated and workshop based approach through industry related practice examples to 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	<ul> <li>Andreasen, M.M., Design for Assembly, Berlin, Springer 1985.</li> <li>Ashby, M. F.: Materials Selection in Mechanical Design, München, Spektrum 2007.</li> <li>Beckmann, H.: Supply Chain Management, Berlin, Springer 2004.</li> <li>Hartmann, M., Rieger, M., Funk, R., Rath, U.: Zielgerichtet moderieren. Ein Handbuch für Führungskräfte, Berater und Trainer, Weinheim, Beltz 2007.</li> <li>Pahl, G., Beitz, W.: Konstruktionslehre, Berlin, Springer 2006.</li> <li>Roth, K.H.: Konstruieren mit Konstruktionskatalogen, Band 1-3, Berlin, Springer 2000.</li> <li>Simpson, T.W., Siddique, Z., Jiao, R.J.: Product Platform and Product Family Design. Methods and Applications, New York,</li> </ul>

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

Springer 2013.

Module M1025: Fluidi	cs			
Courses				
Title Fluidics (L1256) Fluidics (L1371)		Typ Lecture Project-/problem-based Learning	Hrs/wk 2 1	<b>CP</b> 3 2
Fluidics (L1257)		Recitation Section (large)	1	1
Module Responsible	Prof. Dieter Krause			
	None  Good knowledge of mechanics (stereo statics, elastostal engineering design	tics, hydrostatics, kinematics and	kinetics), flu	id mechanics, and
Educational Objectives	After taking part successfully, students have reached the follo	owing learning results		
Professional Competence Knowledge	After passing the module students are able to  explain structures and functionalities of hydrostatic, pr explain the interaction of hydraulic components in hyd explain open and closed loop control of hydraulic syste describe functioning and applications of hydrodynamic and aggregates in plant technology	Iraulic systems, ems,		s centrifugal pumps
Skills	After passing the module students are able to  • analyse and assess hydraulic and pneumatic compone  • design and dimension hydraulic systems for mechanical  • perform numerical simulations of hydraulic systems ba  • select and adapt pump characteristic curves for hydraul  • dimension hydrodynamic torque converters and brakes	al applications, ased on abstract problem definitions ulic systems	i.	
Personal Competence Social Competence	After passing the module students are able to  discuss and present functional context in groups,  organise teamwork autonomously.			
Autonomy	After passing the module students are able to  obtain necessary knowledge for the simulation.			
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56			
Credit points	6			
Course achievement		n hydrostatischer Systeme		
Examination	Written exam	*		
Examination duration and scale  Assignment for the Following Curricula	International Management and Engineering: Specialisation II. International Management and Engineering: Specialisation II. Product Development, Materials and Production: Specialisation	Product Development and Production Product Development: Compulsor	on: Elective Co	mpulsory
	Product Development, Materials and Production: Specialisation Product Development, Materials and Production: Specialisation Theoretical Mechanical Engineering: Specialisation Product Development	on Materials: Elective Compulsory	e Compulsory	

Production"	
Course L1256: Fluidics	
Тур	Lecture
Hrs/wk	2
СР	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
	Prof. Dieter Krause
Language	
Cycle	
Content	Lecture
	Hydrostatics
	physical fundamentals
	hydraulic fluids
	hydrostatic machines     .
	• valves
	• components
	hydrostatic transmissions
	examples from industry
	Pneumatics
	generation of compressed air
	pneumatic motors
	Examples of use
	Hydrodynamics
	- Type of the state of the stat
	physical fundamentals
	hydraulic continous-flow machines
	hydrodynamic transmissions
	interoperation of motor and transmission
	Exercise
	Exercise
	Hydrostatics
	a reading and decian of hydraulic diagrams
	<ul> <li>reading and design of hydraulic diagrams</li> <li>dimensioning of hydrostatic traction and working drives</li> </ul>
	performance calculation
	• performance calculation
	Hydrodynamics
	a laulation / dimensioning of budged unancia to some
	calculation / dimensioning of hydrodynamic torque converters
	calculation / dimensioning of centrifugal pumps
	creating and reading of characteristic curves of pumps and systems
	Field trip
	field trip to a regional company from the hydraulic industry.
	Exercise
	Numerical simulation of hydrostatic systems
	getting to know a numerical simulation environment for hydraulic systems
	transformation of a task into a simulation model
	simulation of common components
	variation of simulation parameters
	using simulations for system dimensioning and optimisation
	(partly) self-organised teamwork
Literature	Bücher
Literature	
	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
	Surpe Late 10 (100m)

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	

Module M1193: Cabin	Systems Engineering				
Courses					
Title			Тур	Hrs/wk	CP
	nnology in cabin electronics and avionics (L1557)		Lecture	2	2
	nnology in cabin electronics and avionics (L1558)		Recitation Section (small)	1	1
Model-Based Systems Engineering			Project-/problem-based Learning	3	3
Module Responsible					
Admission Requirements					
Recommended Previous					
Knowledge					
	Mechanics     Thermodynamics				
	Electrical Engineering				
	Control Systems				
	- Control Systems				
	Previous knowledge in:				
	Systems Engineering				
Educational Objectives	After taking part successfully students have reach	ad the following	na loarnina roculto		
Educational Objectives Professional Competence	After taking part successfully, students have reach	eu trie IUIIUWII	ig learning results		
•	Students are able to:				
Kriowieage	Students are able to:  • describe the structure and operation of computer	architectures			
	explain the structure and operation of digital compared to the structure and operation of digital compa				
	explain the structure and operation of digital con     explain architectures of cabin electronics, integra			Communication	on Notwork (ADCN)
	understand the approach of Model-Based System				
	systems	ens Engineen	ing (MB3E) in the design of ha	iuwaie aliu s	ortware-based cabii
	systems				
Skills	Students are able to:				
	• understand, operate and maintain a Minicompute	er			
	build up a network communication and communication	cate with othe	er network participants		
	connect a minicomputer with a cabin manageme	nt system (A3	80 CIDS) and communicate over	a AFDX®-Ne	twork
	model system functions by means of formal lange	uages SysML/l	JML and generate software code	from the mo	dels
	execute software code on a minicomputer				
Personal Competence					
	Students are able to:				
bocial competence	form teams of two or small groups for the practic	al work			
	work out partial results themselves and combine		ners to form an overall solution		
	represent and contribute their own solution				
	take over the guidance of the team				
	contribute in the team				
Autonomy					
	organize and plan their practical tasks				
	further develop their own skills				
	take their own initiative				
	explore their own new ways of solving problems				
Workload in Hours	Independent Study Time 96, Study Time in Lecture	84			
Credit points	6				
Course achievement	None				
Examination	Written exam				
Examination duration and	120 minutes				
scale					
Assignment for the	Aircraft Systems Engineering: Core Qualification: E	lective Compu	llsory		
Following Curricula	International Management and Engineering: Specia	lisation II. Avi	ation Systems: Elective Compul:	sory	
	Aeronautics: Core Qualification: Elective Compulsor	ry			
	Product Development, Materials and Production: Sp	ecialisation P	roduct Development: Elective C	ompulsory	
	Product Development, Materials and Production: Sp	ecialisation P	roduction: Elective Compulsory		
	Product Development, Materials and Production: Sp	pecialisation M	laterials: Elective Compulsory		

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

	communication technology in cabin electronics and avionics
Тур	Recitation Section (small)
Hrs/wk	1
CP 1	1
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14
Lecturer	Prof. Ralf God
Language [	DE
Cycle \	WiSe
t	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.
į.	The course teaches the basics of design and functionality of computers and data networks. Subsequently it focuses on curren 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
- F -	- Schnabel, P.: Computertechnik-Fibel: Grundlagen Computertechnik, Mikroprozessortechnik, Halbleiterspeicher, Schnittstellen un Peripherie. Books on Demand; 1. Auflage, 2003  - Schnabel, P.: Netzwerktechnik-Fibel: Grundlagen, Übertragungstechnik und Protokolle, Anwendungen und Dienste, Sicherhei Books on Demand; 1. Auflage, 2004  - Wüst, K.: Mikroprozessortechnik: Grundlagen, Architekturen und Programmierung von Mikroprozessoren, Mikrocontrollern un Signalprozessoren. Vieweg Verlag; 2. aktualisierte und erweiterte Auflage, 2006

Course L1551: Model-Based	Systems Engineering (MBSE) with SysML/UML
Тур	Project-/problem-based Learning
Hrs/wk	3
CP	3
Workload in Hours	Independent Study Time 48, Study Time in Lecture 42
Lecturer	Prof. Ralf God
Language	DE
Cycle	SoSe SoSe
Content	Objectives of the problem-oriented course are the acquisition of knowledge on system design using the formal languages
	SysML/UML, learning about tools for modeling and finally the implementation of a project with methods and tools of Model-Based
	Systems Engineering (MBSE) on a realistic hardware platform (e.g. Arduino®, Raspberry Pi®):
	What is a model?
	What is Systems Engineering?
	Survey of MBSE methodologies
	The modelling languages SysML /UML
	Tools for MBSE
	Best practices for MBSE
	Requirements specification, functional architecture, specification of a solution
	From model to software code
	Validation and verification: XiL methods
	Accompanying MBSE project
Literature	- Skript zur Vorlesung
	- Weilkiens, T.: Systems Engineering mit SysML/UML: Modellierung, Analyse, Design. 2. Auflage, dpunkt.Verlag, 2008
	- Holt, J., Perry, S.A., Brownsword, M.: Model-Based Requirements Engineering. Institution Engineering & Tech, 2011

Module M0812: Aircra	oft Design I (Civ	/il Aircraft Des	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	5 1 1 11 1	_				
Knowledge	Bachelor Mech	3				
	<ul><li>Bachelor Traffi</li><li>Vordiplom Med</li></ul>	-				
	Module Air Tra	-				
	• Module All Tra	nisport systems				
<b>Educational Objectives</b>	After taking part succ	essfully, students ha	ave reached the following	ng learning results		
<b>Professional Competence</b>						
Knowledge	1 Principle under	rstanding of integrate	ed and civil aircraft des	ian		
			and contributions of the	-		
	-		meter on the civil aircra	·		
	·	the principle design		are design		
		ppg				
Skills	Understanding and a	pplication of design a	and calculation method	S		
	Understanding of inte	erdisciplinary and inte	egrative interdependen	ncies		
Personal Competence						
-	Working in interdiscip	olinary teams				
,						
	Communication					
Autonomy	Organization of works	lows and -strategies				
Workload in Hours	Independent Study Ti	me 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 Verkehrsflug	zeug
	Written exam					
Examination duration and	180 min					
scale						
-	Aircraft Systems Engi	-				
Following Curricula	-			ation Systems: Elective Com	pulsory	
	Aeronautics: Core Qu		-			
	·		·	roduct Development: Electiv		
	·			roduction: Elective Compuls	-	
	i neoreticai Mechanic	ai Engineering: Spec	ialisation Aircraft Syste	ms Engineering: Elective Co	mpulsory	

Course L0820: Aircraft Desig	n I (Design of Transport Aircraft)
Тур	Lecture
Hrs/wk	3
СР	3
Workload in Hours	Independent Study Time 48, Study Time in Lecture 42
Lecturer	Prof. Volker Gollnick, Jens Thöben
Language	DE
Cycle	WiSe
Content	Introduction into the aircraft design process
	Introduction/process of aircraft design/various aircraft configurations     Requirements and design objectives, main design parameter (u.a. payload-range-diagramme)
	Statistical methods in overall aircraft design/data base methods
	4. Cabin design (fuselage sizing, cabin interior, loading systems)  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"  J.P. Fielding: "Introduction to Aircraft Design"
	Jenkinson, Simpkon, Rhods: "Civil Jet Aircraft Design"

Course L0834: Aircraft Desig	n 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 Med	dicine			
Courses					
Title		Ту	р	Hrs/wk	СР
Robotics and Navigation in Medicir	ie (L0335)	Lec	ture	2	3
Robotics and Navigation in Medicir	ie (L0338)	Pro	ject Seminar	2	2
Robotics and Navigation in Medicir	ie (L0336)	Red	citation Section (small)	1	1
Module Responsible	Prof. Alexander Schlaefer				
Admission Requirements	None				
Recommended Previous					
Knowledge	<ul> <li>principles of math (algebra, an</li> </ul>	alysis/calculus)			
	<ul><li>principles of programming, e.g</li><li>solid R or Matlab skills</li></ul>	., in Java or C++			
Educational Objectives	After taking part successfully, studen	ts have reached the following le	earning results		
Professional Competence					
Knowledge	The students can explain kinematics	and tracking systems in clin	ical contexts and illustr	ate systems and	their components in
	detail. Systems can be evaluated w	ith respect to collision detecti	on and safety and reg	ulations. Students	can assess typical
	systems regarding design and limital				
Skills	The students are able to design and e	valuate navigation systems an	d robotic systems for me	edical applications	
Personal Competence					
Social Competence	The students are able to grasp prac	tical tasks in groups, develop	solution strategies inde	pendently, define	work processes and
	work on them collaboratively.				
	The students are able to collaborative	vely organize their work proce	sses and software solut	ions using virtual	communication and
	software management tools.				
	The students can critically reflect of	n the results of other groups	, make constructive su	ggestions for imp	rovement, and also
	incorporate them into their own work				
Autonomy	The students can assess their level	of knowledge and independen	ntly control their learning	na processes on t	his basis as well as
	document their work results. They ca				
	manner to the other groups.	,	p		
	manner to the other groups.				
Workload in Hours	Independent Study Time 110, Study	ime in Lecture 70			
Credit points	t	Description			
Course achievement	Yes 10 % Written elabor				
	Yes 10 % Presentation	acion			
Evamination	Written exam				
Examination duration and					
scale	Computer Science: Specialisation II: I	atolligonco Enginocrina: Electiv	o Compulsor:		
•	· ·	3 3 3	e Compuisory		
Following Curricula	Data Science: Specialisation III. Applic		son		
	Data Calanga, Canadaligation IV Canada	ai Focus Area: Elective Compui	Sory		
	Data Science: Specialisation IV. Specialisation	Modical Tochnology: Flactive C	ompulcor;		
	Electrical Engineering: Specialisation				
	Electrical Engineering: Specialisation Computer Science in Engineering: Sp	ecialisation II. Engineering Scie	nce: Elective Compulsory		
	Electrical Engineering: Specialisation Computer Science in Engineering: Sp International Management and Engineering	ecialisation II. Engineering Scienteering: Specialisation II. Electric	nce: Elective Compulsory	Compulsory	Constitution
	Electrical Engineering: Specialisation Computer Science in Engineering: Sp International Management and Engin International Management and Engin	ecialisation II. Engineering Scie eering: Specialisation II. Electric eering: Specialisation II. Proces:	nce: Elective Compulsory	Compulsory	Compulsory
	Electrical Engineering: Specialisation Computer Science in Engineering: Sp International Management and Engin International Management and Engin Mechatronics: Core Qualification: Elec	ecialisation II. Engineering Scie eering: Specialisation II. Electric eering: Specialisation II. Process tive Compulsory	nce: Elective Compulsory cal Engineering: Elective s Engineering and Biotec	Compulsory hnology: Elective	Compulsory
	Electrical Engineering: Specialisation Computer Science in Engineering: Sp International Management and Engin International Management and Engin Mechatronics: Core Qualification: Elec Biomedical Engineering: Specialisatio	ecialisation II. Engineering Scie eering: Specialisation II. Electric eering: Specialisation II. Proces tive Compulsory n Artificial Organs and Regener	nce: Elective Compulson cal Engineering: Elective s Engineering and Biotec rative Medicine: Elective	Compulsory hnology: Elective	Compulsory
	Electrical Engineering: Specialisation Computer Science in Engineering: Sp International Management and Engin International Management and Engin Mechatronics: Core Qualification: Elec Biomedical Engineering: Specialisatio Biomedical Engineering: Specialisatio	ecialisation II. Engineering Scie eering: Specialisation II. Electric eering: Specialisation II. Process tive Compulsory n Artificial Organs and Regener n Implants and Endoprostheses	nce: Elective Compulsory cal Engineering: Elective s Engineering and Biotec rative Medicine: Elective s: Elective Compulsory	Compulsory hnology: Elective Compulsory	Compulsory
	Electrical Engineering: Specialisation Computer Science in Engineering: Sp International Management and Engin International Management and Engin Mechatronics: Core Qualification: Elec Biomedical Engineering: Specialisatio Biomedical Engineering: Specialisatio Biomedical Engineering: Specialisatio	ecialisation II. Engineering Scie eering: Specialisation II. Electric eering: Specialisation II. Process titive Compulsory n Artificial Organs and Regener n Implants and Endoprostheses n Medical Technology and Cont	nce: Elective Compulsory cal Engineering: Elective is Engineering and Biotec rative Medicine: Elective is: Elective Compulsory crol Theory: Elective Com	Compulsory hnology: Elective Compulsory	Compulsory
	Electrical Engineering: Specialisation Computer Science in Engineering: Sp International Management and Engin International Management and Engin Mechatronics: Core Qualification: Elec Biomedical Engineering: Specialisatio	ecialisation II. Engineering Scie eering: Specialisation II. Electric eering: Specialisation II. Process titive Compulsory n Artificial Organs and Regener n Implants and Endoprostheses n Medical Technology and Cont n Management and Business An	nce: Elective Compulsory cal Engineering: Elective is Engineering and Biotec rative Medicine: Elective is: Elective Compulsory crol Theory: Elective Com dministration: Elective C	Compulsory Innology: Elective Compulsory Ipulsory Inpulsory Inpulsory	Compulsory
	Electrical Engineering: Specialisation Computer Science in Engineering: Sp International Management and Engin International Management and Engin Mechatronics: Core Qualification: Elec Biomedical Engineering: Specialisatio Biomedical Engineering: Specialisatio Biomedical Engineering: Specialisatio	ecialisation II. Engineering Scie eering: Specialisation II. Electric eering: Specialisation II. Process titive Compulsory n Artificial Organs and Regener n Implants and Endoprostheses n Medical Technology and Cont n Management and Business An	nce: Elective Compulsory cal Engineering: Elective is Engineering and Biotec rative Medicine: Elective is: Elective Compulsory crol Theory: Elective Com dministration: Elective C	Compulsory Innology: Elective Compulsory Ipulsory Inpulsory Inpulsory	Compulsory
	Electrical Engineering: Specialisation Computer Science in Engineering: Sp. International Management and Engin International Management and Engin Mechatronics: Core Qualification: Elect Biomedical Engineering: Specialisation Product Development, Materials and Product Development, Materials and	ecialisation II. Engineering Sciencering: Specialisation II. Electriceering: Specialisation II. Processitive Compulsory  In Artificial Organs and Regener  In Implants and Endoprostheses  In Medical Technology and Cont  In Management and Business Approduction: Specialisation Production:	nce: Elective Compulsory cal Engineering: Elective s Engineering and Biotec rative Medicine: Elective s: Elective Compulsory crol Theory: Elective Com dministration: Elective C uct Development: Elective uction: Elective Compuls	Compulsory Inhnology: Elective Compulsory Inpulsory	Compulsory
	Electrical Engineering: Specialisation Computer Science in Engineering: Sp International Management and Engin International Management and Engin Mechatronics: Core Qualification: Elec Biomedical Engineering: Specialisatio Product Development, Materials and	ecialisation II. Engineering Sciencering: Specialisation II. Electriceering: Specialisation II. Processitive Compulsory  In Artificial Organs and Regener  In Implants and Endoprostheses  In Medical Technology and Cont  In Management and Business Approduction: Specialisation Production:	nce: Elective Compulsory cal Engineering: Elective s Engineering and Biotec rative Medicine: Elective s: Elective Compulsory crol Theory: Elective Com dministration: Elective C uct Development: Elective uction: Elective Compuls	Compulsory Inhnology: Elective Compulsory Inpulsory	Compulsory

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

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

Course L0336: Robotics and	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		

Madula MOZGA: Flight	t Control Systems			
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	mathematics			
	mechanics			
	thermo dynamics			
	electronics			
	fluid mechanics			
	control theory			
	After taking part successfully, students have reached the	le following learning results		
Professional Competence				
Knowieage	Students are able to			
	describe the structure and the functioning of pri	mary 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	ructure of landing gears and landing g	ear systems	
	explain different configurations and designs and	their origins		
Skills	Students are able to			
S.K.II.S	Stadenia 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			
B				
Personal Competence	Students are able to:			
Social Competence	Students are able to:			
	<ul> <li>Develop joint solutions in mixed teams</li> </ul>			
	Present and explain developed solutions in front	of other students		
	Discuss developed solutions with experts			
Autonomy	Students are able to:			
riaconomy				
	derive requirements and perform appropriate ye	t simplified design processes for aircr	raft systems fron	n complex issues and
	circumstances in a self-reliant manner			
	apply new skills and methods in the context of explanation.	kercises in a self-reliant manner		
Workload in Hours	Independent Study Time 110, Study Time in Lecture 70			
Credit points	6			
Course achievement	None			
Examination	Written exam			
Examination duration and	165 Minutes			
scale				
Assignment for the	Aircraft Systems Engineering: Core Qualification: Comp	ulsory	<u></u>	
Following Curricula	International Management and Engineering: Specialisat	ion II. Aviation Systems: Elective Com	pulsory	
	Aeronautics: Core Qualification: Compulsory			
	Product Development, Materials and Production: Specia	lisation Product Development: Elective	e Compulsory	
	Product Development, Materials and Production: Specia	lisation Production: Elective Compulso lisation Materials: Elective Compulsor	ory y	

Course L0736: Flight Control	Systems
Тур	Lecture
Hrs/wk	3
СР	4
Workload in Hours	Independent Study Time 78, Study Time in Lecture 42
Lecturer	Prof. Frank Thielecke
Language	DE
Cycle	SoSe SoSe
Content	<ul> <li>Actuation (Principles of actuators; electro-mechanical actuators; modeling, analysis and sizing of position control systems; hydro-mechanic actuation systems)</li> <li>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)</li> <li>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)</li> <li>Fuel Systems (Architectures; aviation fuels; system components; fueling system; tank inerting system; fuel management; trim tank)</li> <li>De- and Anti-Ice Systems: (Atmospheric icing conditions; principles of de- and anti-ice systems)</li> </ul>
Literature	<ul> <li>Moir, Seabridge: Aircraft Systems</li> <li>Torenbek: Synthesis of Subsonic Airplane Design</li> <li>Curry: Aircraft Landing Gear Design: Principles and Practices</li> </ul>

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

Module M0811: Medic	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	
<b>Educational Objectives</b>	After taking part successfully, students have reached the following learning results
<b>Professional Competence</b>	
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:
	<ul> <li>Explain the physical processes of images and assign to the systems the basic mathematical or physical equations required</li> <li>Calculate the parameters of imaging systems using the mathematical or physical equations;</li> <li>Determine the influence of different system components on the spatial and temporal resolution of imaging systems</li> <li>Explain the importance of different imaging systems for a number of clinical applications;</li> </ul>
	Select a suitable imaging system for an application.
Personal Competence	
Social Competence	none
Autonomy	Students can:
	Understand which physical effects are used in medical imaging;
	Decide independently for which clinical issue a measuring system can be used.
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56
Credit points	
Course achievement	
Examination	Written exam
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 M1141: Selected Topics of Product Development, Materials Science and Production (Alternative A: 12 LP)

Courses				
Title		Тур	Hrs/wk	СР
Applied Automation (L1592)		Project-/problem-based Learning	3	3
Advanced Training Course SE-ZERT (L2739)		Project-/problem-based Learning	2	3
Elements of Integrated Production Systems (L0927)		Project-/problem-based Learning	2	3
Development Management for Med	chatronics (L1512)	Lecture	2	3
Fatigue & Damage Tolerance (L03	10)	Lecture	2	3
GSD - Generational Sheet-Metal De	evelopment (L3064)	Lecture	3	3
Industry 4.0 for Engineers (L2012)		Lecture	2	3
Innovation and Product Manageme	nt (L2168)	Seminar	2	3
Lightweight Design Practical Cours	e (L1258)	Project-/problem-based Learning	3	3
Mechanisms and Systems of Mater	ials Testing - from the viewpoint of product development and Failure	Lecture	2	2
Analysis (L0950)				
Microsystems Technology (L0724)		Lecture	2	4
Sustainable Industrial Production (	_2863)	Lecture	2	4
Productivity Management (L0928)		Project-/problem-based Learning	2	2
Productivity Management (L0931)		Recitation Section (small)	1	1
Feedback Control in Medical Techr	ology (L0664)	Lecture	2	3
Structural Mechanics of Fibre Rein		Lecture	2	3
Technical Design (L1513)		Lecture	2	3
=	oint of industrial application (L0949)	Lecture	2	2
Reliability in Engineering Dynamic		Lecture	2	2
Reliability in Engineering Dynamic		Recitation Section (small)	1	2
Reliability of Aircraft Systems (L07	49)	Lecture	2	3
Module Responsible	Prof. Dieter Krause			
Admission Requirements	None			
Recommended Previous	None			
Knowledge				
Educational Objectives	After taking part successfully, students have reached the follow	ring learning results		
Professional Competence	3,000	3 3		
•				
Knowledge	Students are able to express their extended knowledge	and discuss the connection of di	fferent specia	I fields or applicat
	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 eath other		
Skills				
	Students can apply specialized solution strategies and ne	ew scientific methods in selected	areas	
	Students are able to transfer learned skills to new and unknown problems and can develop own solution approaches			
Personal Competence				
Social Competence	-			
Social Competence Autonomy				
,	Students are able to develop their knowledge and skills be a student of the	oy autonomous election of course	S.	
	Students are able to develop their knowledge and skills to	oy autonomous election of course	s.	
Autonomy	Students are able to develop their knowledge and skills to  Depends on choice of courses	by autonomous election of course	S.	
Autonomy  Workload in Hours  Credit points	Students are able to develop their knowledge and skills be Depends on choice of courses			
Workload in Hours Credit points Assignment for the	Students are able to develop their knowledge and skills be Depends on choice of courses     12 Product Development, Materials and Production: Specialisation	Product Development: Elective Co		
Autonomy  Workload in Hours  Credit points	Students are able to develop their knowledge and skills because the pepends on choice of courses  12  Product Development, Materials and Production: Specialisation	Product Development: Elective Co		

Course L1592	2: Applied Automation
Тур	Project-/problem-based Learning
Hrs/wk	3
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 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	<ul> <li>Bender: Embedded Systems - qualitätsorientierte Entwicklung</li> <li>Ehrlenspiel: Integrierte Produktentwicklung: Denkabläufe, Methodeneinsatz, Zusammenarbeit</li> <li>Gausemeier/Ebbesmeyer/Kallmeyer: Produktinnovation - Strategische Planung und Entwicklung der Produkte von morgen</li> <li>Haberfellner/de Weck/Fricke/Vössner: Systems Engineering: Grundlagen und Anwendung</li> <li>Lindemann: Methodische Entwicklung technischer Produkte: Methoden flexibel und situationsgerecht anwenden</li> <li>Pahl/Beitz: Konstruktionslehre: Grundlagen erfolgreicher Produktentwicklung. Methoden und Anwendung</li> <li>VDI-Richtlinie 2206: Entwicklungsmethodik für mechatronische Systeme</li> </ul>

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

Course L3064: GSD - General	tional Sheet-Metal Development
Тур	Lecture
Hrs/wk	3
СР	3
Workload in Hours	Independent Study Time 48, Study Time in Lecture 42
Examination Form	Mündliche Prüfung
Examination duration and	30 min
scale	
Lecturer	Prof. Dr. Nikola Bursac
Language	DE
Cycle	WiSe
Content	Experience in mechanical engineering design and the fundamentals of manufacturing engineering
	After successful completion of the course, students will be able to explain development projects using the theory of product generation engineering and explain design rules for sheet metal development.
	After successful completion of the course, students will be able to apply the theory of product generation engineering to development tasks and develop sheet-metal products suitable for production.
	After successful completion of the course, students will be able to develop a product in a team and to compete against other teams.
	After successful completion of the course, students will be able to independently access knowledge required for sheet metal development.
Literature	

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

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

	sign Practical Course
Typ Pro	roject-/problem-based Learning
Hrs/wk 3	
<b>CP</b> 3	
Workload in Hours Ind	dependent Study Time 48, Study Time in Lecture 42
Examination Form Mü	ündliche Prüfung
Examination duration and 30	0 min
scale	
<b>Lecturer</b> Pro	rof. Dieter Krause
<b>Language</b> DE	E/EN
Cycle So:	oSe
Content De	evelopment of a sandwich structure made of fibre reinforced plastics
Literature	<ul> <li>getting familiar with fibre reinforced plastics as well as lightweight design</li> <li>Design of a sandwich structure made of fibre reinforced plastics using finite element analysis (FEA)</li> <li>Determination of material properties based on sample tests</li> <li>manufacturing of the structure in the composite lab</li> <li>Testing of the developed structure</li> <li>Concept presentation</li> <li>Self-organised teamwork</li> <li>Schürmann, H., "Konstruieren mit Faser-Kunststoff-Verbunden", Springer, Berlin, 2005.</li> <li>Puck, A., "Festigkeitsanalsyse von Faser-Matrix-Laminaten", Hanser, München, Wien, 1996.</li> <li>R&amp;G, "Handbuch Faserverbundwerkstoffe", Waldenbuch, 2009.</li> <li>VDI 2014 "Entwicklung von Bauteilen aus Faser-Kunststoff-Verbund"</li> <li>Ehrenstein, G. W., "Faserverbundkunststoffe", Hanser, München, 2006.</li> <li>Klein, B., "Leichtbau-Konstruktion", Vieweg &amp; Sohn, Braunschweig, 1989.</li> <li>Wiedemann, J., "Leichtbau Band 1: Elemente", Springer, Berlin, Heidelberg, 1986.</li> <li>Wiedemann, B.F., "Composite Structures, Design, Safety and Innovation", Oxford (UK), Elsevier, 2005.</li> <li>Krause, D., "Leichtbau", In: Handbuch Konstruktion, Hrsg.: Rieg, F., Steinhilper, R., München, Carl Hanser Verlag, 2012.</li> </ul>

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

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	<ul> <li>Introduction (historical view, scientific and economic relevance, scaling laws)</li> <li>Semiconductor Technology Basics, Lithography (wafer fabrication, photolithography, improving resolution, next-generation lithography, nano-imprinting, molecular imprinting)</li> <li>Deposition Techniques (thermal oxidation, epitaxy, electroplating, PVD techniques: evaporation and sputtering; CVD techniques: APCVD, LPCVD, PECVD and LECVD; screen printing)</li> <li>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)</li> <li>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)</li> <li>Thermal and Radiation Sensors (temperature measurement, self-generating sensors: Seabeck effect and thermopile; modulating sensors: stemmor resistor, Pt-100, spreading resistance sensor, pn junction, NTC and PTC; thermal anemometer, mass flow sensor; (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;</li> <li>Magnetic Sensors (galvanomagnetic sensors: spinning current Hall sensor and magneto-transistor; magnetoresistive sensors: magneto resistance, AMR and GMR, fluxgate magnetometer)</li> <li>Chemical and Bio Sensors (thermal gas sensors: pellistor and thermal conductivity sensor; metal oxide semiconductor gas sensor, cambda probe, MOSFET gas sensor, principle of biosensor, Clark electrode, enzyme electrode, DNA chip)</li></ul>
	and silicon fusion bonding; micro electroplating, 3D-MID)
Literature	M. Madou: Fundamentals of Microfabrication, CRC Press, 2002  N. Schwesinger: Lehrbuch Mikrosystemtechnik, Oldenbourg Verlag, 2009
	T. M. Adams, R. A. Layton:Introductory MEMS, Springer, 2010
	G. Gerlach; W. Dötzel: Introduction to microsystem technology, Wiley, 2008

Course L2863: Sustainable Industrial 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 of products. For this, the following topics will be highlighted:  - Motivation for sustainable production, the 17 Sustainable Development Goals (SDGs) of the UN and their relevance for tomorrow's manufacturing;  - raw material vs. production phase vs. use phase vs. recycling/end-of-life phase: importance of the production phase for the environmental impact of manufactured products;  - Typical energy- and resource-intensive processes in industrial production and innovative approaches to increase energy and resource efficiency;  - Methodology for optimizing the energy and resource efficiency of industrial manufacturing chains with the three steps of modeling (1), evaluating (2) and improving (3);  - Resource efficiency of industrial manufacturing pr
	- Exercise: LCA analysis of a manufacturing process (thermoplastic joining of an aircraft fuselage segment) as part of a product li 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	
scale	
Lecturer	
Language	
Cycle	
Content	<ul> <li>Principles of productivity management</li> <li>Shop floor management and standardisation</li> <li>Takt analysis and design of manual operations</li> <li>Maintenance Principles</li> <li>Total Productive Maintenance (TPM)</li> <li>Optimisation of set-up operations</li> <li>Analysis of interlinked production systems</li> </ul>
Literature	Bokranz, R.; Landau, K.:Produktivitätsmanagement von Arbeitssystemen. Schäffer-Poeschel, Stuttgart, 2006.  Takeda, H.: Das synchrone Produktionssystem: Just-in-Time für das ganze Unternehmen. 5. Aufl., mi-Wirtschaftsbuch, FinanzBuch Verlag, München, 2006.  Nakajima, S.: Management der Produktionseinrichtungen (Total Productive Maintenance). Campus Verlag, New York, 1995.  Shingo, S.: A Revolution in Manufacturing: The SMED System. Productivity, Inc., 1985

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

Course L0664: Feedback Control in Medical Technology	
Тур	Lecture
Hrs/wk	2
СР	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Examination Form	Mündliche Prüfung
Examination duration and	20 min
scale	
Lecturer	Johannes Kreuzer, Christian Neuhaus
Language	DE
Cycle	SoSe
Content	Always viewed from the engineer's point of view, the lecture is structured as follows:  Introduction to the topic Fundamentals of physiological modelling Introduction to Breathing and Ventilation Physiology and Pathology in Cardiology Introduction to the Regulation of Blood Glucose kidney function and renal replacement therapy Representation of the control technology on the concrete ventilator Excursion to a medical technology company  Techniques of modeling, simulation and controller development are discussed. In the models, simple equivalent block diagrams for physiological processes are derived and explained how sensors, controllers and actuators are operated. MATLAB and SIMULINK are used as development tools.
Literature	<ul> <li>Leonhardt, S., &amp; Walter, M. (2016). Medizintechnische Systeme. Berlin, Heidelberg: Springer Vieweg.</li> <li>Werner, J. (2005). Kooperative und autonome Systeme der Medizintechnik. München: Oldenbourg.</li> <li>Oczenski, W. (2017). Atmen: Atemhilfen; Atemphysiologie und Beatmungstechnik: Georg Thieme Verlag KG.</li> </ul>

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

Course L1513: Technical Design	
Тур	Lecture
Hrs/wk	2
СР	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Examination Form	Schriftliche Ausarbeitung

Lecturer	Prof. Werner Granzeier, Prof. Dieter Krause
Language	DE
Cycle	SoSe
Content	<ul> <li>Basics with analysis, concept, proposal drawings and sketches</li> <li>Samples from practice of technical industrial design</li> <li>Product concept with new ideas and package</li> <li>ID proposal with structural concept and external product ergonomics</li> <li>Visualisation and presentation of the overall concept</li> <li>Realization as individual case studies</li> </ul>
Literature	Literatur über technisches Produktdesign
	Technisches Rendering und Präsentation
	Zeichnen und perspektivisches Entwerfen
	Literaturhinweise
	What is Product Design ?
	Laura Slack
	RotoVision Schweiz 2006
	Product Design Now
	Design and Scetches
	CollinsDesign and maomao publications Spanien 2006
	Ronald B. Kemnitzer, Rendering With Markers - Definitive Techniques
	for Designers, Illustrators and Architects,
	Watson, Guptil Puplications,a division of Billboard Publications Inc.,
	New York 1983
	Creative Techniques
	DRAWING
	Barons Educational Series
	ISBN-13: 978-0-7641-6182-7
	Joseph Ungar, Rendering In Mixed Media - Techniques for Concept
	Presentation for Designers and Illustrators
	Watson-Guptil Publication a division of Billboard Publications Inc.,  New York 1985
	AIRWORLD
	Design und Architektur für die Flugreise
	Vitra Design Stiftung Weil am Rhein 2004
	Airline Design
	Perter Deslius Jacek Slaski te Neues 2005
	Technik und Sicherheit von Passagierflugzeugen
	Frank Littek
	Motorbuch Verlag 2003
	Jetliner Cabins
	Jennifer Coutts Clay
	Cs books England 2006
	BOEING Widebodies
	Michael Haenggi motorbooks international USA 2003
	form - Zeitschrift für Gestaltung, Verlag form GmbH,
	Hofgut Ober-Berrbach, 6104 Seeheim-Jugenheim
	(erscheint vierteljährlich, Verlag form GmbH )
	design report

Production	
	german magasin,
	(erscheint monatlich)
	md - möbel interior design, Konradin-Verlag
	Robert Kohlhammer GmbH, 7022 Leinfelden-Echterdingen
	(erscheint monatlich)
	CAR STYLING, Car Styling Publishing Co. 4-8-16-11F,
	Kitashinjuku, Shinjuku-ku, Tokio 160, Japan
	(erscheint vierteljährlich in japanischer und englischer Sprache, in Hamburg erhältlich bei: Overseas Courier Service Deutschland GmbH,
	Auto & Design,
	Corso Frabcia 161, 10139 Torino, Italia
	(erscheint vierteljährlich in italienischer und englischer Sprache alle zwei
	Monate , erhältlich am HBF Hamburg
	AERO International,
	Magazin für Zivilluftfahrt
	(erscheint monatlich)
	Aircraft interior international
	Engl. magasin for Aircraft cabin interior
	(erscheint 2 monatlich)
	aerotec
	Technik- und Branchenmagazin für die Luft- und Raumfahrtindustrie

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

Course L2994: Reliability in Engineering Dynamics		
Тур	Lecture	
Hrs/wk	2	
СР	2	
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28	
Examination Form	Klausur	
Examination duration and	90 min	
scale		
Lecturer	Dr. Eric Groß, Prof. Benedikt Kriegesmann	
Language	EN	
Cycle	SoSe	
Content	Method for calculation and testing of reliability of dynamic machine systems	
	Modeling	
	System identification	
	Simulation	
	Processing of measurement data	
	Damage accumulation	
	Test planning and execution	
Literature	Bertsche, B.: Reliability in Automotive and Mechanical Engineering. Springer, 2008. ISBN: 978-3-540-33969-4	
	Inman, Daniel J.: Engineering Vibration. Prentice Hall, 3rd Ed., 2007. ISBN-13: 978-0132281737	
	Dresig, H., Holzweißig, F.: Maschinendynamik, Springer Verlag, 9. Auflage, 2009. ISBN 3540876936.	
	VDA (Hg.): Zuverlässigkeitssicherung bei Automobilherstellern und Lieferanten. Band 3 Teil 2, 3. überarbeitete Auflage, 2004. ISSN 0943-9412	

Course L2995: Reliability in I	Engineering Dynamics
Тур	Recitation Section (small)
Hrs/wk	1
СР	2
Workload in Hours	Independent Study Time 46, Study Time in Lecture 14
Examination Form	Klausur
Examination duration and	90 min
scale	
Lecturer	Prof. Benedikt Kriegesmann, Dr. Eric Groß
Language	EN
Cycle	SoSe
Content	Method for calculation and testing of reliability of dynamic machine systems
	Modeling
	System identification
	Simulation
	Processing of measurement data
	Damage accumulation
	Test planning and execution
Literature	Bertsche, B.: Reliability in Automotive and Mechanical Engineering. Springer, 2008. ISBN: 978-3-540-33969-4
	Inman, Daniel J.: Engineering Vibration. Prentice Hall, 3rd Ed., 2007. ISBN-13: 978-0132281737
	Dresig, H., Holzweißig, F.: Maschinendynamik, Springer Verlag, 9. Auflage, 2009. ISBN 3540876936.
	VDA (Hg.): Zuverlässigkeitssicherung bei Automobilherstellern und Lieferanten. Band 3 Teil 2, 3. überarbeitete Auflage, 2004. ISSN 0943-9412

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

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	<ul> <li>Functions of reliability and safety (regulations, certification requirements)</li> <li>Basics methods of reliability analysis (FMEA, fault tree, functional hazard assessment)</li> <li>Reliability analysis of electrical and mechanical systems</li> </ul>	
Literature	<ul> <li>CS 25.1309</li> <li>SAE ARP 4754</li> <li>SAE ARP 4761</li> </ul>	

Production"				
Module M1156: Syste	ms Engineering			
ourses				
itle		Тур	Hrs/wk	СР
ystems Engineering (L1547)		Lecture	3	4
ystems Engineering (L1548)		Recitation Section (large)	1	2
Module Responsible	Prof. Ralf God			
Admission Requirements	None			
Recommended Previous	Basic knowledge in:			
Knowledge	Mathematics			
	Mechanics			
	Thermodynamics			
	Electrical Engineering			
	Control Systems			
	Previous knowledge in:			
	Aircraft Cabin Systems			
Educational Objectives	After taking part successfully, students have reache	ed the following learning results		
<b>Professional Competence</b>				
Knowledge	Students are able to:			
	<ul> <li>understand systems engineering process models,</li> </ul>		f complex System	าร
	describe innovation processes and the need for tell			
	explain the aircraft development process and the			
	explain the system development process, including the system development process.			
	identify environmental conditions and test proced			~ (MDDE)
	value the methodology of requirements-based en	gineering (RBE) and model-based requirer	nents engineering	J (MDKE)
Skills	Students are able to:			
	• plan the process for the development of complex	Systems		
	<ul> <li>organize the development phases and development</li> </ul>	ent Tasks		
	• assign required business activities and technical 1	Tasks		
	apply systems engineering methods and tools			
Personal Competence				
	Students are able to:			
•	<ul> <li>understand and accept their tasks within a development</li> </ul>	opment team		
	• be comfortable with their role their tasks within the	ne overall process		
	• understand and serve their suppliers and custome	ers in large projects		
	assume responsibility for people and technology i	in the development of safety-critical syste	ms	
A	Charles to a ship to			
Autonomy		with division of tasks		
	<ul> <li>interact and communicate in a development team</li> <li>independently research and identify certification</li> </ul>			
	formulate requirements on their own	specifications		
	create test plans on their own and accompany cel	rtification processes		
Workload in Hours	Independent Study Time 124, Study Time in Lecture	e 56		
Credit points	6			
Course achievement	None			
Examination	Written exam			
Examination duration and	120 Minutes			
scale				
Assignment for the	Aircraft Systems Engineering: Core Qualification: Co	ompulsory		
Following Curricula	International Management and Engineering: Specia	lisation II. Aviation Systems: Elective Com	pulsory	
	International Management and Engineering: Specia	lisation II. Product Development and Produ	uction: Elective Co	ompulsory
	Aeronautics: Core Qualification: Compulsory			
	Mechatronics: Core Qualification: Elective Compulso	•		
	Product Development, Materials and Production: Sp	·	-	
	Product Development, Materials and Production: Sp			
	Product Development, Materials and Production: Sp	·	-	
	Theoretical Mechanical Engineering: Specialisation	Aircraft Systems Engineering: Elective Cor	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 M1161: Turbo	omachinery			
Courses				
Title		Тур	Hrs/wk	CP
Turbomachines (L1562) Turbomachines (L1563)		Lecture Recitation Section (large)	3 1	4 2
Module Responsible	Prof. Markus Schatz	recitation becam (large)		_
Admission Requirements	None			
Recommended Previous	Technical Thermodynamics I, II, Fluid Dynamics, Heat Trans	sfer		
Knowledge	reconnect memory number 1, 1, 1, 1 and 2, 1 annes, medic mans			
Educational Objectives	After taking part successfully, students have reached the fo	ollowing learning results		
Professional Competence	5 p			
•	The students can			
	distinguish the physical phenomena of conversion of			
	understand the different mathematic modelling of tu	rbomachinery,		
	<ul> <li>calculate and evaluate turbomachinery.</li> </ul>			
Skills	The students are able to			
	- understand the physics of Turbomachinery,			
	- solve excersises self-consistent.			
Personal Competence				
Social Competence	The students are able to			
	<ul> <li>discuss in small groups and develop an approach.</li> </ul>			
Autonomy	The students are able to			
	<ul> <li>develop a complex problem self-consistent,</li> </ul>			
	<ul> <li>analyse the results in a critical way,</li> </ul>			
	have an qualified exchange with other students.			
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56			
Credit points				
Course achievement	None			
Examination	Written exam			
Examination duration and	90 min			
scale				
Assignment for the	Energy Systems: Specialisation Energy Systems: Elective C	ompulsory		
Following Curricula	Energy Systems: Specialisation Marine Engineering: Electiv	e Compulsory		
	Product Development, Materials and Production: Specialisa	tion Product Development: Elective	e Compulsory	
	Product Development, Materials and Production: Specialisa	tion Production: Elective Compulso	ry	
	Product Development, Materials and Production: Specialisa	tion Materials: Elective Compulsory	/	
	Theoretical Mechanical Engineering: Specialisation Energy	Systems: Elective Compulsory		

ourse L1562: Turbomachines		
Тур	Lecture	
Hrs/wk	3	
СР	4	
Workload in Hours	Independent Study Time 78, Study Time in Lecture 42	
Lecturer	Prof. Markus Schatz	
Language	DE	
Cycle	SoSe	
Content	Topics to be covered will include:	
Literature	<ul> <li>Application cases of turbomachinery</li> <li>Fundamentals of thermodynamics and fluid mechanics</li> <li>Design fundamentals of turbomachinery</li> <li>Introduction to the theory of turbine stage</li> <li>Design and operation of the turbocompressor</li> <li>Design and operation of the steam turbine</li> <li>Design and operation of the gas turbine</li> <li>Physical limits of the turbomachines</li> </ul>	
Literature	<ul> <li>Traupel: Thermische Turbomaschinen, Springer. Berlin, Heidelberg, New York</li> <li>Bräunling: Flugzeuggasturbinen, Springer., Berlin, Heidelberg, New York</li> <li>Seume: Stationäre Gasturbinen, Springer., Berlin, Heidelberg, New York</li> <li>Menny: Strömungsmaschinen, Teubner., Stuttgart</li> </ul>	

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

#### Module M1209: Selected Topics of Product Development, Materials Science and Production (Alternative B: 6 LP)

Courses				
Title		Тур	Hrs/wk	СР
Applied Automation (L1592)		Project-/problem-based Learning	3	3
Advanced Training Course SE-ZERT (L2739)		Project-/problem-based Learning	2	3
Elements of Integrated Production Systems (L0927)		Project-/problem-based Learning	2	3
Development Management for Med	chatronics (L1512)	Lecture	2	3
Fatigue & Damage Tolerance (L031	10)	Lecture	2	3
GSD - Generational Sheet-Metal De	evelopment (L3064)	Lecture	3	3
Industry 4.0 for Engineers (L2012)		Lecture	2	3
Innovation and Product Manageme	nt (L2168)	Seminar	2	3
Lightweight Design Practical Cours	e (L1258)	Project-/problem-based Learning	3	3
Mechanisms and Systems of Mater	ials Testing - from the viewpoint of product development and Failure	Lecture	2	2
Analysis (L0950)				
Microsystems Technology (L0724)		Lecture	2	4
Sustainable Industrial Production (I		Lecture	2	4
Productivity Management (L0928)		Project-/problem-based Learning	2	2
Productivity Management (L0931)		Recitation Section (small)	1	1
Feedback Control in Medical Techn	ology (L0664)	Lecture	2	3
Structural Mechanics of Fibre Reinf	orced Composites (L1514)	Lecture	2	3
Technical Design (L1513)		Lecture	2	3
Materials Testing - from the viewpo	pint of industrial application (L0949)	Lecture	2	2
Reliability in Engineering Dynamics	s (L2994)	Lecture	2	2
Reliability in Engineering Dynamics		Recitation Section (small)	1	2
Reliability of Aircraft Systems (L074	49)	Lecture	2	3
Module Responsible	Prof. Dieter Krause			
Admission Requirements	None			
Recommended Previous	None			
Knowledge	None			
Educational Objectives	After taking part successfully, students have reached the follow	ing learning results		
Professional Competence	Arter taking part successiony, students have reached the follow	ing learning results		
Knowledge	Students are able to express their extended knowledge	and discuss the connection of di	fferent special f	ields or application
	areas of product development, materials and production			от орринати
	Students are qualified to connect different special fields to	with each other		
	Students are qualified to conflect different special fields	with each other		
Skills				
	<ul> <li>Students can apply specialized solution strategies and ne</li> </ul>	ew scientific methods in selected	areas	
	<ul> <li>Students are able to transfer learned skills to new and ur</li> </ul>	nknown problems and can develo	p own solution a	pproaches
_				
Personal Competence				
Social Competence	-			
Autonomy				
	Students are able to develop their knowledge and skills be a student of the	by autonomous election of course	S.	
Workload in Hours	Depends on choice of courses			
Credit points	6			
-	Product Development, Materials and Production: Specialisation	Product Development: Elective Co	ompulsorv	
Following Curricula	·	·		
Following Curricula	, , ,	, ,		
	Product Development, Materials and Production: Specialisation			
	Theoretical Mechanical Engineering: Specialisation Product Dev	elopment and Production: Electiv	e Compulsory	
<u> </u>				

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

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

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

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

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

Course L3064: GSD - Generational Sheet-Metal Development		
Тур	Lecture	
Hrs/wk	3	
СР	3	
Workload in Hours	Independent Study Time 48, Study Time in Lecture 42	
Examination Form	Mündliche Prüfung	
Examination duration and	30 min	
scale		
Lecturer	Prof. Dr. Nikola Bursac	
Language	DE	
Cycle	WiSe	
Content	Experience in mechanical engineering design and the fundamentals of manufacturing engineering	
	After successful completion of the course, students will be able to explain development projects using the theory of product generation engineering and explain design rules for sheet metal development.	
	After successful completion of the course, students will be able to apply the theory of product generation engineering to development tasks and develop sheet-metal products suitable for production.	
	After successful completion of the course, students will be able to develop a product in a team and to compete against other teams.	
	After successful completion of the course, students will be able to independently access knowledge required for sheet metal development.	
Literature		

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

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

Course L1258: Lightweight Design Practical Course		
Тур	Project-/problem-based Learning	
Hrs/wk	3	
СР	3	
Workload in Hours	Independent Study Time 48, Study Time in Lecture 42	
Examination Form	Mündliche Prüfung	
Examination duration and	30 min	
scale		
Lecturer	Prof. Dieter Krause	
Language	DE/EN	
Cycle	SoSe	
Content	Development of a sandwich structure made of fibre reinforced plastics	
	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.	
	2003.	

Course L0950: Mechanisms a	and Systems of Materials Testing - from the viewpoint of product development and Failure Analysis
Тур	Lecture
Hrs/wk	2
СР	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Examination Form	Klausur
Examination duration and	90 Minuten
scale	
Lecturer	Dr. Jan Oke Peters
Language	DE
Cycle	SoSe
Content	Application, analysis and discussion of basic and advanced testing methods to ensure correct selection of applicable testing
	procedure for investigation of part/materials deficiencies
	Stress-strain relationships
	Strain gauge application
	Visko elastic behavior
	Tensile test (strain hardening, necking, strain rate)
	Compression test, bending test, torsion test
	Crack growth upon static loading (J-Integral)
	Crack growth upon cyclic loading (micro- und macro cracks)
	Effect of notches
	<ul> <li>Creep testing (physical creep test, influence of stress and temperature, Larson Miller parameter)</li> </ul>
	Wear testing
	Non destructive testing application for overhaul of jet engines
Literature	
	E. Macherauch: Praktikum in Werkstoffkunde, Vieweg     G. F. Dieter: Machenical Metallurgu, McCray Hill
	G. E. Dieter: Mechanical Metallurgy, McGraw-Hill     D. Dürzel: Lahr, and Übergebech Septials italahra. Visusar
	<ul> <li>R. Bürgel: Lehr- und Übungsbuch Festigkeitslehre, Vieweg</li> <li>R. Bürgel: Werkstoffe sícher beurteilen und richtig einsetzen, Vieweg</li> </ul>
	• n. burger, werkstone sicher beurtenen und fichtig 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	<ul> <li>Introduction (historical view, scientific and economic relevance, scaling laws)</li> <li>Semiconductor Technology Basics, Lithography (wafer fabrication, photolithography, improving resolution, next-generation lithography, nano-imprinting, molecular imprinting)</li> <li>Deposition Techniques (thermal oxidation, epitaxy, electroplating, PVD techniques: evaporation and sputtering; CVD techniques: APCVD, LPCVD, PECVD and LECVD; screen printing)</li> <li>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, KeF2 etching)</li> <li>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)</li> <li>Thermal and Radiation Sensors (temperature measurement, self-generating sensors: Seebeck effect and thermopile; modulating sensors: thermor resistor, Pt-100, spreading resistance sensor, pn junction, NTC and PTC; thermal anemometer, mass flow sensor, photometry, radiometry, IR sensor: thermopile and bolometer)</li> <li>Mechanical Sensors (strain based and stress based principle, capacitive readout, piezoresistivity, pressure sensor: piezoresistive, capacitive and fabrication process)</li> <li>Magnetic Sensors (galvanomagnetic sensors: spinning current Hall sensor and magneto-transistor; magnetoresistive sensors: magneto resistance, AMR and GMR, fluxgate magnetometer)</li> <li>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 electrod</li></ul>
114	M. Madau, Fundamentals of Missafahrisation, CDC Bress, 2003
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	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					
	The state of the s				
Language					
Cycle	SoSe				
Content	<ul> <li>Principles of productivity management</li> <li>Shop floor management and standardisation</li> <li>Takt analysis and design of manual operations</li> <li>Maintenance Principles</li> <li>Total Productive Maintenance (TPM)</li> <li>Optimisation of set-up operations</li> </ul>				
	Analysis of interlinked production systems				
Literature	Bokranz, R.; Landau, K.:Produktivitätsmanagement von Arbeitssystemen. Schäffer-Poeschel, Stuttgart, 2006.  Takeda, H.: Das synchrone Produktionssystem: Just-in-Time für das ganze Unternehmen. 5. Aufl., mi-Wirtschaftsbuch, FinanzBuch Verlag, München, 2006.  Nakajima, S.: Management der Produktionseinrichtungen (Total Productive Maintenance). Campus Verlag, New York, 1995.				
	Shingo, S.: A Revolution in Manufacturing: The SMED System. Productivity, Inc., 1985				

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

Course L0664: Feedback Control in Medical Technology				
Тур	Lecture			
Hrs/wk	2			
CP	3			
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28			
Examination Form	Mündliche Prüfung			
Examination duration and	20 min			
scale				
Lecturer	Johannes Kreuzer, Christian Neuhaus			
Language	DE			
Cycle	SoSe			
Content	Always viewed from the engineer's point of view, the lecture is structured as follows:  Introduction to the topic  Fundamentals of physiological modelling  Introduction to Breathing and Ventilation  Physiology and Pathology in Cardiology  Introduction to the Regulation of Blood Glucose  kidney function and renal replacement therapy  Representation of the control technology on the concrete ventilator  Excursion to a medical technology company  Techniques of modeling, simulation and controller development are discussed. In the models, simple equivalent block diagrams for physiological processes are derived and explained how sensors, controllers and actuators are operated. MATLAB and SIMULINK are used as development tools.			
Literature	<ul> <li>Leonhardt, S., &amp; Walter, M. (2016). Medizintechnische Systeme. Berlin, Heidelberg: Springer Vieweg.</li> <li>Werner, J. (2005). Kooperative und autonome Systeme der Medizintechnik. München: Oldenbourg.</li> <li>Oczenski, W. (2017). Atmen: Atemhilfen; Atemphysiologie und Beatmungstechnik: Georg Thieme Verlag KG.</li> </ul>			

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

Course L1513: Technical Design		
Тур	Lecture	
Hrs/wk	2	
СР	3	
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28	
Examination Form	Schriftliche Ausarbeitung	

Lecturer	Prof. Werner Granzeier, Prof. Dieter Krause				
Language	DE				
Cycle	5056				
Content	Basics with analysis, concept, proposal drawings and sketches Samples from practice of technical industrial design Product concept with new ideas and package ID proposal with structural concept and external product ergonomics Visualisation and presentation of the overall concept Realization as individual case studies				
Literature	Literatur über technisches Produktdesign				
	Technisches Rendering und Präsentation				
	Zeichnen und perspektivisches Entwerfen				
	Literaturhinweise				
	What is Product Design ?				
	Laura Slack				
	RotoVision Schweiz 2006				
	Product Design Now				
	Design and Scetches				
	CollinsDesign and maomao publications Spanien 2006				
	Ronald B. Kemnitzer, Rendering With Markers - Definitive Techniques				
	for Designers, Illustrators and Architects,				
	Watson, Guptil Puplications,a division of Billboard Publications Inc.,				
	New York 1983				
	Creative Techniques				
	DRAWING				
	Barons Educational Series				
	ISBN-13: 978-0-7641-6182-7				
	Joseph Ungar, Rendering In Mixed Media - Techniques for Concept				
	Presentation for Designers and Illustrators				
	Watson-Guptil Publication a division of Billboard Publications Inc.,  New York 1985				
	AIRWORLD				
	Design und Architektur für die Flugreise				
	Vitra Design Stiftung Weil am Rhein 2004				
	Airline Design				
	Perter Deslius Jacek Slaski te Neues 2005				
	Technik und Sicherheit von Passagierflugzeugen				
	Frank Littek				
	Motorbuch Verlag 2003				
	Jetliner Cabins				
	Jennifer Coutts Clay				
	Cs books England 2006				
	BOEING Widebodies				
	Michael Haenggi motorbooks international USA 2003				
	form - Zeitschrift für Gestaltung, Verlag form GmbH,				
	Hofgut Ober-Berrbach, 6104 Seeheim-Jugenheim				
	(erscheint vierteljährlich, Verlag form GmbH )				
	design report				

german magasin, (erscheint monatlich) md - möbel interior design, Konradin-Verlag Robert Kohlhammer GmbH, 7022 Leinfelden-Echterdingen (erscheint monatlich) CAR STYLING, Car Styling Publishing Co. 4-8-16-11F, Kitashinjuku, Shinjuku-ku, Tokio 160, Japan (erscheint vierteljährlich in japanischer und englischer Sprache, in Hamburg erhältlich bei: Overseas Courier Service Deutschland Auto & Design, Corso Frabcia 161, 10139 Torino, Italia (erscheint vierteljährlich in italienischer und englischer Sprache alle zwei Monate , erhältlich am HBF Hamburg AERO International, Magazin für Zivilluftfahrt (erscheint monatlich) Aircraft interior international Engl. magasin for Aircraft cabin interior (erscheint 2 monatlich) aerotec Technik- und Branchenmagazin für die Luft- und Raumfahrtindustrie

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

Course L2994: Reliability in Engineering Dynamics					
Тур	Lecture				
Hrs/wk	2				
СР	2				
Workload in Hours	ndependent Study Time 32, Study Time in Lecture 28				
Examination Form	Klausur				
Examination duration and	90 min				
scale					
Lecturer	Dr. Eric Groß, Prof. Benedikt Kriegesmann				
Language	EN				
Cycle	SoSe SoSe				
Content	Method for calculation and testing of reliability of dynamic machine systems				
	Modeling				
	System identification				
	Simulation				
	Processing of measurement data				
	Damage accumulation				
	Test planning and execution				
Literature	Bertsche, B.: Reliability in Automotive and Mechanical Engineering. Springer, 2008. ISBN: 978-3-540-33969-4				
	Inman, Daniel J.: Engineering Vibration. Prentice Hall, 3rd Ed., 2007. ISBN-13: 978-0132281737				
	Dresig, H., Holzweißig, F.: Maschinendynamik, Springer Verlag, 9. Auflage, 2009. ISBN 3540876936.				
	VDA (Hg.): Zuverlässigkeitssicherung bei Automobilherstellern und Lieferanten. Band 3 Teil 2, 3. überarbeitete Auflage, 2004. ISSN 0943-9412				

Course L2995: Reliability in Engineering Dynamics					
Тур	Recitation Section (small)				
Hrs/wk	1				
СР					
Workload in Hours	Independent Study Time 46, Study Time in Lecture 14				
Examination Form	Klausur				
Examination duration and	90 min				
scale					
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 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	<ul> <li>Functions of reliability and safety (regulations, certification requirements)</li> <li>Basics methods of reliability analysis (FMEA, fault tree, functional hazard assessment)</li> </ul>			
	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 Materials (L1661)		Lecture	2	3		
Dislocation Theory of Plasticity (L16	662)	Lecture	2	3		
Module Responsible	Prof. Shan Shi					
Admission Requirements	None					
Recommended Previous	Basics in Materials Science I/II					
Knowledge						
Educational Objectives	After taking part successfully, students have reached t	After taking part successfully, students have reached the following learning results				
<b>Professional Competence</b>						
Knowledge	Students can explain basic principles of crystallograph	phy, statics (free body diagram	s, tractions) and therm	nodynamics (energy		
	minimization, energy barriers, entropy)					
Chille						
SKIIIS	Students are capable of using standardized calculation methods: tensor calculations, derivatives, integrals, tensor transformations					
Personal Competence						
Social Competence	Students can provide appropriate feedback and handle feedback on their own performance constructively.					
Autonomy	Students are able to					
	- assess their own strengths and weaknesses					
		assess their own salengals and weakilesses				
	- assess their own state of learning in specific terms an	nd to define further work steps or	n this basis guided by te	achers.		
	- work independently based on lectures and notes to solve problems, and to ask for help or clarifications when needed					
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56	6				
Credit points	6					
Course achievement	None					
Examination	Written exam					
Examination duration and	180 min					
scale						
Assignment for the	Materials Science: Core Qualification: Compulsory					
Following Curricula	Mechanical Engineering and Management: Specialisation	on Materials: Elective Compulsor	у			
	Product Development, Materials and Production: 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 Be	ehaviour of Brittle Materials			
Тур	Lecture			
Hrs/wk	2			
СР	3			
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28			
Lecturer	Prof. Gerold Schneider			
Language	DE/EN			
Cycle	SoSe			
Content	Theoretical Strength			
	Of a perfect crystalline material, theoretical critical shear stress			
	Real strength of brittle materials			
	Energy release reate, stress intensity factor, fracture criterion			
	Scattering of strength of brittle materials			
	Defect distribution, strength distribution, Weibull distribution			
	Heterogeneous materials I			
	Internal stresses, micro cracks, weight function,			
	Heterogeneous materials II			
	bughening mechanisms: crack bridging, fibres			
	eterogeneous materials III			
	oughening mechanisms. Process zone			
	esting methods to determine the fracture toughness of brittle materials			
	t-curve, stable/unstable crack growth, fractography			
	Thermal shock			
	Subcritical crack growth)			
	v-K-curve, life time prediction			
	Kriechen			
	Mechanical properties of biological materials			
	Examples of use for a mechanically reliable design of ceramic components			
Literature	D R H Jones, Michael F. Ashby, Engineering Materials 1, An Introduction to Properties, Applications and Design, Elesevier			
	D.J. Green, An introduction to the mechanical properties of ceramics", Cambridge University Press, 1998			
	B.R. Lawn, Fracture of Brittle Solids", Cambridge University Press, 1993			
	D. Munz, T. Fett, Ceramics, Springer, 2001			
	D.W. Richerson, Modern Ceramic Engineering, Marcel Decker, New York, 1992			
-				

Course L1662: Dislocation Th	
	Lecture
Hrs/wk	2
СР	3
	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Prof. Shan Shi
Language	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

Module M0840: Optim	al and Robust Control			
Courses				
Title		Тур	Hrs/wk	СР
Optimal and Robust Control (L0658		Lecture	2	3
Optimal and Robust Control (L0659		Recitation Section (small)	2	3
Module Responsible	NN			
Admission Requirements	None			
Recommended Previous				
Knowledge	<ul> <li>Classical control (frequency response, root locus)</li> </ul>			
•	State space methods			
	<ul> <li>Linear algebra, singular value decomposition</li> </ul>			
Educational Objectives	After taking part successfully, students have reached th	e following learning results		
Professional Competence	3,	<u> </u>		
Knowledge				
	<ul> <li>Students can explain the significance of the matr</li> </ul>	ix Riccati equation for the solution of	LQ problems.	
	<ul> <li>They can explain the duality between optimal sta</li> </ul>			
	<ul> <li>They can explain how the H2 and H-infinity norm</li> </ul>			
	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 to
	<ul><li>an uncertain plant.</li><li>They understand how analysis and synthesis con</li></ul>	ditions on foodback loops can be repr	ocented as linear	matrix inequalities
	• They understand now analysis and synthesis con	ultions on reedback loops can be repr	esented as inlear	matrix mequanties.
Skills	- Chudanta are sanable of designing and tuning LO	C controllers for multivariable plant m	adala	
	Students are capable of designing and tuning LQ  Thou are capable of representing a U2 and infinite			and of union aboundary
	They are capable of representing a H2 or H-infinity design problem in the form of a generalized plant, and of using standard     settings to be for solving it.			
	software tools for solving it.  • They are capable of translating time and frequency demain specifications for control loops into constraints on closed loops.			
	They are capable of translating time and frequency domain specifications for control loops into constraints on closed-loop sensitivity functions, and of carrying out a mixed-sensitivity design.			
	<ul> <li>sensitivity functions, and of carrying out a mixed-sensitivity design.</li> <li>They are capable of constructing an LFT uncertainty model for an uncertain system, and of designing a mixed-objective</li> </ul>			
	robust controller.	anney model for an ancertain system	, and or designi	ig a mixed objective
	They are capable of formulating analysis and syl	nthesis conditions as linear matrix inc	equalities (LMI). a	nd of using standard
	LMI-solvers for solving them.		7,	, , , , , , , , , , , , , , , , , , ,
	They can carry out all of the above using standar	d software tools (Matlab robust contro	ol toolbox).	
Personal Competence				
	Students can work in small groups on specific problems			
Autonomy	Students are able to find required information in source	s provided (lecture notes, literature,	software docume	ntation) and use it to
	solve given problems.			
Wanda ad la Harria	Index and art Charle Time 124 Charle Time in Lantum 50			
	Independent Study Time 124, Study Time in Lecture 56			
Credit points				
Course achievement	None Oral evers			
Examination	Oral exam			
Examination duration and	30 min			
scale				
Assignment for the	Electrical Engineering: Specialisation Control and Power	Systems Engineering: Elective Comp	ulsory	
Following Curricula	Energy Systems: Core Qualification: Elective Compulsor	у		
	Aircraft Systems Engineering: Core Qualification: Electiv	e Compulsory		
	Aeronautics: Core Qualification: Elective Compulsory			
	Mechatronics: Core Qualification: Elective Compulsory			
	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	lisation Product Development: Electiv	e Compulsory	
	Product Development, Materials and Production: Specia	lisation Production: Elective Compulso	ory	
	Product Development, Materials and Production: Specia	·	у	
	Theoretical Mechanical Engineering: Core Qualification:	Elective Compulsory		

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

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

Module M1344: Proce	essing of Fibre-Polymer-Composites			
Courses				
Title		Тур	Hrs/wk	СР
Processing of fibre-polymer-composites (L1895)		Lecture	2	3
From Molecule to Composites Part (	T	Project-/problem-based Learning	2	3
Module Responsible	Prof. Bodo Fiedler			
Admission Requirements	None			
Recommended Previous	Knowledge in the basics of chemistry / physics / materials	science		
Knowledge				
Educational Objectives	After taking part successfully, students have reached the	following learning results		
<b>Professional Competence</b>				
Knowledge	Students are able to give a summary of the technical de	tails of the manufacturing processes co	mposites and	I illustrate respective
	relationships. They are capable of describing and comm	nunicating relevant problems and que	stions using a	appropriate technical
	language. They can explain the typical process of solving	practical problems and present related	results.	
Skills	Students can use the knowledge of fiber-reinforced comp	posites (FRP) and its constituents (fiber	/ matrix) and	define the necessary
	testing and analysis.	(	,	,
	,			
	They can explain the complex structure-property relation:	ship and		
	the interactions of chemical structure of the polymers	s, their processing with the different	fiber types,	including to explain
	neighboring contexts (e.g. sustainability, environmental p	protection).		
Personal Competence				
Social Competence	Students are able to cooperate in small, mixed-subject g	roups in order to independently derive	solutions to g	iven problems in the
	context of civil engineering. They are able to effectively	present and explain their results alone	or in groups i	n front of a qualified
	audience. Students have the ability to develop alternativ	e approaches to an engineering proble	m independe	ntly or in groups and
	discuss advantages as well as drawbacks.			
Autonomy	Students are capable of independently solving mechani	cal engineering problems using provid	ed literature.	They are able to fill
	gaps in as well as extent their knowledge using the litera	ture and other sources provided by the	supervisor. Fu	urthermore, they can
	meaningfully extend given problems and pragmatically so	olve them by means of corresponding se	olutions and c	oncepts.
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56			
Credit points	6			
Course achievement	None			
Examination	Written exam			
Examination duration and	90 min			
scale				
Assignment for the	Materials Science and Engineering: Specialisation Engineer	ering Materials: Elective Compulsory		
Following Curricula	Materials Science: Specialisation Engineering Materials: E	lective Compulsory		
	Mechanical Engineering and Management: Specialisation			
	Product Development, Materials and Production: Specialis	·	mpulsory	
	Product Development, Materials and Production: Specialis	• •		
	Product Development, Materials and Production: Specialis			
	Theoretical Mechanical Engineering: Specialisation Materi	als Science: Elective Compulsory		

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

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

Module M1690: Aircra	aft Design II (Special Air Vehicle Desigr	1)		
Courses				
	gn of Rotorcraft, special operations aircraft, UAV) (L0844) gn of Rotorcraft, special operations aircraft, UAV) (L0847)	<b>Typ</b> Lecture Recitation Section (large)	Hrs/wk 3 2	<b>CP</b> 3 3
Module Responsible	Prof. Volker Gollnick			
Admission Requirements	None			
Recommended Previous	Aircraft Design I (Design of Transport Aircraft)			
Knowledge	Air Transportation Systems			
<b>Educational Objectives</b>	After taking part successfully, students have reached the	following learning results		
<b>Professional Competence</b>				
Knowledge	Understanding of various flight systems and its special unmanned air systems)	characteristics (supersonic aircraft,	rotorcraft, high p	performance aircraft,
	Understanding of pro´s and con´s and physical character	istics of different air systems		
	Understanding of special mission requirements and its in	npact on systems definition and conc	eptual design	
	Intensified knowledge of performance design on various	air systems		
Skills	Understanding and application of design and calculation	methods		
	Understanding of interdisciplinary and integrative interde	ependencies		
	mission oriented technical definition of air systems			
	special conceptual calculation methods for special equip	ment characteristics		
	assessment of different design solutions			
Personal Competence				
Social Competence	Working in teams for focused solutions			
	communication, assertiveness, technical persuasion			
Autonomy	Organisation of worksflows and strategies for solutions			
	structured task analysis and definition of solutions			
Workload in Hours	Independent Study Time 110, Study Time in Lecture 70			
Credit points	6			
Course achievement	None			
	Written exam			
Examination duration and scale	180 min			
	Aircraft Systems Engineering: Core Qualification: Elective	Compulsory		
Following Curricula			oulsory	
	Aeronautics: Core Qualification: Elective Compulsory		-	
	Product Development, Materials and Production: Speciali	sation Product Development: Elective	Compulsory	
	Product Development, Materials and Production: Speciali	sation Production: Elective Compulso	ry	
	Theoretical Mechanical Engineering: Specialisation Aircra	ft Systems Engineering: Elective Con	npulsory	

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

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

Module M1343: Struc	ture and properties of fibre-polymer	-composites		
Module M1343. Struc	ture and properties of fibre-polymer	-composites		
Courses				
Title		Тур	Hrs/wk	СР
Structure and properties of fibre-po		Lecture	2	3
Structure and properties of fibre-po		Project-/problem-based Learning	2	2
Structure and properties of fibre-po		Recitation Section (large)	1	1
Module Responsible				
Admission Requirements	None			
Kecommended Previous  Knowledge	Basics: chemistry / physics / materials science			
Educational Objectives	After taking part successfully, students have reached	the following learning results		
Professional Competence	Arter taking part successivily, students have reached	the following learning results		
•	Students can use the knowledge of fiber-reinforced necessary testing and analysis.	composites (FRP) and its constituents to	olay (fiber / m	atrix) and define the
	They can explain the complex relationships structure-	property relationship and		
	the interactions of chemical structure of the polyr neighboring contexts (e.g. sustainability, environment		fiber types,	including to explain
Skills	Students are capable of			
	<ul> <li>using standardized calculation methods in a given context to mechanical properties (modulus, strength) to calculate evaluate the different materials.</li> <li>approximate sizing using the network theory of the structural elements implement and evaluate.</li> <li>selecting appropriate solutions for mechanical recycling problems and sizing example stiffness, corrosion resistance.</li> </ul>			
Personal Competence				
Social Competence	Students can			
	<ul> <li>arrive at funded work results in heterogenius groups and document them.</li> <li>provide appropriate feedback and handle feedback on their own performance constructively.</li> </ul>			
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	sis.	
	- assess possible consequences of their professional activity.			
Workload in Hours	Independent Study Time 110, Study Time in Lecture 7	70		
		70		
Course ashiovement				
Course achievement				
Examination  Examination duration and				
scale	90 mm			
Assignment for the	Aircraft Systems Engineering: Core Qualification: Elect	tive Compulsory		
Following Curricula	, , , , , , ,	• •	ion: Elective C	ompulsory
. cc.mig carricula	International Management and Engineering: Specialisation II. Product Development and Production: Elective Compulsory  Aeronautics: Core Qualification: Elective Compulsory			
	Materials Science and Engineering: Specialisation Engineering Materials: Elective Compulsory			
	Materials Science: Specialisation Engineering Material	, ,		
	Mechanical Engineering and Management: Core Qualification: Compulsory			
	Product Development, Materials and Production: Spec	ialisation Product Development: Elective C	Compulsory	
	Product Development, Materials and Production: Spec	ialisation Production: Elective Compulsory		
	Product Development, Materials and Production: Spec	ialisation Materials: Compulsory		
	Renewable Energies: Specialisation Bioenergy System	ns: Elective Compulsory		
	Renewable Energies: Specialisation Wind Energy Syst	ems: Elective Compulsory		
	Renewable Energies: Specialisation Solar Energy Syst	• •		
	Theoretical Mechanical Engineering: Specialisation Ma	aterials 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	

Course L2614: Structure and	properties of fibre-polymer-composites
Тур	Project-/problem-based Learning
Hrs/wk	2
СР	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Prof. Bodo Fiedler
Language	DE/EN
Cycle	SoSe
Content	The students receive the assignment in the form of a material design for test bodies made of fibre composites. Technical and normative requirements are listed in the assignment, all other required information comes from the lectures and exercises or the respective documents (electronically and in conversation).  The procedure is specified in a milestone plan and enables the students to plan subtasks and thus work continuously. At the end of the project, different test specimens were tested in tensile or bending tests.  In the individual project meetings, the conception (discussion of requirements and risks) is scrutinised. The calculations are analysed, the production methods are evaluated and determined. Materials are selected and the test specimens are manufactured according to standards. The quality and mechanical properties are checked and classified. At the end, a final report is prepared and the results are presented to all participants in the form of a presentation and discussed.  Translated with www.DeepL.com/Translator (free version)
Literature	Hall, Clyne: Introduction to Composite materials, Cambridge University Press Daniel, Ishai: Engineering Mechanics of Composites Materials, Oxford University Press Mallick: Fibre-Reinforced Composites, Marcel Deckker, New York

Course L2613: Structure and properties of fibre-polymer-composites		
Тур	Recitation Section (large)	
Hrs/wk	1	
СР	1	
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14	
Lecturer	Prof. Bodo Fiedler	
Language	EN	
Cycle	SoSe	
Content	The contents of the lecture are repeated and deepened using practical examples.	
	Calculations are carried out together or individually, and the results are discussed critically.	
Literature	Hall, Clyne: Introduction to Composite materials, Cambridge University Press	
	Daniel, Ishai: Engineering Mechanics of Composites Materials, Oxford University Press	
	Mallick: Fibre-Reinforced Composites, Marcel Deckker, New York	

Module M1878: Sustainable energy from wind and water				
Courses				
Title		Тур	Hrs/wk	СР
Offshore Geotechnical Engineering	(L0067)	Lecture	1	1
Hydro Power Use (L0013)		Lecture	1	1
Wind Turbine Plants (L0011)		Lecture	2	3
Wind Energy Use - Focus Offshore (		Lecture	1	1
Module Responsible	·			
Admission Requirements	None			
	Module: Technical Thermodynamics I,			
Knowledge	Module: Technical Thermodynamics II,			
	Madula Fundamentals of Fluid Mashania			
	Module: Fundamentals of Fluid Mechanics			
Educational Objectives	After taking part successfully, students have reached the	e following learning results		
Professional Competence				
Knowledge	By ending this module students can explain in detail k	nowledge of wind turbines w	ith a particular focus of	wind energy use in
	offshore conditions and can critical comment these aspe	ects in consideration of currer	nt developments. Further	more, they are able
	to describe fundamentally the use of water power to ger	erate electricity. The students	s reproduce and explain	the basic procedure
	in the implementation of renewable energy projects in co	ountries outside Europe.		
	Through active discussions of various topics within the	e seminar of the module, stu	dents improve their und	derstanding and the
	application of the theoretical background and are thus a			, , , , , , , , , , , , , , , , , , ,
Skills	Students are able to apply the acquired theoretical fo			
	assess technically the resulting relationships in the con			
	compare critically the special procedure for the impleme			side Europe with the
	in principle applied approach in Europe and can apply th	is procedure on exemplary the	eoretical projects.	
Personal Competence				
Social Competence	Students can discuss scientific tasks subjet-specificly ar	d multidisciplinary within a se	minar.	
Autonomy	Students can independently exploit sources in the con	text of the emphasis of the l	ecture material to clear	the contents of the
Autonomy	lecture and to acquire the particular knowledge about the		ecture material to clear	the contents of the
	rectare and to dequire the particular knowledge about the	- 540,000 41041		
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				
Assignment for the	Civil Engineering: Specialisation Structural Engineering:	Elective Compulsory		
Following Curricula	Civil Engineering: Specialisation Geotechnical Engineering			
	Civil Engineering: Specialisation Coastal Engineering: Ele			
	International Management and Engineering: Specialisation			Compulsory
	International Management and Engineering: Specialisation			
	Product Development, Materials and Production: Special			
	Product Development, Materials and Production: Special Product Development, Materials and Production: Special			
	Renewable Energies: Core Qualification: Compulsory	sation materials, Elective Colf	ipaisui y	
	Theoretical Mechanical Engineering: Specialisation Energy	ıv Systems: Elective Compulso	orv	
	Process Engineering: Specialisation Environmental Proce			
	Water and Environmental Engineering: Specialisation Cit			
	Water and Environmental Engineering: Specialisation En			

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

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	<ul> <li>Introduction, importance of water power in the national and global context</li> <li>Physical basics: Bernoulli's equation, usable height of fall, hydrological measures, loss mechanisms, efficiencies</li> <li>Classification of Hydropower: Flow and Storage hydropower, low and high pressure systems</li> <li>Construction of hydroelectric power plants: description of the individual components and their technical system interaction</li> <li>Structural engineering components; representation of dams, weirs, dams, power houses, computer systems, etc.</li> <li>Energy Technical Components: Illustration of the different types of hydraulic machinery, generators and grid connection</li> <li>Hydropower and the Environment</li> <li>Examples from practice</li> </ul>
Literature	<ul> <li>Schröder, W.; Euler, G.; Schneider, K.: Grundlagen des Wasserbaus; Werner, Düsseldorf, 1999, 4. Auflage</li> <li>Quaschning, V.: Regenerative Energiesysteme: Technologie - Berechnung - Simulation; Carl Hanser, München, 2011, 7. Auflage</li> <li>Giesecke, J.; Heimerl, S.; Mosony, E.: Wasserkraftanlagen - Planung, Bau und Betrieb; Springer, Berlin, Heidelberg, 2009, 5. Auflage</li> <li>von König, F.; Jehle, C.: Bau von Wasserkraftanlagen - Praxisbezogene Planungsunterlagen; C. F. Müller, Heidelberg, 2005, 4. Auflage</li> <li>Strobl, T.; Zunic, F.: Wasserbau: Aktuelle Grundlagen - Neue Entwicklungen; Springer, Berlin, Heidelberg, 2006</li> </ul>

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

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Module M1894: Autor	mation Technology and Systems			
Courses				
Title		Тур	Hrs/wk	СР
Automation Technology and System	ns (L2329)	Lecture	4	4
Automation Technology and Systems (L2329) Automation Technology and Systems (L2331)		Project-/problem-based Learning	1	1
Automation Technology and System		Recitation Section (small)	1	1
Module Responsible	Prof. Thorsten Schüppstuhl			
Admission Requirements	None			
Recommended Previous	without major course assessment			
Knowledge				
Educational Objectives	After taking part successfully, students have rea	ched the following learning results		
Professional Competence				
Knowledge	Students			
		automation systems and have good understand	ing of their int	ceraction
		of automation tasks and are able to use them		
	have special competences in industrial roll	out based automation systems		
Skills	Students are able to			
	analyze complex Automation tasks			
	develop application based concepts and s	olutions		
	design subsystems and integrate into one			
	investigate and evaluate safety of machin			
	<ul> <li>create simple programs for robots and programs</li> </ul>			
	<ul> <li>design of circuit for pneumatic application</li> </ul>	S		
Personal Competence	Chudanha ana ahla ha			
Social Competence	Students are able to			
	- find solutions for automation and handling task	s in groups		
	- 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 program			
	develop solutions for practice oriented tas			
	design safety concepts for automation ap			
	assess consequences of their professional	actions and responsibilities		
Workload in Hours	Independent Study Time 96, Study Time in Lectu	ire 84		
Credit points	6		<u></u>	
Course achievement		Description	<u> </u>	
	· ·	andDie Studienleistung umfasst die Ergebnisse		sierten Anteile des
	practical work	Moduls sowie der Präsentation in der Gruppe.		
Examination				
Examination duration and	120 min			
scale				
Assignment for the	International Management and Engineering: Spe	cialisation II. Product Development and Production	on: Elective Co	ompulsory
Following Curricula	Mechatronics: Core Qualification: Elective Comp	•		
	Product Development, Materials and Production:		ompulsory	
	Product Development, Materials and Production:			
	Product Development, Materials and Production:			
	Theoretical Mechanical Engineering: Specialisati	on Product Development and Production: Elective	e Compulsory	

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

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

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

Module M0563: Robot	tics							
Courses								
Title					Тур		Hrs/wk	СР
Robotics: Modelling and Control (LC	)168)				Integrated Lecture		4	4
Robotics: Modelling and Control (L1					Project-/problem-based Lea	arning	2	2
Module Responsible	Dr. Martin Gomse							
Admission Requirements	None							
Recommended Previous	Fundamentals of elec	trical engine	eering					
Knowledge								
	Broad knowledge of r	nechanics						
	Fundamentals of cont	rol theory						
<b>Educational Objectives</b>	After taking part succ	essfully, stu	dents have r	eached the followi	ng learning results			
<b>Professional Competence</b>								
Knowledge	Students are able to	describe fun	damental pro	operties of robots a	and solution approaches fo	or multi	ple problems	in robotics.
Skills	Students are able to	derive and s	olve equation	ns of motion for va	rious manipulators.			
	Students can generat	e traiectorie	s in various	coordinate system	s			
	Stadents can general	e trajectorie	.5 III various	coordinate system	J.			
	Students can design l	inear and pa	artially nonlir	near controllers for	robotic manipulators.			
Personal Competence								
Social Competence	Students are able to work goal-oriented in small mixed groups.							
Autonomy	Students are able to recognize and improve knowledge deficits independently.							
	With instructor assist	ance, studer	nts are able t	o evaluate their o	wn knowledge level and de	efine a	further course	e of study.
Workload in Hours	Independent Study Ti	me 96, Stud	ly Time in Le	cture 84				
Credit points	6							
Course achievement	Compulsory Bonus	Form		Description				
	Yes None	•	theoretical		an PBL-Einheiten sowie	Erreicl	hen des Ge	samtziels und de
		practical w	vork	jeweiligen Se	ession-Ziele			
Examination	Written exam							
Examination duration and scale	120 min							
Assignment for the	Aircraft Systems Engi	nooring: Cor	ro Qualificatio	an, Flortivo Comp	ulcon/			
Following Curricula		-			oduct Development and Pr	oductio	n: Flective Co	mnulsory
1 onowing curricula	_		-		echatronics: Elective Comp		on. Elective co	лприізої у
	Aeronautics: Core Qu		-		enda omes. Elective comp	, a.50. j		
	Mechanical Engineeri			-	ompulsory			
	Mechatronics: Core Q	ualification:	Compulsory					
	Product Development	, Materials a	and Production	n: Specialisation F	Product Development: Elec	tive Co	mpulsory	
	Product Development	, Materials a	and Production	n: Specialisation F	Production: Elective Compu	ulsory		
	Product Development	, Materials a	and Production	n: Specialisation N	Materials: Elective Compul	sory		
		-			elopment and Production: I			
	Theoretical Mechanic	al Engineerii	ng: Specialis	ation Robotics and	Computer Science: Electiv	ve Com	pulsory	

Course L0168: Robotics: Mod	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: Mod	ourse L1305: Robotics: Modelling and Control		
Тур	Project-/problem-based Learning		
Hrs/wk	2		
СР	2		
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28		
Lecturer	Dr. Martin Gomse		
Language	EN		
Cycle	WiSe		
Content	See interlocking course		
Literature	See interlocking course		

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

Course L0387: Health, Safety	y and Environmental Management
Тур	Integrated Lecture
Hrs/wk	3
СР	3
Workload in Hours	Independent Study Time 48, Study Time in Lecture 42
Lecturer	Hans-Joachim Nau
Language	EN
Cycle	WiSe
Content	<ul> <li>Objectives of and benefit from HSE management</li> <li>From dilution and end-of-pipe technology to eco-efficiency and eco-effectiveness Behaviour control: regulations, economic instruments and voluntary initiatives</li> <li>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</li> <li>Crisis management</li> </ul>
Literature	C. Stephan: Industrial Health, Safety and Environmental Management, MV-Verlag, Münster, 2007/2012 (can be found in the library under GTG 315)  Exercises can be downloaded from StudIP

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

Module M1909: Syste	m Simulation			
Courses				
Title		Тур	Hrs/wk	СР
System Simulation Modul (L3150)		Lecture	2	3
System Simulation Modul (L3151)		Recitation Section (large)	2	3
Module Responsible	Prof. Arne Speerforck			
Admission Requirements	None			
Recommended Previous	Mathematics I-III, Computer Sciense, Engineering Thern	nodynamics I, II, Fluid Dynamics, Heat	Transfer, Contro	Systems
Knowledge				
<b>Educational Objectives</b>	After taking part successfully, students have reached th	e following learning results		
<b>Professional Competence</b>				
Knowledge				
Skills				
<b>Personal Competence</b>				
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: Electiv	ve Compulsory		
	Aeronautics: Core Qualification: Elective Compulsory			
	Product Development, Materials and Production: Specia	lisation Product Development: Elective	e Compulsory	
	Product Development, Materials and Production: Specia	lisation Production: Elective Compulso	ry	
	Product Development, Materials and Production: Specia	lisation Materials: Elective Compulsor	/	
	Renewable Energies: Specialisation Bioenergy Systems	Elective Compulsory		
	Renewable Energies: Specialisation Solar Energy System	ns: Elective Compulsory		
	Renewable Energies: Specialisation Wind Energy System	ns: Elective Compulsory		
	Theoretical Mechanical Engineering: Specialisation Simi	ulation Technology: Elective Compulso	ry	
	Theoretical Mechanical Engineering: Specialisation Energy	gy 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	<ul> <li>[1] Modelica Association: "Modelica Language Specification - Version 3.5", Linköping, Sweden, 2021.</li> <li>[2] OpenModelica: OpenModelica 1.17.0, https://www.openmodelica.org (siehe Download), 2021.</li> <li>[3] M. Tiller: "Modelica by Example", https://book.xogeny.com, 2014.</li> <li>[4] M. Otter, H. Elmqvist, et al.: "Objektorientierte Modellierung Physikalischer Systeme", at- Automatisierungstechnik (german), Teil 1 - 17, Oldenbourg Verlag, 1999 - 2000.</li> <li>[5] P. Fritzson: "Principles of Object-Oriented Modeling and Simulation with Modelica 3.3", Wiley-IEEE Press, New York, 2015.</li> <li>[6] P. Fritzson: "Introduction to Modeling and Simulation of Technical and Physical Systems with Modelica", Wiley, New York, 2011.</li> </ul>

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	

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	following learning results		
Professional Competence				
•	Students are able to			
3				
	Describe the fundamental equations of aerodynam	ics for compressible, incompressibl	e 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			
	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 re	al flight test data		
Personal Competence				
Social Competence	Students are able to:			
	Desferon simulations in annual and discuss and the			
	Perform simulations in groups and discuss results	and the consider		
	Evaluate flight test data in groups, discuss and pre	sent the results		
Autonomy	Students are able to:			
	Drococc toaching content index and arthur			
	Process teaching content independently     Prepare, work out and process simulation models in	ndenendently		
	Apply teaching content on virtual and real flight test			
	7 Apply teaching content on virtual and real higheres.	oc data		
Workload in Hours	Independent Study Time 96, Study Time in Lecture 84			
Credit points				
Course achievement				
	Written exam			
Examination duration and	160 Minutes			
scale				
Assignment for the	Aircraft Systems Engineering: Core Qualification: Compuls	sory		
Following Curricula	1	•	pulsory	
3	Aeronautics: Core Qualification: Compulsory	,		
	Product Development, Materials and Production: Specialis	ation Product Development: Electiv	e Compulsory	
	Product Development, Materials and Production: Specialis	•	. ,	
	Product Development, Materials and Production: Specialis	·	•	
	Theoretical Mechanical Engineering: Specialisation Aircraft			
	, J 3 - p - 1 - 1 - 1 - 1 - 1 - 1 - 1 - 1 - 1	. 3 3	•	

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	<ul> <li>Aerodynamics (fundamental equations of aerodynamics; compressible and incompressible flows; airfoils and wings; viscous flows)</li> <li>Flight Mechanics (Equations of motion; flight performance; control surfaces; derivatives; lateral stability and control; trim conditions; flight maneuvers)</li> </ul>	
Literature	Schlichting, H.; Truckenbrodt, E.: Aerodynamik des Flugzeuges I und II Etkin, B.: Dynamics of Atmospheric Flight Sachs/Hafer: Flugmechanik Brockhaus: Flugregelung J.D. Anderson: Introduction to flight	

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

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

Module M0815: Produ	ect Planning				
Module Mod13. 1 Tout	ice i laming				
Courses					
Title		7	Гур	Hrs/wk	СР
Product Planning (L0851)		L	ecture	3	3
Product Planning Seminar (L0853)		P	Project-/problem-based Learning	2	3
Module Responsible	Prof. Cornelius Herstatt				
Admission Requirements	None				
<b>Recommended Previous</b>	Good basic-knowledge of Business Administra	tion			
Knowledge					
<b>Educational Objectives</b>	After taking part successfully, students have r	eached the following	learning results		
<b>Professional Competence</b>					
Knowledge	Students will gain insights into:				
	Product Planning				
	Process				
	Methods				
	Design thinking				
	o Process				
	<ul> <li>Methods</li> </ul>				
	<ul> <li>User integration</li> </ul>				
Skills	Students will gain deep insights into:				
	Product Planning				
	<ul> <li>Process-related aspects</li> </ul>				
	Organisational-related aspects				
		to			
	Human-Ressource related aspect				
	<ul><li>Working-tools, methods and inst</li><li></li></ul>	ruments			
Personal Competence					
Social Competence					
Social competence	<ul> <li>Interact within a team</li> </ul>				
	Raise awareness for globabl issues				
Autonomy					
Autonomy	<ul> <li>Gain access to knowledge sources</li> </ul>				
	<ul> <li>Interpret complex cases</li> </ul>				
	<ul> <li>Develop presentation skills</li> </ul>				
Workload in Hours	Independent Study Time 110, Study Time in L	octuro 70			
Credit points	6				
Course achievement	Compulsory Bonus Form	Description			
Course acineventent	Yes 20 % Subject theoretical	and			
	practical work				
Examination	Thesis				
Examination duration and	90 minutes				
scale					
Assignment for the	Global Innovation Management: Core Qualifica	ation: Compulsory			
Following Curricula	International Management and Engineering: S	. ,	ves Management: Flective Cor	npulsorv	
. ooming curricula	Mechanical Engineering and Management: Sp			paisor y	
				mnulcon	
	Product Development, Materials and Production		•	лприіѕогу	
	Product Development, Materials and Production	•			
	Product Development, Materials and Production	•			
	Theoretical Mechanical Engineering: Specialise	ation Product Develo	pment 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 Farings C. Budget Daving and Davidsonant 2nd Edition McConv IIII 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 M0867: Produ	iction Planning & Control and	Digital Enterprise		
Courses				
Title		Тур	Hrs/wk	СР
The Digital Enterprise (L0932)		Lecture	2	2
Production Planning and Control (LC	0929)	Lecture	2	2
Production Planning and Control (LC	0930)	Recitation Section (small)	1	1
Exercise: The Digital Enterprise (L0	933)	Recitation Section (small)	1	1
Module Responsible	Prof. Hermann Lödding			
Admission Requirements	None			
Recommended Previous	Fundamentals of Production and Quality Ma	nagement		
Knowledge				
<b>Educational Objectives</b>	After taking part successfully, students have	e reached the following learning results		
<b>Professional Competence</b>				
Knowledge	Students can explain the contents of the module in detail and take a critical position to them.			
Skills	Students are capable of choosing and apply	ing models and methods from the module to indu	strial problems.	
Personal Competence				
Social Competence	Students can develop joint solutions in mixe	ed teams and present them to others.		
Autonomy	-	- · · · · · · · · · · · · · · · · · · ·		
Workload in Hours	Independent Study Time 96, Study Time in	Independent Study Time 96, Study Time in Lecture 84		
Credit points	6			
Course achievement	None			
Examination	Written exam			
Examination duration and	180 Minuten			
scale				
Assignment for the	International Management and Engineering:	: Specialisation II. Product Development and Produ	uction: Elective Co	ompulsory
Following Curricula	Logistics, Infrastructure and Mobility: Specia	alisation Production and Logistics: Elective Compu	Isory	
	Biomedical Engineering: Specialisation Artif	icial Organs and Regenerative Medicine: Elective	Compulsory	
	Biomedical Engineering: Specialisation Impl	ants and Endoprostheses: Elective Compulsory		
	Biomedical Engineering: Specialisation Medi	ical Technology and Control Theory: Elective Com	pulsory	
	Biomedical Engineering: Specialisation Mana	agement and Business Administration: Compulsor	у	
	Product Development, Materials and Produc	tion: Specialisation Product Development: Elective	e Compulsory	
	Product Development, Materials and Produc	tion: Specialisation Production: Compulsory		
	Product Development, Materials and Produc	tion: Specialisation Materials: Elective Compulsor	y	
	Theoretical Mechanical Engineering: Special	lisation Product Development and Production: Elec	ctive Compulsory	

Course L0932: The Digital En	iterprise
Тур	Lecture
Hrs/wk	2
СР	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Dr. Robert Rost
Language	DE
Cycle	WiSe
Content	Due to the developments of Industry 4.0, digitalization and interconnectivity become a strategic advantage for companies in the international competition. This lecture focuses on the relevant modules and enables the participants to evaluate current developments in this context. In particular, knowledge management, simulation, process modelling and virtual technologies are covered.  Content:  Business Process Management and Data Modelling, Simulation Knowledge and Competence Management Process Management (PPC, Workflow Management) Computer Aided Planning (CAP) and NC-Programming Virtual Reality (VR) and Augmented Reality (AR) Computer Aided Quality Management (CAQ) Industry 4.0
Literature	Scheer, AW.: ARIS - vom Geschäftsprozeß zum Anwendungssystem. Springer-Verlag, Berlin 4. Aufl. 2002  Schuh, G. et. al.: Produktionsplanung und -steuerung, Springer-Verlag. Berlin 3. Auflage 2006  Becker, J.; Luczak, H.: Workflowmanagement in der Produktionsplanung und -steuerung. Springer-Verlag, Berlin 2004  Pfeifer, T; Schmitt, R.: Masing Handbuch Qualitätsmanagement. Hanser-Verlag, München 5. Aufl. 2007  Kühn, W.: Digitale Fabrik. Hanser-Verlag, München 2006

Course L0929: Production 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	<ul> <li>Vorlesungsskript</li> <li>Lödding, H: Verfahren der Fertigungssteuerung, Springer 2008</li> <li>Nyhuis, P.; Wiendahl, HP.: Logistische Kennlinien, Springer 2002</li> </ul>	

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

Course L0933: Exercise: The	Course L0933: Exercise: The Digital Enterprise	
Тур	Recitation Section (small)	
Hrs/wk	1	
СР	1	
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14	
Lecturer	Dr. Robert Rost	
Language	DE	
Cycle	WiSe	
Content	See interlocking course	
Literature	Siehe korrespondierende Vorlesung	
	See interlocking course	

Module M0962: Susta	inability and Risk Management			
Courses				
Title		Тур	Hrs/wk	СР
Safety, Reliability and Risk Assessn	nent (L1145)	Seminar	2	3
Environment and Sustainability (L0	319)	Lecture	2	3
Module Responsible	Prof. Kerstin Kuchta			
Admission Requirements	None			
<b>Recommended Previous</b>	none			
Knowledge				
<b>Educational Objectives</b>	After taking part successfully, students have reached	the following learning results		
<b>Professional Competence</b>				
Knowledge	Students are able to describe single techniques an	d to give an overview for the field	of safety and risk ass	sessment as well as
	environmental and sustainable engineering, in detail	:		
	<ul> <li>basics in safety and reliability of technical faci</li> </ul>	lities		
	safety and reliability analysis methods	nices		
	risk assessment			
	Production and usage of bio-char			
	<ul> <li>energy production and supply</li> </ul>			
	sustainable product design			
Skills	Students are able apply interdisciplinary system-or	riented methods for risk assessme	nt and sustainability	reporting. They can
	evaluate the effort and costs for processes and select economically feasible treatment concepts.			
Personal Competence				
Social Competence				
Autonomy	Students can gain knowledge of the subject area fr			-
	define targets for new application or research-orient	ed duties in for risk management ai	nd sustainability conce	pts accordance with
	the potential social, economic and cultural impact.			
Workload in Hours	Independent Study Time 124, Study Time in Lecture	56		
Credit points	6			
Course achievement	None			
Examination	Written elaboration			
<b>Examination duration and</b>	Elaboration and presentation (45 minutes in groups)			
scale				
Assignment for the	Civil Engineering: Core Qualification: Compulsory			
Following Curricula	Bioprocess Engineering: Specialisation C - Bioeco	nomic Process Engineering, Focus	s Management and (	Controlling: Elective
	Compulsory			
	International Management and Engineering: Speciali	sation II. Civil Engineering: Elective	Compulsory	
	Product Development, Materials and Production: Spe	·		
	Product Development, Materials and Production: Spe			
	Product Development, Materials and Production: Spe		ulsory	
	Water and Environmental Engineering: Core Qualifica	ation: Compulsory		

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

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

Production				
Module M1155: Aircra	aft Cabin Systems			
Courses				
Title	Ту		Hrs/wk	СР
Aircraft Cabin Systems (L1545)		cture	3	4
Aircraft Cabin Systems (L1546)		citation Section (large)	1	2
Module Responsible				
Admission Requirements	None			
Recommended Previous				
Knowledge				
	• Mechanics			
	• Thermodynamics			
	Electrical Engineering     Control Systems			
	Control Systems			
Educational Objectives	After taking part successfully, students have reached the following	earning results		
Professional Competence				
Knowledge	Students are able to:			
	describe cabin operations, equipment in the cabin and cabin System	ems		
	• explain the functional and non-functional requirements for cabin S	ystems		
	• elucidate the necessity of cabin operating systems and emergenc	y Systems		
	assess the challenges human factors integration in a cabin environ	nment		
CI::III-	Students are able to:			
SKIIIS	design a cabin layout for a given business model of an Airline			
	design a cabin layout for a given business model of an Allillie     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 common needs and entertainment requirements in the casin			
Personal Competence				
Social Competence	Students are able to:			
	comprehend existing system solutions and explain them on the ball	asis of existing requirements	5	
	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				
Credit points				
Course achievement				
Examination				
Examination duration and				
scale				
Assignment for the		gineering: Elective Compuls	ory	
Following Curricula				
	International Management and Engineering: Specialisation II. Aviation	on Systems: Elective Compu	Isory	
	Aeronautics: Core Qualification: Compulsory			
	Product Development, Materials and Production: Specialisation Production:			
	Product Development, Materials and Production: Specialisation Production:			
	Product Development, Materials and Production: Specialisation Materials and Production: Specialisation Materials and Production: Specialisation Aircraft Systems		ulaan:	
	Theoretical Mechanical Engineering: Specialisation Aircraft Systems	Engineering: Elective Comp	uisory	

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

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

Module M1183: Laser	Systems and Methods of	f Manufacturing Design and A	nalysis	
Courses				
Title		Тур	Hrs/wk	СР
Laser Systems and Process Techno	•	Lecture	2	3
Methods for Analysing Production F	Processes (L0876)	Lecture	2	3
Module Responsible	Prof. Jan Hendrik Dege			
Admission Requirements	None			
Recommended Previous				
Knowledge				
<b>Educational Objectives</b>	After taking part successfully, stude	nts have reached the following learning resul	lts	
<b>Professional Competence</b>				
Knowledge				
Skills				
Personal Competence				
Social Competence				
Autonomy				
Workload in Hours	Independent Study Time 124, Study	Time in Lecture 56		
Credit points	6			
Course achievement	None			
Examination	Written exam			
Examination duration and	180 min			
scale				
Assignment for the	Product Development, Materials and	Production: Specialisation Product Developn	nent: Elective Compulsory	
Following Curricula	Product Development, Materials and	Production: Specialisation Production: Comp	oulsory	
	Product Development, Materials and	Production: Specialisation Materials: Elective	e Compulsory	
	Theoretical Mechanical Engineering:	Specialisation Product Development and Pro	duction: Elective Compulsory	!

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

Course L0876: Methods for A	Analysing Production Processes
Тур	Lecture
Hrs/wk	2
СР	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Prof. Jan Hendrik Dege
Language	DE
Cycle	WiSe
Content	<ul> <li>Modelling and simulation of maching and forming processes</li> <li>Numerical simulation of forces, temperatures, deformation in machining</li> <li>Analysis of vibration problems in maching (chatter, modal analysis,)</li> <li>Knowledge based process planning</li> <li>Design of experiments</li> <li>Machinability of nonmetallic materials</li> <li>Analysis of interaction between maching process and machine tool systems with regard to process stability and quality</li> <li>Simulation of maching processes by virtual reality methods</li> </ul>
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
Title Structure and Properties of Polymers (L0389)		<b>Typ</b> Lecture	Hrs/wk 2	<b>CP</b> 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 weilhght distribution
	- Morphology
	amorph, crystalline, blends
	- Properties
	Elasticity, plasticity, viscoelacity
	- Thermal properties
	- Electrical properties
	- Theoretical modelling
	- Applications
Literature	Ehrenstein: Polymer-Werkstoffe, Carl Hanser Verlag

Course L1892: Processing an	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		Lecture	2	2
Phase equilibria and transformation		Lecture	2	2
	en der Materialwissenschaft (L2991)	Recitation Section (large)	2	2
Module Responsible	None			
Admission Requirements		and official and a sharp that		
Recommended Previous Knowledge	Basic knowledge in Materials Science, e.g. Werk	storwissenschaft I/II		
<b>.</b>				
Educational Objectives	After taking part successfully, students have rea	ached the following learning results		
Professional Competence	,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,			
-	The students will be able to explain the proper	ties of advanced materials along with their	applications in tec	hnology, in particular
	metallic, ceramic, polymeric, semiconductor, m			
Skills	The students will be able to select material of	configurations according to the technical r	eeds and, if neces	ssary, to design new
	materials considering architectural principles			
	modern materials science, which enables t	hem to select optimum materials com	binations dependi	ng on the technical
	applications.			
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	ses.		
	gather new necessary expertise by their			
	Independent Study Time 96, Study Time in Lect	ure 84		
Credit points	6			
Course achievement	None			
Examination	Written exam			
Examination duration and	90 min			
scale				
Assignment for the	Chemical and Bioprocess Engineering: Specialis	ation General Process Engineering: Elective	Compulsory	
Following Curricula	Chemical and Bioprocess Engineering: Specialis	ation Chemical Process Engineering: Electiv	e Compulsory	
	International Management and Engineering: Sp	ecialisation II. Product Development and Pro	oduction: Elective C	ompulsory
	Materials Science: Core Qualification: Compulso			
	Product Development, Materials and Production	·		
	Product Development, Materials and Production	·	Isory	
	Product Development, Materials and Production			
	Theoretical Mechanical Engineering: Specialisat	ion Materials Science: Elective Compulsory		

Course L1580: Experimental	Methods for the Characterization of Materials
Тур	Lecture
Hrs/wk	2
СР	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Prof. Shan Shi
Language	EN
Cycle	WiSe
Content	<ul> <li>Structural characterization by photons, neutrons and electrons (in particular X-ray and neutron scattering, electron microscopy, tomography)</li> <li>Mechanical and thermodynamical characterization methods (indenter measurements, mechanical compression and tension tests, specific heat measurements)</li> <li>Characterization of optical, electrical and magnetic properties (spectroscopy, electrical conductivity and magnetometry)</li> </ul>
Literature	William D. Callister und David G. Rethwisch, Materialwissenschaften und Werkstofftechnik, Wiley&Sons, Asia (2011).  William D. Callister, Materials Science and Technology, Wiley& Sons, Inc. (2007).

Course L1579: Phase equilib	ria and transformations
Тур	Lecture
Hrs/wk	2
СР	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Prof. Jörg Weißmüller
Language	DE
Cycle	WiSe
Content	Fundamentals of statistical physics, formal structure of phenomenological thermodynamics, simple atomistic models and free- energy functions of solid solutions and compounds. Corrections due to nonlocal interaction (elasticity, gradient terms). Phase equilibria and alloy phase diagrams as consequence thereof. Simple atomistic considerations for interaction energies in metallic solid solutions. Diffusion in real systems. Kinetics of phase transformations for real-life boundary conditions. Partitioning, stability and morphology at solidification fronts. Order of phase transformations; glass transition. Phase transitions in nano- and microscale systems.
Literature	D.A. Porter, K.E. Easterling, "Phase transformations in metals and alloys", New York, CRC Press, Taylor & Francis, 2009, 3. Auflage Peter Haasen, "Physikalische Metallkunde", Springer 1994 Herbert B. Callen, "Thermodynamics and an introduction to thermostatistics", New York, NY: Wiley, 1985, 2. Auflage. Robert W. Cahn und Peter Haasen, "Physical Metallurgy", Elsevier 1996 H. Ibach, "Physics of Surfaces and Interfaces" 2006, Berlin: Springer.

Course L2991: Übung zu Phä	nomene und Methoden der Materialwissenschaft
Тур	Recitation Section (large)
Hrs/wk	2
СР	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Prof. Shan Shi
Language	DE
Cycle	WiSe
Content	Practice problems to practice and deepen the skills and content taught in the module.
	Exercises explore mathematical details in greater depth with the aim of familiarizing students with equations/concepts and how to apply them in practice (e.g. defining thermodynamic potentials and relationships, calculating enthalpy and entropy of a solid solution, constructing phase diagrams,).
Literature	D.A. Porter, K.E. Easterling, "Phase transformations in metals and alloys", New York, CRC Press, Taylor & Francis, 2009, 3. Auflage Peter Haasen, "Physikalische Metallkunde", Springer 1994 Herbert B. Callen, "Thermodynamics and an introduction to thermostatistics", New York, NY: Wiley, 1985, 2. Auflage. Robert W. Cahn und Peter Haasen, "Physical Metallurgy", Elsevier 1996 H. Ibach, "Physics of Surfaces and Interfaces" 2006, Berlin: Springer. William D. Callister und David G. Rethwisch, Materialwissenschaften und Werkstofftechnik, Wiley&Sons, Asia (2011). William D. Callister, Materials Science and Technology, Wiley& Sons, Inc. (2007).

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

Course L3160: Fundamentals of Maintenance, Repair and Overhaul (MRO)		
Тур	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):	
	<ul> <li>Life cycle analytics</li> <li>Material circularity and service products</li> <li>Rules and regulations</li> <li>Processes and production methods</li> <li>Tools and technologies</li> <li>Data handling and usage</li> <li>Design for maintenance</li> <li>Self-healing technical systems</li> </ul>	
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		
<b>Educational Objectives</b>	After taking part successfully, students have reached the following learning results	
<b>Professional Competence</b>		
Knowledge	see selected module according to FSPO	
Skills	see selected module according to FSPO	
Personal Competence		
Social Competence	see selected module according to FSPO	
Autonomy	see selected module according to FSPO	
Workload in Hours	Depends on choice of courses	
Credit points	6	
Assignment for the	Product Development, Materials and Production: Specialisation Product Development: Elective Compulsory	
Following Curricula	Product Development, Materials and Production: Specialisation Production: Elective Compulsory	
	Product Development, Materials and Production: Specialisation Materials: Elective Compulsory	

### **Specialization Production**

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

Module M0763: Aircra	aft Energy Systems			
Courses				
Title		Typ	Hrs/wk	СР
Aircraft Energy Systems (L0735)		<b>Typ</b> Lecture	3	4
Aircraft Energy Systems (L0739)		Recitation Section (large)	2	2
Module Responsible	Prof. Frank Thielecke			
Admission Requirements	None			
Recommended Previous	Basic knowledge in:			
Knowledge	Mathematics			
	Mechanics			
	Thermodynamics			
	Electrical Engineering			
	Fluid mechanics			
Educational Objectives	After taking part successfully, students have reached th	e following learning results		
Professional Competence	31			
Knowledge	Students are able to:			
	Assess challenges during the design of aircraft er	aray systems		
	Assess challenges during the design of aircraft er     Describe essential components and design points		stems	
	Give an overview of the functionality of air condit			
	Describe different system concepts for de-icing			
	Identify constraints for the electrification of aircra	ft systems, and evaluate possible co	ncepts and limita	tions
	<ul> <li>Describe architectures for fuel supply systems an</li> </ul>	d illustrate design examples		
	Explain possible approaches for the integration of	fuel cell systems and evaluate zero-	emission concept	S.S.
Skills	Students are able to:			
	Desire budge die end electric complex sectors of			
	<ul> <li>Design hydraulic and electric supply systems of a</li> <li>Analyze the thermodynamic behavior of air condi</li> </ul>			
	Design ice protection systems	cioning systems		
	Apply possible electrification concepts to existing	aircraft systems		
	Design fuel supply systems			
	<ul> <li>Perform the design of a fuel cell system</li> </ul>			
Personal Competence				
	Students are able to:			
,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,				
	Perform system design in groups and present and			
	<ul> <li>Present systems engineering problems and discu</li> </ul>	ss solutions with experts		
Autonomy	Students are able to:			
	Reflect on the content of lectures autonomously			
	<ul> <li>Apply methods learned in the course of exercises</li> </ul>	to more advanced problems		
	Identify complex system dependencies autonomo	usly and abstract simplified models a	and design proces	sses
Workload in Hours	Independent Study Time 110, Study Time in Lecture 70			
Credit points	6			
Course achievement	None			
Examination	Written exam			
Examination duration and	165 Minutes			
scale				
	Energy Systems: Specialisation Energy Systems: Electiv			
Following Curricula	Aircraft Systems Engineering: Core Qualification: Compu	•		
	International Management and Engineering: Specialisati	on II. Aviation Systems: Elective Com	pulsory	
	Aeronautics: Core Qualification: Compulsory Product Development, Materials and Production: Specia	isation Product Development: Flective	e Compulsory	
	Product Development, Materials and Production: Specia	•		
	Product Development, Materials and Production: Specia	·	-	
	Theoretical Mechanical Engineering: Specialisation Aircr			

Course L0735: Aircraft Energ	y Systems
Тур	Lecture
Hrs/wk	3
СР	4
Workload in Hours	Independent Study Time 78, Study Time in Lecture 42
Lecturer	Prof. Frank Thielecke
Language	DE
Cycle	WiSe
Content	<ul> <li>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)</li> <li>Electric Energy Systems (Generators; constant-speed-drives; DC and AC converters; electrical power distribution; bus systems; monitoring; load analysis)</li> <li>High Lift Systems (Principles; investigation of loads and system actuation power; principles and sizing of actuation and positioning systems; safety requirements and devices)</li> <li>Environmental Control Systems (Thermodynamic analysis; expansion and compression cooling systems; control strategies; cabin pressure control systems)</li> </ul>
Literature	<ul> <li>Moir, Seabridge: Aircraft Systems</li> <li>Green: Aircraft Hydraulic Systems</li> <li>Torenbek: Synthesis of Subsonic Airplane Design</li> <li>SAE1991: ARP; Air Conditioning Systems for Subsonic Airplanes</li> </ul>

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

Module M0867: Produ	iction Planning & Control and	Digital Enterprise		
Courses				
Title		Тур	Hrs/wk	СР
The Digital Enterprise (L0932)		Lecture	2	2
Production Planning and Control (LC	0929)	Lecture	2	2
Production Planning and Control (LC	0930)	Recitation Section (small)	1	1
Exercise: The Digital Enterprise (L0	933)	Recitation Section (small)	1	1
Module Responsible	Prof. Hermann Lödding			
Admission Requirements	None			
Recommended Previous	Fundamentals of Production and Quality Ma	nagement		
Knowledge				
<b>Educational Objectives</b>	After taking part successfully, students have	e reached the following learning results		
<b>Professional Competence</b>				
Knowledge	Students can explain the contents of the mo	odule in detail and take a critical position to them.		
Skills	Students are capable of choosing and apply	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 mixe	ed teams and present them to others.		
Autonomy	-			
Workload in Hours	Independent Study Time 96, Study Time in	Independent Study Time 96, Study Time in Lecture 84		
Credit points	6			
Course achievement	None			
Examination	Written exam			
Examination duration and	180 Minuten			
scale				
Assignment for the	International Management and Engineering:	: Specialisation II. Product Development and Produ	uction: Elective Co	ompulsory
Following Curricula	Logistics, Infrastructure and Mobility: Specia	alisation Production and Logistics: Elective Compu	Isory	
	Biomedical Engineering: Specialisation Artif	icial Organs and Regenerative Medicine: Elective	Compulsory	
	Biomedical Engineering: Specialisation Impl	ants and Endoprostheses: Elective Compulsory		
	Biomedical Engineering: Specialisation Medi	ical Technology and Control Theory: Elective Com	pulsory	
	Biomedical Engineering: Specialisation Mana	agement and Business Administration: Compulsor	у	
	Product Development, Materials and Produc	tion: Specialisation Product Development: Elective	e Compulsory	
	Product Development, Materials and Produc	tion: Specialisation Production: Compulsory		
	Product Development, Materials and Produc	tion: Specialisation Materials: Elective Compulsor	y	
	Theoretical Mechanical Engineering: Special	lisation Product Development and Production: Elec	ctive Compulsory	

Course L0932: The Digital En	iterprise
Тур	Lecture
Hrs/wk	2
СР	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Dr. Robert Rost
Language	DE
Cycle	WiSe
Content	Due to the developments of Industry 4.0, digitalization and interconnectivity become a strategic advantage for companies in the international competition. This lecture focuses on the relevant modules and enables the participants to evaluate current developments in this context. In particular, knowledge management, simulation, process modelling and virtual technologies are covered.  Content:  Business Process Management and Data Modelling, Simulation Knowledge and Competence Management Process Management (PPC, Workflow Management) Computer Aided Planning (CAP) and NC-Programming Virtual Reality (VR) and Augmented Reality (AR) Computer Aided Quality Management (CAQ) Industry 4.0
Literature	Scheer, AW.: ARIS - vom Geschäftsprozeß zum Anwendungssystem. Springer-Verlag, Berlin 4. Aufl. 2002  Schuh, G. et. al.: Produktionsplanung und -steuerung, Springer-Verlag. Berlin 3. Auflage 2006  Becker, J.; Luczak, H.: Workflowmanagement in der Produktionsplanung und -steuerung. Springer-Verlag, Berlin 2004  Pfeifer, T; Schmitt, R.: Masing Handbuch Qualitätsmanagement. Hanser-Verlag, München 5. Aufl. 2007  Kühn, W.: Digitale Fabrik. Hanser-Verlag, München 2006

Course L0929: Production 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	<ul> <li>Vorlesungsskript</li> <li>Lödding, H: Verfahren der Fertigungssteuerung, Springer 2008</li> <li>Nyhuis, P.; Wiendahl, HP.: Logistische Kennlinien, Springer 2002</li> </ul>

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

Course L0933: Exercise: The	Course L0933: Exercise: The Digital Enterprise		
Тур	Recitation Section (small)		
Hrs/wk	1		
СР	1		
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14		
Lecturer	Dr. Robert Rost		
Language	DE		
Cycle	WiSe		
Content	See interlocking course		
Literature	Siehe korrespondierende Vorlesung		
	See interlocking course		

Module M1183: Laser	Systems and Methods of	Manufacturing Design and An	alysis	
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				
<b>Educational Objectives</b>	After taking part successfully, studen	nts have reached the following learning results	S	
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 Developme	ent: Elective Compulsory	
Following Curricula	Product Development, Materials and	Production: Specialisation Production: Compu	lsory	
	Product Development, Materials and	Production: Specialisation Materials: Elective	Compulsory	
	Theoretical Mechanical Engineering:	Specialisation Product Development and Prod	luction: 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	<ul> <li>Fundamentals of laser technology</li> <li>Laser beam sources: CO2-, Nd:YAG-, Fiber- and Diodelasers</li> <li>Laser system technology: beam forming, beam guidance systems, beam motion and beam control</li> <li>Laser-based manufacturing technologies: generation, marking, cutting, joining, surface treatment</li> <li>Quality assurance and economical aspects of laser material processing</li> <li>Markets and Applications of laser technology</li> <li>Student group exercises</li> </ul>
Literature	<ul> <li>Hügel, H., T. Graf: Laser in der Fertigung: Strahlquellen, Systeme, Fertigungsverfahren, 3. Aufl., Vieweg + Teubner Wiesbaden 2014.</li> <li>Eichler, J., Eichler. H. J.: Laser: Bauformen, Strahlführung, Anwendungen, 7. Aufl., Springer-Verlag Berlin Heidelberg 2010.</li> <li>Steen W. M.; Mazumder J.: Laser material processing, 4th Edition, Springer-Verlag London 2010.</li> <li>J.C. Ion: Laser processing of engineering materials: principles, procedure and industrial applications, Elsevier Butterworth-Heinemann 2005.</li> <li>Gebhardt, A.: Understanding additive manufacturing, München [u.a.] Hanser 2011</li> </ul>

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

Module M1193: Cabin	Systems Engineering				
	, , ,				
Courses					
Title			Тур	Hrs/wk	СР
	nnology in cabin electronics and avionics (L1557)		Lecture	2	2
	nnology in cabin electronics and avionics (L1558)		Recitation Section (small)	1	1
Model-Based Systems Engineering			Project-/problem-based Learning	3	3
Module Responsible					
Admission Requirements	None				
Recommended Previous					
Knowledge					
	Mechanics     Thermodynamics				
	Electrical Engineering				
	Control Systems				
	Control Systems				
	Previous knowledge in:				
	Systems Engineering				
Educational Objectives	After taking part successfully, students have reach	ad the followi	ng loorning recults		
Brofossional Competence	After taking part successfully, students have reach	ed the followi	ng learning results		
Professional Competence	Chudanta ara abla ta				
Knowledge	Students are able to:  • describe the structure and operation of compute	r architacture	-		
	1				
	explain the structure and operation of digital con     available architectures of ophic electronics integral			Camanauniaati	on Notwork (ADCN)
	explain architectures of cabin electronics, integral     ward archand, the companion of Madel Based Custom				
	understand the approach of Model-Based Systems	ems Engineer	ing (MBSE) in the design of ha	raware and s	software-based cabir
	systems				
Skills	Students are able to:				
	• understand, operate and maintain a Minicompute	er			
	build up a network communication and communi	cate with othe	er network participants		
	• connect a minicomputer with a cabin manageme	nt system (A3	880 CIDS) and communicate over	r a AFDX®-Ne	etwork
	model system functions by means of formal languages SysML/UML and generate software code from the models				
	execute software code on a minicomputer				
Davasus Commetence					
Personal Competence	Chudanta ava abla ta				
Social Competence	Students are able to:	باسمىيا ي			
	form teams of two or small groups for the practice     work out partial results the practice and combine		and to form an averall colution		
	<ul> <li>work out partial results themselves and combine</li> <li>represent and contribute their own solution</li> </ul>	them with our	ners to form an overall solution		
	take over the guidance of the team				
	contribute in the team				
	- contribute in the team				
Autonomy	Students are able to:				
	organize and plan their practical tasks				
	further develop their own skills				
	take their own initiative				
	explore their own new ways of solving problems				
Workload in Hours	Independent Study Time 96, Study Time in Lecture	: 84			
Credit points					
Course achievement					
Examination	Written exam				
Examination duration and	120 minutes				
scale					
Assignment for the	Aircraft Systems Engineering: Core Qualification: E	lective Comni	ulsory		
Following Curricula	International Management and Engineering: Specia		•	sorv	
. cc.mig carricula	Aeronautics: Core Qualification: Elective Compulso		Systems. Elective comput.	,	
	Product Development, Materials and Production: S	-	Product Development: Flective Co	ompulsory	
	Product Development, Materials and Production: S		•	o.iipuisui y	
	Product Development, Materials and Production: S				
	Theoretical Mechanical Engineering: Specialisation			ılsorv	
	es escar recenanical Engineering. Specialisation	, an er art by ste	Lingingering. Liective compt		

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	<ul> <li>Skript zur Vorlesung</li> <li>Schnabel, P.: Computertechnik-Fibel: Grundlagen Computertechnik, Mikroprozessortechnik, Halbleiterspeicher, Schnittstellen und Peripherie. Books on Demand; 1. Auflage, 2003</li> <li>Schnabel, P.: Netzwerktechnik-Fibel: Grundlagen, Übertragungstechnik und Protokolle, Anwendungen und Dienste, Sicherheit. Books on Demand; 1. Auflage, 2004</li> <li>Wüst, K.: Mikroprozessortechnik: Grundlagen, Architekturen und Programmierung von Mikroprozessoren, Mikrocontrollern und Signalprozessoren. Vieweg Verlag; 2. aktualisierte und erweiterte Auflage, 2006</li> </ul>

Тур	Recitation Section (small)
Hrs/wk	1
СР	1
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14
	Prof. Ralf God
Language	DE .
Cycle	WiSe
Content	The objective of the lecture with the corresponding exercise is the acquisition of knowledge of computer and communication technology in electronic systems in the cabin and in aircraft. For the system engineer the strong interaction of software mechanical and electronic system components nowadays requires a basic understanding of cabin electronics and avionics.
	The course teaches the basics of design and functionality of computers and data networks. Subsequently it focuses on current principles and applications in integrated modular avionics (IMA), aircraft data communication networks (ADCN), cabin electronics and cabin networks:
	History of computer and network technology
	Layer model in computer technology
	Computer architectures (PC, IPC, Embedded Systems)
	BIOS, UEFI and operating system (OS)
	Programming languages (machine code and high-level languages)
	Applications and Application Programming Interfaces     Statemed interfaces (paried LISP, Ethernet)
	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 L1551: Model-Based	Systems Engineering (MBSE) with SysML/UML
Тур	Project-/problem-based Learning
Hrs/wk	3
СР	3
Workload in Hours	Independent Study Time 48, Study Time in Lecture 42
Lecturer	Prof. Raif God
Language	DE
Cycle	SoSe SoSe
Content	Objectives of the problem-oriented course are the acquisition of knowledge on system design using the formal languages
	SysML/UML, learning about tools for modeling and finally the implementation of a project with methods and tools of Model-Based
	Systems Engineering (MBSE) on a realistic hardware platform (e.g. Arduino®, Raspberry Pi®):
	What is a model?
	What is Systems Engineering?
	Survey of MBSE methodologies
	The modelling languages SysML /UML
	Tools for MBSE
	Best practices for MBSE
	Requirements specification, functional architecture, specification of a solution
	From model to software code
	Validation and verification: XiL methods
	Accompanying MBSE project
Literature	- Skript zur Vorlesung
	- Weilkiens, T.: Systems Engineering mit SysML/UML: Modellierung, Analyse, Design. 2. Auflage, dpunkt.Verlag, 2008
	- Holt, J., Perry, S.A., Brownsword, M.: Model-Based Requirements Engineering. Institution Engineering & Tech, 2011
	- Holt, J., Perry, S.A., Brownsword, M.: Model-Based Requirements Engineering. Institution Engineering & Tech, 2011

Module M0812: Aircra	aft Design I (Ci	vil Aircraft De	esign)			
Courses						
Title Aircraft Design I (Design of Transpo				Typ Lecture Recitation Section (large)	Hrs/wk 3 2	<b>CP</b> 3
Module Responsible	1			Nectation Section (large)		3
Admission Requirements	None					
Recommended Previous Knowledge	Bachelor Mecl     Bachelor Traff     Vordiplom Me     Module Air Tra	ic Systems ch. Eng.				
Educational Objectives	After taking part suc	cessfully, students h	nave reached the followi	ng learning results		
Personal Competence	Understanding     Impact of the     Introduction o  Understanding and a	g of the interactions relevant design par- f the principle design pplication of design erdisciplinary and in plinary teams	and calculation method	e various disciplines aft design		
Workload in Hours	Independent Study T	ime 110, Study Tim	e in Lecture 70			
Credit points	6					
Course achievement	No 10 %	Form Attestation	<b>Description</b> Durchführun	g einer Konzeptauslegung für	ein Verkehrsflug	zeug
Examination	Written exam					
Examination duration and scale	180 min					
Assignment for the	Aircraft Systems Eng	ineering: Core Qual	ification: Compulsory			
Following Curricula	Aeronautics: Core Qu Product Developmen Product Developmen	ialification: Compuls t, Materials and Pro t, Materials and Pro	sory duction: Specialisation F duction: Specialisation F	iation Systems: Elective Com Product Development: Electiv Production: Elective Compulso ems Engineering: Elective Col	e Compulsory ory	

Course L0820: Aircraft Desig	n I (Design of Transport Aircraft)
	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
	<ol> <li>Introduction/process of aircraft design/various aircraft configurations</li> <li>Requirements and design objectives, main design parameter (u.a. payload-range-diagramme)</li> <li>Statistical methods in overall aircraft design/data base methods</li> <li>Cabin design (fuselage sizing, cabin interior, loading systems)</li> <li>Principles of aerodynamic aircraft design (polar, geometry, 2D/3D aerodynamics)</li> <li>Wing Design</li> <li>Tail wings and landing gear</li> <li>Principles of engine design and integration</li> <li>Flight performance in cruise</li> </ol>
	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	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		

Courses					
Title			Тур	Hrs/wk	СР
Robotics and Navigation in Medicin	e (L0335)		Lecture	2	3
Robotics and Navigation in Medicin			Project Seminar	2	2
Robotics and Navigation in Medicin			Recitation Section (small)	1	1
Module Responsible	Prof. Alexander Schlaefer				
Admission Requirements	None				
Recommended Previous	• principles of math (a	gebra, analysis/calculus)			
Knowledge		ming, e.g., in Java or C++			
	solid R or Matlab skil				
Educational Objectives	After telling more account.	v studente hove voodbod t	ha fallauring languing year the		
Educational Objectives Professional Competence	After taking part succession	y, students have reached t	he following learning results		
•	The students can explain I	inematics and tracking sy	stems in clinical contexts and illustra	ate systems and	their components
Mowieage			llision detection and safety and reg		
	systems regarding design a				, ,,,
	.,				
Skills	The students are able to de	sign and evaluate navigation	on systems and robotic systems for me	edical applications	5.
Personal Competence					
Social Competence	-		ups, develop solution strategies indep	pendently, define	work processes ar
	work on them collaborative	•			
			ir work processes and software solut	ions using virtual	communication a
	software management tools				
	-		other groups, make constructive su	ggestions for imp	provement, and al
	incorporate them into their	own work.			
Autonomy			d independently control their learning		
			ate the results achieved and present t	mem in an appro	priate argumentati
	manner to the other groups				
Workload in Hours	· · · · · · · · · · · · · · · · · · ·	0, Study Time in Lecture 70	)		
Credit points  Course achievement	6 Compulsory Bonus Form	Des	cription		
Course achievement		entation	•		
	Yes 10 % Writ	en elaboration			
Examination	Written exam				
Examination duration and	90 minutes				
scale					
Assignment for the	Computer Science: Specialis	ation II: Intelligence Engine	eering: Elective Compulsory		
Following Curricula	Data Science: Specialisation	III. Applications: Elective C	Compulsory		
	Data Science: Specialisation	IV. Special Focus Area: Ele	ective Compulsory		
	Electrical Engineering: Spec	ialisation Medical Technolo	gy: Elective Compulsory		
	Computer Science in Engine	ering: Specialisation II. Eng	ineering Science: Elective Compulsory	/	
	_		tion II. Electrical Engineering: Elective		
	_		tion II. Process Engineering and Biotec	hnology: Elective	Compulsory
	Mechatronics: Core Qualific	, ,			
	,	-	and Regenerative Medicine: Elective	Compulsory	
	,	•	ndoprostheses: Elective Compulsory		
	,		logy and Control Theory: Elective Com		
	,	-	nd Business Administration: Elective C		
	Product Development, Mate	rials and Production: Specia	alisation Product Development: Electiv	e Compulsory	
	•				
	•	•	alisation Production: Elective Compuls	-	
	Product Development, Mate	rials and Production: Specia	alisation Production: Elective Compulson alisation Materials: Elective Compulson and Medical Technology: Elective Con	У	

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	Typ Recitation Section (small)	
Hrs/wk 1		
СР	1	
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14	
Lecturer	Prof. Alexander Schlaefer	
Language	EN	
Cycle	SoSe	
Content	See interlocking course	
Literature	See interlocking course	

Production				
Module M0764: Flight	t Control Systems			
Courses				
Title		T	Here (seek	CD
Flight Control Systems (L0736)		Typ Lecture	Hrs/wk 3	<b>CP</b> 4
Flight Control Systems (L0740)		Recitation Section (large)	2	2
Module Responsible	Prof. Frank Thielecke			
Admission Requirements				
Recommended Previous				
Knowledge				
_	mathematics			
	mechanics			
	thermo dynamics     electronics			
	• fluid mechanics			
	control theory			
	control theory			
<b>Educational Objectives</b>	After taking part successfully, students have reached the follow	ing learning results		
Professional Competence				
Knowledge	Students are able to			
	describe the structure and the functioning of primary flig	aht control systems as well as	actuation avior	nic high lift systems
	of aircrafts in general along with corresponding propertie			,g 2,222
	give an overview over the functioning and the structure of the struct		ear systems	
	<ul> <li>explain different configurations and designs and their ori</li> </ul>	gins		
CL III				
Skills	Students are able to			
	size primary flight control actuation systems			
	perform a controller design process for the flight control	actuators		
	<ul> <li>design high-lift systems and high-lift kinematics</li> </ul>			
	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	stadents		
	Biscuss developed solutions with experts			
Autonomy	Students are able to:			
	derive requirements and perform appropriate yet simplifications.	ied design processes for aircr	aft systems from	complex issues and
	circumstances in a self-reliant manner		-,	,
	apply new skills and methods in the context of exercises	in a self-reliant manner		
	Independent Study Time 110, Study Time in Lecture 70			
Credit points				
Course achievement				
	Written exam			
Examination duration and				
scale				
*	Aircraft Systems Engineering: Core Qualification: Compulsory	viation Systems: Floative Com-	oulcory	
Following Curricula		nation Systems: Elective Comp	ouisory	
	Aeronautics: Core Qualification: Compulsory Product Development, Materials and Production: Specialisation	Product Devolonment: Flaction	Compulsor	
	Product Development, Materials and Production: Specialisation Product Development, Materials and Production: Specialisation			
	Theoretical Mechanical Engineering: Specialisation Aircraft Syst			
	Theoretical Mechanical Engineering, Specialisation AirCraft Syst	cina Engineering, Elective Cor	пригаот у	

Course L0736: Flight Control Systems				
Тур	Lecture			
Hrs/wk	3			
СР	4			
Workload in Hours	dependent Study Time 78, Study Time in Lecture 42			
Lecturer	Prof. Frank Thielecke			
Language	DE			
Cycle	SoSe			
Content	<ul> <li>Actuation (Principles of actuators; electro-mechanical actuators; modeling, analysis and sizing of position control systems; hydro-mechanic actuation systems)</li> <li>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)</li> <li>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)</li> <li>Fuel Systems (Architectures; aviation fuels; system components; fueling system; tank inerting system; fuel management; trim tank)</li> <li>De- and Anti-Ice Systems: (Atmospheric icing conditions; principles of de- and anti-ice systems)</li> </ul>			
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	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	
<b>Educational Objectives</b>	After taking part successfully, students have reached the following learning results
<b>Professional Competence</b>	
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:
	<ul> <li>Explain the physical processes of images and assign to the systems the basic mathematical or physical equations required</li> <li>Calculate the parameters of imaging systems using the mathematical or physical equations;</li> <li>Determine the influence of different system components on the spatial and temporal resolution of imaging systems</li> <li>Explain the importance of different imaging systems for a number of clinical applications;</li> </ul>
	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
	тнеотейса меснаніся впутвенну. эресіанзаціон біо- ани меціса тесппоюду: віесціче сотпривоту

Course L0819: Medical Imaging Systems		
Тур	Lecture	
Hrs/wk	4	
СР	6	
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56	
Lecturer	Dr. Michael Grass, Dr. Michael Helle, Dr. Sven Prevrhal, Frank Michael Weber	
Language	DE	
Cycle	SoSe	
Content		
Literature	Primary book:	
	1. P. Suetens, "Fundamentals of Medical Imaging", Cambridge Press	
	Secondary books:	
	- A. Webb, "Introduction to Biomedical Imaging", IEEE Press 2003.	
	- W.R. Hendee and E.R. Ritenour, "Medical Imaging Physics", Wiley-Liss, New York, 2002.	
	- H. Morneburg (Edt), "Bildgebende Systeme für die medizinische Diagnostik", Erlangen: Siemens Publicis MCD Verlag, 1995.	
	- O. Dössel, "Bildgebende Verfahren in der Medizin", Springer Verlag Berlin, 2000.	

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

Courses				
litle .		Тур	Hrs/wk	СР
Applied Automation (L1592)		Project-/problem-based Learning	3	3
Advanced Training Course SE-ZER	Γ (L2739)	Project-/problem-based Learning	2	3
Elements of Integrated Production	Systems (L0927)	Project-/problem-based Learning	2	3
Development Management for Me	chatronics (L1512)	Lecture	2	3
atigue & Damage Tolerance (L03	10)	Lecture	2	3
GSD - Generational Sheet-Metal De	evelopment (L3064)	Lecture	3	3
ndustry 4.0 for Engineers (L2012)		Lecture	2	3
nnovation and Product Manageme	ent (L2168)	Seminar	2	3
ightweight Design Practical Cours	e (L1258)	Project-/problem-based Learning	3	3
lechanisms and Systems of Mater	ials Testing - from the viewpoint of product development and Failure	Lecture	2	2
nalysis (L0950)				
licrosystems Technology (L0724)		Lecture	2	4
ustainable Industrial Production (	L2863)	Lecture	2	4
roductivity Management (L0928)		Project-/problem-based Learning	2	2
Productivity Management (L0931)		Recitation Section (small)	1	1
eedback Control in Medical Techr	ology (L0664)	Lecture	2	3
structural Mechanics of Fibre Rein	forced Composites (L1514)	Lecture	2	3
echnical Design (L1513)		Lecture	2	3
Naterials Testing - from the viewpo	pint of industrial application (L0949)	Lecture	2	2
Reliability in Engineering Dynamic	s (L2994)	Lecture	2	2
Reliability in Engineering Dynamic	s (L2995)	Recitation Section (small)	1	2
Reliability of Aircraft Systems (L07	49)	Lecture	2	3
Module Responsible				
Admission Requirements				
<u> </u>				
Recommended Previous	None			
Knowledge				
Educational Objectives	After taking part successfully, students have reached the follow	ing learning results		
Professional Competence				
Knowledge				
	Students are able to express their extended knowledge	and discuss the connection of di	fferent specia	I fields or applic
	areas of product development, materials and production			
	Students are qualified to connect different special fields	with each other		
Skills     Students can apply specialized solution strategies and new scientific methods in selected areas				
	Students can apply specialized solution strategies and its     Students are able to transfer learned skills to new and up			annroaches
	Stadents are able to transfer learned skills to flew and ut	inchowin problems and can develo	p own solution	approacties
Personal Competence				
Social Competence				
•				
Autonomy	Students are able to develop their knowledge and skills it.	ov autonomous election of course	s.	
	salar and and an income age und skills i	.,	-	
	Depends on choice of courses			
Workload in Hours	Depends on choice of courses			
Workload in Hours Credit points	·			
	12	Product Development: Elective Co	ompulsory	
Credit points Assignment for the	12 Product Development, Materials and Production: Specialisation	·	ompulsory	
Credit points	12 Product Development, Materials and Production: Specialisation	Production: Elective Compulsory	ompulsory	

Course L1592	2: Applied Automation
Тур	Project-/problem-based Learning
Hrs/wk	3
СР	3
Workload in	Independent Study Time 48, Study Time in Lecture 42
Hours	
Examination	Mündliche Prüfung
Form	
Examination	30 Minuten
duration	
and scale	
Lecturer	Prof. Thorsten Schüppstuhl
	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£%

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	t		
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	<ul> <li>Processes and methods of product development - from idea to market launch         <ul> <li>identification of market and technology potentials</li> <li>development of a common product architecture</li> <li>Synchronized product development across all engineering disciplines</li> <li>product validation incl. customer view</li> </ul> </li> <li>Steering and optimization of product development         <ul> <li>Design of processes for product development</li> <li>IT systems for product development</li> <li>Establishment of management standards</li> <li>Typical types of organization</li> </ul> </li> </ul>
Literature	<ul> <li>Bender: Embedded Systems - qualitätsorientierte Entwicklung</li> <li>Ehrlenspiel: Integrierte Produktentwicklung: Denkabläufe, Methodeneinsatz, Zusammenarbeit</li> <li>Gausemeier/Ebbesmeyer/Kallmeyer: Produktinnovation - Strategische Planung und Entwicklung der Produkte von morgen</li> <li>Haberfellner/de Weck/Fricke/Vössner: Systems Engineering: Grundlagen und Anwendung</li> <li>Lindemann: Methodische Entwicklung technischer Produkte: Methoden flexibel und situationsgerecht anwenden</li> <li>Pahl/Beitz: Konstruktionslehre: Grundlagen erfolgreicher Produktentwicklung. Methoden und Anwendung</li> <li>VDI-Richtlinie 2206: Entwicklungsmethodik für mechatronische Systeme</li> </ul>

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

Course L3064: GSD - Generational Sheet-Metal Development	
Тур	Lecture
Hrs/wk	3
СР	3
Workload in Hours	Independent Study Time 48, Study Time in Lecture 42
Examination Form	Mündliche Prüfung
Examination duration and	30 min
scale	
Lecturer	Prof. Dr. Nikola Bursac
Language	DE
Cycle	WiSe
Content	Experience in mechanical engineering design and the fundamentals of manufacturing engineering
	After successful completion of the course, students will be able to explain development projects using the theory of product generation engineering and explain design rules for sheet metal development.
	After successful completion of the course, students will be able to apply the theory of product generation engineering to development tasks and develop sheet-metal products suitable for production.
	After successful completion of the course, students will be able to develop a product in a team and to compete against other teams.
	After successful completion of the course, students will be able to independently access knowledge required for sheet metal development.
Literature	

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

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

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

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

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	<ul> <li>Introduction (historical view, scientific and economic relevance, scaling laws)</li> <li>Semiconductor Technology Basics, Lithography (wafer fabrication, photolithography, improving resolution, next-generation lithography, nano-imprinting, molecular imprinting)</li> <li>Deposition Techniques (thermal oxidation, epitaxy, electroplating, PVD techniques: evaporation and sputtering; CVD techniques: APCVD, LPCVD, PECVD and LECVD; screen printing)</li> <li>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)</li> <li>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)</li> <li>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)</li> <li>Mechanical Sensors (strain based and stress based principle, capacitive readout, piezoresistivity, pressure sensor: piezoresistive, capacitive and fabrication process;</li> <li>Magnetic Sensors (galvanomagnateit sensors: spinning current Hall sensor and magneto-transistor; magnetoresistive sensors: magneto resistance, AMR and GMR, fluxgate magnetometer)</li> <li>Chemical and Bio Sensors (thermal gas sensors: spinning current Hall sensor and magneto-transistor; magnetoresistive sensors semiconductor gas sensor, capacitive process, capacitive process, capacitive process, capacitive process, capacity process, capacity process, capa</li></ul>
Literature	M. Madou: Fundamentals of Microfabrication, CRC Press, 2002
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
	ochach, W. Dozzel. Indoduction to microsystem technology, Wiley, 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	The state of the s
Language	
Cycle	SoSe
Content	<ul> <li>Principles of productivity management</li> <li>Shop floor management and standardisation</li> <li>Takt analysis and design of manual operations</li> <li>Maintenance Principles</li> <li>Total Productive Maintenance (TPM)</li> <li>Optimisation of set-up operations</li> </ul>
	Analysis of interlinked production systems
Literature	Bokranz, R.; Landau, K.:Produktivitätsmanagement von Arbeitssystemen. Schäffer-Poeschel, Stuttgart, 2006.
	Takeda, H.: Das synchrone Produktionssystem: Just-in-Time für das ganze Unternehmen. 5. Aufl., mi-Wirtschaftsbuch, FinanzBuch Verlag, München, 2006.  Nakajima, S.: Management der Produktionseinrichtungen (Total Productive Maintenance). Campus Verlag, New York, 1995.  Shingo, S.: A Revolution in Manufacturing: The SMED System. Productivity, Inc., 1985

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

Course L0664: Feedback Control in Medical Technology			
Тур	Lecture		
Hrs/wk	2		
СР	3		
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28		
Examination Form	Mündliche Prüfung		
Examination duration and	20 min		
scale			
Lecturer	Johannes Kreuzer, Christian Neuhaus		
Language	DE		
Cycle	SoSe		
Content	Always viewed from the engineer's point of view, the lecture is structured as follows:  Introduction to the topic Fundamentals of physiological modelling Introduction to Breathing and Ventilation Physiology and Pathology in Cardiology Introduction to the Regulation of Blood Glucose kidney function and renal replacement therapy Representation of the control technology on the concrete ventilator Excursion to a medical technology company  Techniques of modeling, simulation and controller development are discussed. In the models, simple equivalent block diagrams for physiological processes are derived and explained how sensors, controllers and actuators are operated. MATLAB and SIMULINK are used as development tools.		
Literature	<ul> <li>Leonhardt, S., &amp; Walter, M. (2016). Medizintechnische Systeme. Berlin, Heidelberg: Springer Vieweg.</li> <li>Werner, J. (2005). Kooperative und autonome Systeme der Medizintechnik. München: Oldenbourg.</li> <li>Oczenski, W. (2017). Atmen: Atemhilfen; Atemphysiologie und Beatmungstechnik: Georg Thieme Verlag KG.</li> </ul>		

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

Course L1513: Technical Design	
Тур	Lecture
Hrs/wk	2
СР	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Examination Form	Schriftliche Ausarbeitung

Lecturer	Prof. Werner Granzeier, Prof. Dieter Krause
Language	DE
Cycle	SoSe
Content	<ul> <li>Basics with analysis, concept, proposal drawings and sketches</li> <li>Samples from practice of technical industrial design</li> <li>Product concept with new ideas and package</li> <li>ID proposal with structural concept and external product ergonomics</li> <li>Visualisation and presentation of the overall concept</li> <li>Realization as individual case studies</li> </ul>
Literature	Literatur über technisches Produktdesign
	Technisches Rendering und Präsentation
	Zeichnen und perspektivisches Entwerfen
	Literaturhinweise
	What is Product Design ?
	Laura Slack
	RotoVision Schweiz 2006
	Product Design Now
	Design and Scetches
	CollinsDesign and maomao publications Spanien 2006
	Ronald B. Kemnitzer, Rendering With Markers - Definitive Techniques
	for Designers, Illustrators and Architects,
	Watson, Guptil Puplications,a division of Billboard Publications Inc.,
	New York 1983
	Creative Techniques
	DRAWING
	Barons Educational Series
	ISBN-13: 978-0-7641-6182-7
	Joseph Ungar, Rendering In Mixed Media - Techniques for Concept
	Presentation for Designers and Illustrators
	Watson-Guptil Publication a division of Billboard Publications Inc.,  New York 1985
	AIRWORLD
	Design und Architektur für die Flugreise
	Vitra Design Stiftung Weil am Rhein 2004
	Airline Design
	Perter Deslius Jacek Slaski te Neues 2005
	Technik und Sicherheit von Passagierflugzeugen
	Frank Littek
	Motorbuch Verlag 2003
	Jetliner Cabins
	Jennifer Coutts Clay
	Cs books England 2006
	BOEING Widebodies
	Michael Haenggi motorbooks international USA 2003
	form - Zeitschrift für Gestaltung, Verlag form GmbH,
	Hofgut Ober-Berrbach, 6104 Seeheim-Jugenheim
	(erscheint vierteljährlich, Verlag form GmbH )
	design report

Production"	
	german magasin,
	(erscheint monatlich)
	md - möbel interior design, Konradin-Verlag
	Robert Kohlhammer GmbH, 7022 Leinfelden-Echterdingen
	(erscheint monatlich)
	CAR STYLING, Car Styling Publishing Co. 4-8-16-11F,
	Kitashinjuku, Shinjuku-ku, Tokio 160, Japan
	(erscheint vierteljährlich in japanischer und englischer Sprache, in Hamburg erhältlich bei: Overseas Courier Service Deutschland GmbH,
	Auto & Design,
	Corso Frabcia 161, 10139 Torino, Italia
	(erscheint vierteljährlich in italienischer und englischer Sprache alle zwei
	Monate , erhältlich am HBF Hamburg
	AERO International,
	Magazin für Zivilluftfahrt
	(erscheint monatlich)
	Aircraft interior international
	Engl. magasin for Aircraft cabin interior
	(erscheint 2 monatlich)
	aerotec
	Technik- und Branchenmagazin für die Luft- und Raumfahrtindustrie

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

Course L2994: Reliability in Engineering Dynamics		
Тур	Lecture	
Hrs/wk	2	
СР	2	
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28	
Examination Form	Klausur	
Examination duration and	90 min	
scale		
Lecturer	Dr. Eric Groß, Prof. Benedikt Kriegesmann	
Language	EN	
Cycle	SoSe SoSe	
Content	Method for calculation and testing of reliability of dynamic machine systems	
	Modeling	
	System identification	
	Simulation	
	Processing of measurement data	
	Damage accumulation	
	Test planning and execution	
Literature	Bertsche, B.: Reliability in Automotive and Mechanical Engineering. Springer, 2008. ISBN: 978-3-540-33969-4	
	Inman, Daniel J.: Engineering Vibration. Prentice Hall, 3rd Ed., 2007. ISBN-13: 978-0132281737	
	Dresig, H., Holzweißig, F.: Maschinendynamik, Springer Verlag, 9. Auflage, 2009. ISBN 3540876936.	
	VDA (Hg.): Zuverlässigkeitssicherung bei Automobilherstellern und Lieferanten. Band 3 Teil 2, 3. überarbeitete Auflage, 2004. ISSN 0943-9412	

Course L2995: Reliability in I	Engineering Dynamics
Тур	Recitation Section (small)
Hrs/wk	1
СР	2
Workload in Hours	Independent Study Time 46, Study Time in Lecture 14
Examination Form	Klausur
Examination duration and	90 min
scale	
Lecturer	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

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

Course L0749: Reliability of Aircraft Systems		
Тур	Lecture	
Hrs/wk	2	
СР	3	
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28	
Examination Form	Klausur	
Examination duration and	90 Minuten	
scale		
Lecturer	Prof. Frank Thielecke, Dr. Andreas Vahl, Dr. Uwe Wieczorek	
Language	DE	
Cycle	WiSe	
Content	<ul> <li>Functions of reliability and safety (regulations, certification requirements)</li> <li>Basics methods of reliability analysis (FMEA, fault tree, functional hazard assessment)</li> <li>Reliability analysis of electrical and mechanical systems</li> </ul>	
Literature	• CS 25.1309 • SAE ARP 4754 • SAE ARP 4761	

rioduction				
Module M1156: Syste	ms Engineering			
Courses				
Title		Тур	Hrs/wk	СР
Systems Engineering (L1547)		Lecture	3	4
Systems Engineering (L1548)		Recitation Section (large)	1	2
Module Responsible	Prof. Ralf God			
Admission Requirements	None			
Recommended Previous	Basic knowledge in:			
Knowledge	Mathematics			
	Mechanics			
	Thermodynamics			
	Electrical Engineering			
	Control Systems			
	Describera la contrata de la			
	Previous knowledge in:			
	Aircraft Cabin Systems			
Educational Objectives	After taking part successfully, students have reached the fo	ollowing learning results		
Professional Competence				
•	Students are able to:			
	understand systems engineering process models, method	ds and tools for the development o	f complex Systen	าร
	describe innovation processes and the need for technology		, ,	
	explain the aircraft development process and the process			
	explain the system development process, including requi			
	identify environmental conditions and test procedures for			
	<ul> <li>value the methodology of requirements-based engineering</li> </ul>		nents engineering	g (MBRE)
Skills	Students are able to:			
	• plan the process for the development of complex System			
	organize the development phases and development Task	S		
	assign required business activities and technical Tasks			
	apply systems engineering methods and tools			
Personal Competence				
	Students are able to:			
,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,	<ul> <li>understand and accept their tasks within a development</li> </ul>	team		
	be comfortable with their role their tasks within the overa			
	<ul> <li>understand and serve their suppliers and customers in la</li> </ul>			
	assume responsibility for people and technology in the decomposition of the decompositio		ns	
Autonomy	Students are able to:			
	interact and communicate in a development team with d			
	independently research and identify certification specification spe	ations		
	formulate requirements on their own			
	create test plans on their own and accompany certification	n processes		
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56			
Credit points	6			
Course achievement	None			
Examination	Written exam			
Examination duration and				
scale	120 Pallutes			
Assignment for the	Aircraft Systems Engineering: Core Qualification: Compulso	ry		
Following Curricula	International Management and Engineering: Specialisation	•	nulsory	
i onowing curricula	International Management and Engineering: Specialisation	-	-	ompulsory
	Aeronautics: Core Qualification: Compulsory	Froduct Development and Produ	iccion. Liective C	лпривогу
	Mechatronics: Core Qualification: Elective Compulsory			
	Product Development, Materials and Production: Specialisa	tion Product Development: Compu	Isorv	
	Product Development, Materials and Production: Specialisa			
	Product Development, Materials and Production: Specialisa			
	Theoretical Mechanical Engineering: Specialisation Aircraft	·		
		5,555m5 Engineering, Elective Cor		

Course L1547: Systems Engineering		
Тур	Lecture	
Hrs/wk	3	
СР	4	
Workload in Hours	Independent Study Time 78, Study Time in Lecture 42	
Lecturer	Prof. Ralf God	
Language	DE	
Cycle	SoSe	
Content	The objective of the lecture with the corresponding exercise is to accomplish the prerequisites for the development and integration of complex systems using the example of commercial aircraft and cabin systems. Competences in the systems engineering process, tools and methods is to be achieved. Regulations, guidelines and certification issues will be known.  Key aspects of the course are processes for innovation and technology management, system design, system integration and	
	certification as well as tools and methods for systems engineering:  Innovation processes  IP-protection  Technology management  Systems engineering  Aircraft program  Certification issues  Systems development  Safety objectives and fault tolerance  Environmental and operating conditions  Tools for systems engineering  Requirements-based engineering (RBE)  Model-based requirements engineering (MBRE)	
Literature	- Skript zur Vorlesung - diverse Normen und Richtlinien (EASA, FAA, RTCA, SAE) - Hauschildt, J., Salomo, S.: Innovationsmanagement. Vahlen, 5. Auflage, 2010 - NASA Systems Engineering Handbook, National Aeronautics and Space Administration, 2007 - Hinsch, M.: Industrielles Luftfahrtmanagement: Technik und Organisation luftfahrttechnischer Betriebe. Springer, 2010 - De Florio, P.: Airworthiness: An Introduction to Aircraft Certification. Elsevier Ltd., 2010 - Pohl, K.: Requirements Engineering. Grundlagen, Prinzipien, Techniken. 2. korrigierte Auflage, dpunkt. Verlag, 2008	

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

Module M1161: Turbo	omachinery			
Courses				
Title		Тур	Hrs/wk	CP
Turbomachines (L1562) Turbomachines (L1563)		Lecture Recitation Section (large)	3 1	4 2
Module Responsible	Prof. Markus Schatz	necitation becam (large)	-	-
	None			
Recommended Previous	Technical Thermodynamics I, II, Fluid Dynamics, Heat Trans	ifer		
Knowledge	real mean mean and a final a system to a final			
Educational Objectives	After taking part successfully, students have reached the fo	ollowing learning results		
Professional Competence	5 p	<u> </u>		
-	The students can			
	distinguish the physical phenomena of conversion of			
	understand the different mathematic modelling of tu	rbomachinery,		
	<ul> <li>calculate and evaluate turbomachinery.</li> </ul>			
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			
	<ul> <li>develop a complex problem self-consistent,</li> </ul>			
	analyse the results in a critical way,			
	have an qualified exchange with other students.			
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56			
Credit points	6			
Course achievement	None			
Examination	Written exam			
Examination duration and	90 min			
scale				
Assignment for the	Energy Systems: Specialisation Energy Systems: Elective Co	ompulsory		
Following Curricula	Energy Systems: Specialisation Marine Engineering: Elective	e Compulsory		
	Product Development, Materials and Production: Specialisat	tion Product Development: Elective	Compulsory	
	Product Development, Materials and Production: Specialisat	tion Production: Elective Compulso	ry	
	Product Development, Materials and Production: Specialisat	tion Materials: Elective Compulsory	,	
	Theoretical Mechanical Engineering: Specialisation Energy S	Systems: Elective Compulsory		

Course L1562: Turbomachine	as 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:
Literature	<ul> <li>Application cases of turbomachinery</li> <li>Fundamentals of thermodynamics and fluid mechanics</li> <li>Design fundamentals of turbomachinery</li> <li>Introduction to the theory of turbine stage</li> <li>Design and operation of the turbocompressor</li> <li>Design and operation of the steam turbine</li> <li>Design and operation of the gas turbine</li> <li>Physical limits of the turbomachines</li> </ul>
Literature	<ul> <li>Traupel: Thermische Turbomaschinen, Springer. Berlin, Heidelberg, New York</li> <li>Bräunling: Flugzeuggasturbinen, Springer., Berlin, Heidelberg, New York</li> <li>Seume: Stationäre Gasturbinen, Springer., Berlin, Heidelberg, New York</li> <li>Menny: Strömungsmaschinen, Teubner., Stuttgart</li> </ul>

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

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

## Module M1209: Selected Topics of Product Development, Materials Science and Production (Alternative B: 6 I P)

Courses				
Title		Тур	Hrs/wk	СР
Applied Automation (L1592)		Project-/problem-based Learning	3	3
Advanced Training Course SE-ZERT (L2739)		Project-/problem-based Learning	2	3
Elements of Integrated Production Systems (L0927)		Project-/problem-based Learning	2	3
Development Management for Mechatronics (L1512)		Lecture	2	3
Fatigue & Damage Tolerance (L03		Lecture	2	3
GSD - Generational Sheet-Metal D		Lecture	3	3
ndustry 4.0 for Engineers (L2012)		Lecture	2	3
nnovation and Product Manageme	ent (L2168)	Seminar	2	3
ightweight Design Practical Cours	e (L1258)	Project-/problem-based Learning	3	3
Mechanisms and Systems of Mate	rials Testing - from the viewpoint of product development and Failure	Lecture	2	2
Analysis (L0950)				
Microsystems Technology (L0724)		Lecture	2	4
Sustainable Industrial Production (	L2863)	Lecture	2	4
Productivity Management (L0928)		Project-/problem-based Learning	2	2
Productivity Management (L0931)		Recitation Section (small)	1	1
Feedback Control in Medical Techr	ology (L0664)	Lecture	2	3
Structural Mechanics of Fibre Rein	orced Composites (L1514)	Lecture	2	3
Technical Design (L1513)		Lecture	2	3
Materials Testing - from the viewp	pint of industrial application (L0949)	Lecture	2	2
Reliability in Engineering Dynamic	s (L2994)	Lecture	2	2
Reliability in Engineering Dynamic	s (L2995)	Recitation Section (small)	1	2
Reliability of Aircraft Systems (L07	49)	Lecture	2	3
Module Responsible	Prof. Dieter Krause			
Admission Requirements	None			
Recommended Previous	None			
Knowledge				
Educational Objectives	After taking part successfully, students have reached the follow	ving learning results		
Professional Competence				
•				
	<ul> <li>Students are able to express their extended knowledge and discuss the connection of different special fields or a</li> </ul>			
Knowieage	Students are able to express their extended knowledge	and discuss the connection of di	fferent special	fields or applica
Miomeage	Students are able to express their extended knowledge		fferent special	fields or applica
Knowledge	<ul> <li>Students are able to express their extended knowledge areas of product development, materials and production</li> </ul>		fferent special	fields or applica
Moneage	Students are able to express their extended knowledge		fferent special	fields or applica
Skills	Students are able to express their extended knowledge areas of product development, materials and production     Students are qualified to connect different special fields to	with each other	·	fields or applica
	Students are able to express their extended knowledge areas of product development, materials and production     Students are qualified to connect different special fields we students can apply specialized solution strategies and ne	with each other ew scientific methods in selected	areas	
	Students are able to express their extended knowledge areas of product development, materials and production     Students are qualified to connect different special fields to	with each other ew scientific methods in selected	areas	
Skills	Students are able to express their extended knowledge areas of product development, materials and production Students are qualified to connect different special fields were students can apply specialized solution strategies and need to students are able to transfer learned skills to new and understanding to the skills to new and understanding to the students are able to transfer learned skills to new and understanding to the skill to the skills to the skills to the skill to the sk	with each other ew scientific methods in selected	areas	
Skills  Personal Competence	Students are able to express their extended knowledge areas of product development, materials and production Students are qualified to connect different special fields were students can apply specialized solution strategies and need to students are able to transfer learned skills to new and understanding to the skills to new and understanding to the students are able to transfer learned skills to new and understanding to the skill to the skill to the skill to the skill to the skil	with each other ew scientific methods in selected	areas	
Skills  Personal Competence  Social Competence	Students are able to express their extended knowledge areas of product development, materials and production Students are qualified to connect different special fields were students can apply specialized solution strategies and need to transfer learned skills to new and ure	with each other ew scientific methods in selected	areas	
Skills  Personal Competence	Students are able to express their extended knowledge areas of product development, materials and production  Students are qualified to connect different special fields v  Students can apply specialized solution strategies and nees to students are able to transfer learned skills to new and ur  -	with each other ew scientific methods in selected nknown problems and can develo	areas p own solution	
Skills  Personal Competence  Social Competence	Students are able to express their extended knowledge areas of product development, materials and production Students are qualified to connect different special fields were students can apply specialized solution strategies and need to transfer learned skills to new and ure	with each other ew scientific methods in selected nknown problems and can develo	areas p own solution	
Skills  Personal Competence  Social Competence	Students are able to express their extended knowledge areas of product development, materials and production Students are qualified to connect different special fields to Students can apply specialized solution strategies and ne Students are able to transfer learned skills to new and ur  Students are able to develop their knowledge and skills be	with each other ew scientific methods in selected nknown problems and can develo	areas p own solution	
Skills  Personal Competence  Social Competence  Autonomy	Students are able to express their extended knowledge areas of product development, materials and production Students are qualified to connect different special fields to Students can apply specialized solution strategies and ne Students are able to transfer learned skills to new and ur  Students are able to develop their knowledge and skills be Depends on choice of courses	with each other ew scientific methods in selected nknown problems and can develo	areas p own solution	
Skills  Personal Competence Social Competence Autonomy  Workload in Hours	Students are able to express their extended knowledge areas of product development, materials and production Students are qualified to connect different special fields to Students can apply specialized solution strategies and nees Students are able to transfer learned skills to new and urestudents are able to develop their knowledge and skills be Depends on choice of courses	with each other  ew scientific methods in selected nknown problems and can develo  by autonomous election of course	areas p own solution	
Personal Competence Social Competence Autonomy Workload in Hours Credit points Assignment for the	Students are able to express their extended knowledge areas of product development, materials and production Students are qualified to connect different special fields of the students can apply specialized solution strategies and need to students are able to transfer learned skills to new and urest of the students are able to develop their knowledge and skills be to be pends on choice of courses  Depends on choice of courses  Product Development, Materials and Production: Specialisation	with each other  ew scientific methods in selected nknown problems and can develo  by autonomous election of course  Product Development: Elective Co	areas p own solution	
Skills  Personal Competence Social Competence Autonomy  Workload in Hours  Credit points	Students are able to express their extended knowledge areas of product development, materials and production Students are qualified to connect different special fields to Students can apply specialized solution strategies and ne Students are able to transfer learned skills to new and ur  Students are able to develop their knowledge and skills be bepends on choice of courses  6 Product Development, Materials and Production: Specialisation Product Development, Materials and Production: Specialisation	with each other  ew scientific methods in selected nknown problems and can develously autonomous election of course product Development: Elective Corpoduction: Elective Compulsory	areas p own solution	
Personal Competence Social Competence Autonomy Workload in Hours Credit points Assignment for the	Students are able to express their extended knowledge areas of product development, materials and production Students are qualified to connect different special fields of the students can apply specialized solution strategies and need to students are able to transfer learned skills to new and urest of the students are able to develop their knowledge and skills be to be pends on choice of courses  Depends on choice of courses  Product Development, Materials and Production: Specialisation	with each other  ew scientific methods in selected nknown problems and can develously autonomous election of course product Development: Elective Corpoduction: Elective Compulsory Materials: Elective Compulsory	areas p own solution s.	

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	<ul> <li>Bender: Embedded Systems - qualitätsorientierte Entwicklung</li> <li>Ehrlenspiel: Integrierte Produktentwicklung: Denkabläufe, Methodeneinsatz, Zusammenarbeit</li> <li>Gausemeier/Ebbesmeyer/Kallmeyer: Produktinnovation - Strategische Planung und Entwicklung der Produkte von morgen</li> <li>Haberfellner/de Weck/Fricke/Vössner: Systems Engineering: Grundlagen und Anwendung</li> <li>Lindemann: Methodische Entwicklung technischer Produkte: Methoden flexibel und situationsgerecht anwenden</li> <li>Pahl/Beitz: Konstruktionslehre: Grundlagen erfolgreicher Produktentwicklung. Methoden und Anwendung</li> <li>VDI-Richtlinie 2206: Entwicklungsmethodik für mechatronische Systeme</li> </ul>

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

Course L3064: GSD - General	tional Sheet-Metal Development
Тур	Lecture
Hrs/wk	3
СР	3
Workload in Hours	Independent Study Time 48, Study Time in Lecture 42
Examination Form	Mündliche Prüfung
Examination duration and	30 min
scale	
Lecturer	Prof. Dr. Nikola Bursac
Language	DE
Cycle	WiSe
Content	Experience in mechanical engineering design and the fundamentals of manufacturing engineering
	After successful completion of the course, students will be able to explain development projects using the theory of product generation engineering and explain design rules for sheet metal development.
	After successful completion of the course, students will be able to apply the theory of product generation engineering to development tasks and develop sheet-metal products suitable for production.
	After successful completion of the course, students will be able to develop a product in a team and to compete against other teams.
	After successful completion of the course, students will be able to independently access knowledge required for sheet metal development.
Literature	

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

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

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

Course L0950: Mechanisms a	and Systems of Materials Testing - from the viewpoint of product development and Failure Analysis
Тур	Lecture
Hrs/wk	2
СР	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Examination Form	Klausur
Examination duration and	90 Minuten
scale	
Lecturer	Dr. Jan Oke Peters
Language	DE
Cycle	SoSe
Content	Application, analysis and discussion of basic and advanced testing methods to ensure correct selection of applicable testing
	procedure for investigation of part/materials deficiencies
	Stress-strain relationships
	Strain gauge application
	Visko elastic behavior
	Tensile test (strain hardening, necking, strain rate)
	Compression test, bending test, torsion test
	Crack growth upon static loading (J-Integral)
	Crack growth upon cyclic loading (micro- und macro cracks)
	Effect of notches
	<ul> <li>Creep testing (physical creep test, influence of stress and temperature, Larson Miller parameter)</li> </ul>
	Wear testing
	Non destructive testing application for overhaul of jet engines
Literature	
	E. Macherauch: Praktikum in Werkstoffkunde, Vieweg     G. F. Dieter: Machenical Metallyray, McCray Hill
	G. E. Dieter: Mechanical Metallurgy, McGraw-Hill     D. Dürzel: Lahr, and Übergebech Septials italahra. Visusar
	<ul> <li>R. Bürgel: Lehr- und Übungsbuch Festigkeitslehre, Vieweg</li> <li>R. Bürgel: Werkstoffe sícher beurteilen und richtig einsetzen, Vieweg</li> </ul>
	• n. burger, werkstone sicher beurtenen und fichtig 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	
	<ul> <li>Introduction (historical view, scientific and economic relevance, scaling laws)</li> <li>Semiconductor Technology Basics, Lithography (wafer fabrication, photolithography, improving resolution, next-generation lithography, nano-imprinting, molecular imprinting)</li> <li>Deposition Techniques (thermal oxidation, epitaxy, electroplating, PVD techniques: evaporation and sputtering; CVD techniques: APCVD, LPCVD, PECVD and LECVD; screen printing)</li> <li>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)</li> <li>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)</li> <li>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)</li> <li>Mechanical Sensors (strain based and stress based principle, capacitive readout, piezoresistivity, pressure sensor: piezoresistive, capacitive and fabrication process)</li> <li>Magnetic Sensors (galvanomagnetic sensors: spinning current Hall sensor and magneto-transistor; magnetoresistive sensors: magneto resistance, AlMR and GMR, fluxgate magnetometer)</li> <li>Chemical and Bio Sensors (thermal gas sensors: spilning current Hall sensor and magneto-transistor; magnetoresistive sensors (semiconductor gas sensor, chambda probe, MOSFET gas sensor, pH-FET, SAW sensor, principle of biosensor, Clark electrode, enzyme electrode, DNA ch</li></ul>
Literature	M. Madou: Fundamentals of Microfabrication, CRC Press, 2002
	N. Schwesinger: Lehrbuch Mikrosystemtechnik, Oldenbourg Verlag, 2009
	T. M. Adams, R. A. Layton:Introductory MEMS, Springer, 2010
	G. Gerlach; W. Dötzel: Introduction to microsystem technology, Wiley, 2008

Course L2863: Sustainable Industrial Production	
Тур	Lecture
Hrs/wk	2
СР	4
Workload in Hours	Independent Study Time 92, Study Time in Lecture 28
Examination Form	
Examination duration and	
scale	
Lecturer	Dr. Simon Markus Kothe
Language	DE
Cycle	SoSe
Content	
	processes that change the form and physical properties of raw materials. Manufacturing is a central driver of economi development and has a major impact on the well-being of humanity. However, the scale of current manufacturing activities result: in enormous global energy and material demands that are harmful to both the environment and people. Historically, industria activities were mostly oriented towards economic constraints, while social and environmental consequences were only hardl considered. As a result, today's global consumption rates of many resources and associated emissions often exceed the natural regeneration rate of our planet. In this respect, current industrial production can mostly be described as unsustainable. This is emphasized each year by the Earth Overshoot Day, which marks the day when humanity's ecological footprint exceeds the Earth' annual regenerative capacity.
	This lecture aims to provide the motivation, analytical methods as well as approaches for sustainable industrial production and t clarify the influence of the production phase in relation to the raw material, use and recycling phases in the entire life cycle of products. For this, the following topics will be highlighted:
	- Motivation for sustainable production, the 17 Sustainable Development Goals (SDGs) of the UN and their relevance for tomorrow's manufacturing;
	- raw material vs. production phase vs. use phase vs. recycling/end-of-life phase: importance of the production phase for th environmental impact of manufactured products;
	- Typical energy- and resource-intensive processes in industrial production and innovative approaches to increase energy and resource efficiency;
	- Methodology for optimizing the energy and resource efficiency of industrial manufacturing chains with the three steps of modeling (1), evaluating (2) and improving (3);
	- Resource efficiency of industrial manufacturing value chains and its assessment using life cycle analysis (LCA);
	- Exercise: LCA analysis of a manufacturing process (thermoplastic joining of an aircraft fuselage segment) as part of a product lif cycle assessment.
Literature	Literatur:
	- Stefan Alexander (2020): Resource efficiency in manufacturing value chains. Cham: Springer International Publishing.
	- Hauschild, Michael Z.; Rosenbaum, Ralph K.; Olsen, Stig Irving (Hg.) (2018): Life Cycle Assessment. Theory and Practice. Cham Springer International Publishing.
	- Kishita, Yusuke; Matsumoto, Mitsutaka; Inoue, Masato; Fukushige, Shinichi (2021): EcoDesign and sustainability. Singapore Springer.
	- Schebek, Liselotte; Herrmann, Christoph; Cerdas, Felipe (2019): Progress in Life Cycle Assessment. Cham: Springer International Publishing.
	- Thiede, Sebastian; Hermann, Christoph (2019): Eco-factories of the future. Cham: Springer Nature Switzerland AG.
	- Vorlesungsskript.

Course L0928: Productivity Management	
Тур	Project-/problem-based Learning
Hrs/wk	2
СР	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Examination Form	Klausur
Examination duration and	90 Minuten
scale	
Lecturer	The state of the s
Language	
Cycle	SoSe
Content	<ul> <li>Principles of productivity management</li> <li>Shop floor management and standardisation</li> <li>Takt analysis and design of manual operations</li> <li>Maintenance Principles</li> <li>Total Productive Maintenance (TPM)</li> <li>Optimisation of set-up operations</li> </ul>
	Analysis of interlinked production systems
Literature	Bokranz, R.; Landau, K.:Produktivitätsmanagement von Arbeitssystemen. Schäffer-Poeschel, Stuttgart, 2006.  Takeda, H.: Das synchrone Produktionssystem: Just-in-Time für das ganze Unternehmen. 5. Aufl., mi-Wirtschaftsbuch, FinanzBuch Verlag, München, 2006.
	Nakajima, S.: Management der Produktionseinrichtungen (Total Productive Maintenance). Campus Verlag, New York, 1995.  Shingo, S.: A Revolution in Manufacturing: The SMED System. Productivity, Inc., 1985

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

Course L0664: Feedback Control in Medical Technology	
Тур	Lecture
Hrs/wk	2
СР	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Examination Form	Mündliche Prüfung
Examination duration and	20 min
scale	
Lecturer	Johannes Kreuzer, Christian Neuhaus
Language	DE
Cycle	SoSe
Content	Always viewed from the engineer's point of view, the lecture is structured as follows:  Introduction to the topic Fundamentals of physiological modelling Introduction to Breathing and Ventilation Physiology and Pathology in Cardiology Introduction to the Regulation of Blood Glucose kidney function and renal replacement therapy Representation of the control technology on the concrete ventilator Excursion to a medical technology company  Techniques of modeling, simulation and controller development are discussed. In the models, simple equivalent block diagrams for physiological processes are derived and explained how sensors, controllers and actuators are operated. MATLAB and SIMULINK are used as development tools.
Literature	<ul> <li>Leonhardt, S., &amp; Walter, M. (2016). Medizintechnische Systeme. Berlin, Heidelberg: Springer Vieweg.</li> <li>Werner, J. (2005). Kooperative und autonome Systeme der Medizintechnik. München: Oldenbourg.</li> <li>Oczenski, W. (2017). Atmen: Atemhilfen; Atemphysiologie und Beatmungstechnik: Georg Thieme Verlag KG.</li> </ul>

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	<ul> <li>Schürmann, H., "Konstruieren mit Faser-Kunststoff-Verbunden", Springer, Berlin, aktuelle Auflage.</li> <li>Wiedemann, J., "Leichtbau Band 1: Elemente", Springer, Berlin, Heidelberg, , aktuelle Auflage.</li> <li>Reddy, J.N., "Mechanics of Composite Laminated Plates and Shells", CRC Publishing, Boca Raton et al., current edition.</li> <li>Jones, R.M., "Mechanics of Composite Materials", Scripta Book Co., Washington, current edition.</li> <li>Timoshenko, S.P., Gere, J.M., "Theory of elastic stability", McGraw-Hill Book Company, Inc., New York, current edition.</li> <li>Turvey, G.J., Marshall, I.H., "Buckling and postbuckling of composite plates", Chapman and Hall, London, current edition.</li> <li>Herakovich, C.T., "Mechanics of fibrous composites", John Wiley and Sons, Inc., New York, current edition.</li> <li>Mittelstedt, C., Becker, W., "Strukturmechanik ebener Laminate", aktuelle Auflage.</li> </ul>

Course L1513: Technical Design	
Тур	Lecture
Hrs/wk	2
СР	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Examination Form	Schriftliche Ausarbeitung

Lecturer	Prof. Werner Granzeier, Prof. Dieter Krause
Language	DE
Cycle	SoSe
Content	<ul> <li>Basics with analysis, concept, proposal drawings and sketches</li> <li>Samples from practice of technical industrial design</li> <li>Product concept with new ideas and package</li> <li>ID proposal with structural concept and external product ergonomics</li> <li>Visualisation and presentation of the overall concept</li> <li>Realization as individual case studies</li> </ul>
Literature	Literatur über technisches Produktdesign
	Technisches Rendering und Präsentation
	Zeichnen und perspektivisches Entwerfen
	Literaturhinweise
	What is Product Design ?
	Laura Slack
	RotoVision Schweiz 2006
	Product Design Now
	Design and Scetches
	CollinsDesign and maomao publications Spanien 2006
	Ronald B. Kemnitzer, Rendering With Markers - Definitive Techniques
	for Designers, Illustrators and Architects,
	Watson, Guptil Puplications,a division of Billboard Publications Inc.,
	New York 1983
	Creative Techniques
	DRAWING
	Barons Educational Series
	ISBN-13: 978-0-7641-6182-7
	Joseph Ungar, Rendering In Mixed Media - Techniques for Concept
	Presentation for Designers and Illustrators
	Watson-Guptil Publication a division of Billboard Publications Inc.,
	New York 1985
	AIRWORLD
	Design und Architektur für die Flugreise
	Vitra Design Stiftung Weil am Rhein 2004
	Airline Design
	Perter Deslius Jacek Slaski te Neues 2005
	Technik und Sicherheit von Passagierflugzeugen
	Frank Littek
	Motorbuch Verlag 2003
	Jetliner Cabins
	Jennifer Coutts Clay
	Cs books England 2006
	BOEING Widebodies
	Michael Haenggi motorbooks international USA 2003
	form - Zeitschrift für Gestaltung, Verlag form GmbH,
	Hofgut Ober-Berrbach, 6104 Seeheim-Jugenheim
	(erscheint vierteljährlich, Verlag form GmbH )
	design report

Production	
	german magasin,
	(erscheint monatlich)
	md - möbel interior design, Konradin-Verlag
	Robert Kohlhammer GmbH, 7022 Leinfelden-Echterdingen
	(erscheint monatlich)
	CAR STYLING, Car Styling Publishing Co. 4-8-16-11F,
	Kitashinjuku, Shinjuku-ku, Tokio 160, Japan
	(erscheint vierteljährlich in japanischer und englischer Sprache, in Hamburg erhältlich bei: Overseas Courier Service Deutschland GmbH,
	Auto & Design,
	Corso Frabcia 161, 10139 Torino, Italia
	(erscheint vierteljährlich in italienischer und englischer Sprache alle zwei
	Monate , erhältlich am HBF Hamburg
	AERO International,
	Magazin für Zivilluftfahrt
	(erscheint monatlich)
	Aircraft interior international
	Engl. magasin for Aircraft cabin interior
	(erscheint 2 monatlich)
	aerotec
	Technik- und Branchenmagazin für die Luft- und Raumfahrtindustrie

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

Course L2994: Reliability in Engineering Dynamics					
Тур	Lecture				
Hrs/wk	2				
СР	2				
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28				
Examination Form	Klausur				
Examination duration and	90 min				
scale					
Lecturer	Dr. Eric Groß, Prof. Benedikt Kriegesmann				
Language	EN				
Cycle	SoSe				
Content	Method for calculation and testing of reliability of dynamic machine systems				
	Modeling				
	System identification				
	Simulation				
	Processing of measurement data				
	Damage accumulation				
	Test planning and execution				
Literature	Bertsche, B.: Reliability in Automotive and Mechanical Engineering. Springer, 2008. ISBN: 978-3-540-33969-4				
	Inman, Daniel J.: Engineering Vibration. Prentice Hall, 3rd Ed., 2007. ISBN-13: 978-0132281737				
	Dresig, H., Holzweißig, F.: Maschinendynamik, Springer Verlag, 9. Auflage, 2009. ISBN 3540876936.				
	VDA (Hg.): Zuverlässigkeitssicherung bei Automobilherstellern und Lieferanten. Band 3 Teil 2, 3. überarbeitete Auflage, 2004. ISSN 0943-9412				

Course L2995: Reliability in 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				
	Oresig, H., Holzweißig, F.: Maschinendynamik, Springer Verlag, 9. Auflage, 2009. ISBN 3540876936.				
	VDA (Hg.): Zuverlässigkeitssicherung bei Automobilherstellern und Lieferanten. Band 3 Teil 2, 3. überarbeitete Auflage, 2004. ISSN 0943-9412				

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

Course L0749: Reliability of Aircraft Systems				
Тур	Lecture			
Hrs/wk	2			
СР	3			
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28			
Examination Form	Klausur			
Examination duration and	90 Minuten			
scale				
Lecturer	Prof. Frank Thielecke, Dr. Andreas Vahl, Dr. Uwe Wieczorek			
Language	DE			
Cycle	WiSe			
Content	<ul> <li>Functions of reliability and safety (regulations, certification requirements)</li> <li>Basics methods of reliability analysis (FMEA, fault tree, functional hazard assessment)</li> <li>Reliability analysis of electrical and mechanical systems</li> </ul>			
Literature	• CS 25.1309 • SAE ARP 4754 • SAE ARP 4761			

Module M1226: Mechanical Properties							
Courses							
Title		Тур	Hrs/wk	СР			
Mechanical Behaviour of Brittle Materials (L1661)		Lecture	2	3			
Dislocation Theory of Plasticity (L16	662)	Lecture	2	3			
Module Responsible	Prof. Shan Shi						
Admission Requirements	None						
Recommended Previous	Basics in Materials Science I/II						
Knowledge							
Educational Objectives	After taking part successfully, students have reached the following learning results						
<b>Professional Competence</b>							
Knowledge	Students can explain basic principles of crystallography, statics (free body diagrams, tractions) and thermodynamics (energy						
	minimization, energy barriers, entropy)	minimization, energy barriers, entropy)					
Chille							
SKIIIS	Students are capable of using standardized calculation methods: tensor calculations, derivatives, integrals, tensor transformations						
Personal Competence							
Social Competence	Students can provide appropriate feedback and handle feedback on their own performance constructively.						
Autonomy	Students are able to						
	- assess their own strengths and weaknesses						
	- assess their own state of learning in specific terms and to define further work steps on this basis guided by teachers.						
	- work independently based on lectures and notes to solve problems, and to ask for help or clarifications when needed						
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56						
Credit points	6						
Course achievement	None						
Examination	Written exam						
Examination duration and	180 min						
scale							
Assignment for the	Materials Science: Core Qualification: Compulsory						
Following Curricula	Mechanical Engineering and Management: Specialisation Materials: Elective Compulsory						
	Product Development, Materials and Production: Specialisation Product Development: Elective Compulsory						
	Product Development, Materials and Production: Specialisation Production: Elective Compulsory						
	Product Development, Materials and Production: Specialisation Materials: Compulsory						
	Theoretical Mechanical Engineering: Specialisation Mat	terials Science: Elective Compuls	ory				

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

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

Module M0840: Optin	nal and Robust Control			
Courses				
Title		Typ	Hrs/wk	СР
Optimal and Robust Control (L0658	()	<b>Typ</b> Lecture	2	3
Optimal and Robust Control (L0659		Recitation Section (small)	2	3
Module Responsible	NN			
Admission Requirements	None			
Recommended Previous				
Knowledge	Classical control (frequency response, root locu	is)		
	State space methods			
	Linear algebra, singular value decomposition			
Educational Objectives	After taking part successfully, students have reached	the following learning results		
Professional Competence				
Knowledge				
_	Students can explain the significance of the ma			
	They can explain the duality between optimal s			
	They can explain how the H2 and H-infinity nor     They can explain how an LOC design problem.			
	<ul> <li>They can explain how an LQG design problem of They can explain how model uncertainty can be</li> </ul>			
	They can explain how - based on the small ga			
	an uncertain plant.	in theorem a robust controller can gu	arantee stability	and performance to
	They understand how analysis and synthesis co	onditions on feedback loops can be repr	esented as linear	matrix inequalities.
		·		•
Skills	<ul> <li>Students are capable of designing and tuning L</li> </ul>	.OG controllers for multivariable plant m	odels.	
	They are capable of representing a H2 or H-infi			and of using standard
	software tools for solving it.	,	, , , , , ,	
	They are capable of translating time and frequency.	uency domain specifications for control	loops into const	raints on closed-loop
	sensitivity functions, and of carrying out a mixed-sensitivity design.			
	<ul> <li>They are capable of constructing an LFT unce</li> </ul>	ertainty model for an uncertain system	, and of designing	ng a mixed-objective
	robust controller.			
	<ul> <li>They are capable of formulating analysis and s</li> </ul>	synthesis conditions as linear matrix ine	equalities (LMI), a	nd of using standard
	LMI-solvers for solving them.			
	They can carry out all of the above using stand	ard software tools (Matlab robust contro	ol toolbox).	
Personal Competence				
	Students can work in small groups on specific problen	ns to arrive at joint solutions.		
Autonomy	Students are able to find required information in sour		software docume	ntation) and use it to
	solve given problems.			
Workload in Hours	Independent Study Time 124, Study Time in Lecture 5	56		
Credit points				
Course achievement	None			
Examination	Oral exam			
Examination duration and	30 min			
scale				
Assignment for the	Electrical Engineering: Specialisation Control and Pow		uisory	
Following Curricula				
	Aircraft Systems Engineering: Core Qualification: Elective Computer V	tive Compulsory		
	Aeronautics: Core Qualification: Elective Compulsory Mechatronics: Core Qualification: Elective Compulsory			
	Biomedical Engineering: Specialisation Artificial Organ		Compulsory	
	Biomedical Engineering: Specialisation Implants and E	•	compuisor y	
	Biomedical Engineering: Specialisation Medical Technic		pulsory	
	Biomedical Engineering: Specialisation Management a			
	Product Development, Materials and Production: Spec			
	Product Development, Materials and Production: Spec	ialisation Production: Elective Compulso	ory	
		·	-	

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

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

Module M1343: Struc	cure and properties of fibre-polymo	er-composites		
Courses				
Title		Тур	Hrs/wk	СР
Structure and properties of fibre-po	lymer-composites (L1894)	Lecture	2	3
Structure and properties of fibre-po	ymer-composites (L2614)	Project-/problem-based Learning	2	2
Structure and properties of fibre-po	ymer-composites (L2613)	Recitation Section (large)	1	1
Module Responsible	Prof. Bodo Fiedler			
Admission Requirements	None			
Recommended Previous	Basics: chemistry / physics / materials science			
Knowledge				
Educational Objectives	After taking part successfully, students have reach	ed the following learning results		
Professional Competence				
Knowledge	Students can use the knowledge of fiber-reinforce necessary testing and analysis.	ed composites (FRP) and its constituents to	olay (fiber / m	atrix) and define the
	They can explain the complex relationships structu	re-property relationship and		
	the interactions of chemical structure of the po- neighboring contexts (e.g. sustainability, environm		fiber types,	including to explain
Skills	Students are capable of			
	<ul> <li>using standardized calculation methods in a given context to mechanical properties (modulus, strength) to calculate and evaluate the different materials.</li> <li>approximate sizing using the network theory of the structural elements implement and evaluate.</li> <li>selecting appropriate solutions for mechanical recycling problems and sizing example stiffness, corrosion resistance.</li> </ul>			
Personal Competence				
Social Competence	Students can			
	<ul> <li>arrive at funded work results in heterogenius groups and document them.</li> <li>provide appropriate feedback and handle feedback on their own performance constructively.</li> </ul>			
Autonomy	Students are able to			
	- assess their own strengths and weaknesses.			
	- assess their own state of learning in specific term	s and to define further work steps on this bas	sis.	
	- assess possible consequences of their professiona	al activity.		
Workload in Hours	Independent Study Time 110, Study Time in Lectur	re 70		
Credit points				
Course achievement				
Examination	Written exam			
Examination duration and	90 min			
scale				
-	Aircraft Systems Engineering: Core Qualification: E			
Following Curricula	International Management and Engineering: Specia	·	ion: Elective C	ompulsory
	Aeronautics: Core Qualification: Elective Compulsor	,		
	Materials Science and Engineering: Specialisation E	, ,		
	Materials Science: Specialisation Engineering Mater Mechanical Engineering and Management: Core Qu	• •		
	Product Development, Materials and Production: Sp	· · ·	`omnuleory	
	Product Development, Materials and Production: Sp Product Development, Materials and Production: Sp	•		
	Product Development, Materials and Production: Sp			
	Renewable Energies: Specialisation Bioenergy Syst			
	Renewable Energies: Specialisation Wind Energy Systems	· · ·		
	Renewable Energies: Specialisation Solar Energy St	• •		
	Theoretical Mechanical Engineering: Specialisation	• •		

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

Course L2614: Structure and	properties of fibre-polymer-composites
Тур	Project-/problem-based Learning
Hrs/wk	2
СР	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Prof. Bodo Fiedler
Language	DE/EN
Cycle	SoSe
Content	The students receive the assignment in the form of a material design for test bodies made of fibre composites. Technical and normative requirements are listed in the assignment, all other required information comes from the lectures and exercises or the respective documents (electronically and in conversation).  The procedure is specified in a milestone plan and enables the students to plan subtasks and thus work continuously. At the end of the project, different test specimens were tested in tensile or bending tests.  In the individual project meetings, the conception (discussion of requirements and risks) is scrutinised. The calculations are analysed, the production methods are evaluated and determined. Materials are selected and the test specimens are manufactured according to standards. The quality and mechanical properties are checked and classified. At the end, a final report is prepared and the results are presented to all participants in the form of a presentation and discussed.  Translated with www.DeepL.com/Translator (free version)
Literature	Hall, Clyne: Introduction to Composite materials, Cambridge University Press Daniel, Ishai: Engineering Mechanics of Composites Materials, Oxford University Press Mallick: Fibre-Reinforced Composites, Marcel Deckker, New York

Course L2613: Structure and	Course L2613: Structure and properties of fibre-polymer-composites		
Тур	Recitation Section (large)		
Hrs/wk	1		
СР	1		
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14		
Lecturer	Prof. Bodo Fiedler		
Language	EN		
Cycle	SoSe		
Content	The contents of the lecture are repeated and deepened using practical examples.		
	Calculations are carried out together or individually, and the results are discussed critically.		
Literature	Hall, Clyne: Introduction to Composite materials, Cambridge University Press		
	Daniel, Ishai: Engineering Mechanics of Composites Materials, Oxford University Press		
	Mallick: Fibre-Reinforced Composites, Marcel Deckker, New York		

Module M1344: Proce	essing of Fibre-Polymer-Composites			
Courses				
Title		Тур	Hrs/wk	СР
Processing of fibre-polymer-compos	sites (L1895)	Lecture	2	3
From Molecule to Composites Part (	T	Project-/problem-based Learning	2	3
Module Responsible	Prof. Bodo Fiedler			
Admission Requirements	None			
Recommended Previous	Knowledge in the basics of chemistry / physics / materials	science		
Knowledge				
Educational Objectives	After taking part successfully, students have reached the	following learning results		
<b>Professional Competence</b>				
Knowledge	Students are able to give a summary of the technical de	tails of the manufacturing processes co	mposites and	I illustrate respective
	relationships. They are capable of describing and comm	nunicating relevant problems and que	stions using a	appropriate technical
	language. They can explain the typical process of solving	practical problems and present related	results.	
Skills	Students can use the knowledge of fiber-reinforced comp	posites (FRP) and its constituents (fiber	/ matrix) and	define the necessary
	testing and analysis.	(	,	,
	,			
	They can explain the complex structure-property relation:	ship and		
	the interactions of chemical structure of the polymers	s, their processing with the different	fiber types,	including to explain
	neighboring contexts (e.g. sustainability, environmental p	protection).		
Personal Competence				
Social Competence	Students are able to cooperate in small, mixed-subject g	roups in order to independently derive	solutions to g	iven problems in the
	context of civil engineering. They are able to effectively	present and explain their results alone	or in groups i	n front of a qualified
	audience. Students have the ability to develop alternativ	e approaches to an engineering proble	m independe	ntly or in groups and
	discuss advantages as well as drawbacks.			
Autonomy	Students are capable of independently solving mechani	cal engineering problems using provid	ed literature.	They are able to fill
	gaps in as well as extent their knowledge using the litera	ture and other sources provided by the	supervisor. Fu	urthermore, they can
	meaningfully extend given problems and pragmatically so	olve them by means of corresponding se	olutions and c	oncepts.
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56			
Credit points	6			
Course achievement	None			
Examination	Written exam			
Examination duration and	90 min			
scale				
Assignment for the	Materials Science and Engineering: Specialisation Engineer	ering Materials: Elective Compulsory		
Following Curricula	Materials Science: Specialisation Engineering Materials: E	lective Compulsory		
	Mechanical Engineering and Management: Specialisation			
	Product Development, Materials and Production: Specialis	·	mpulsory	
	Product Development, Materials and Production: Specialis	• •		
	Product Development, Materials and Production: Specialis			
	Theoretical Mechanical Engineering: Specialisation Materi	als Science: Elective Compulsory		

Course L1895: Processing of	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 Molecule to Composites Part		
Тур	Project-/problem-based Learning	
Hrs/wk	2	
СР	3	
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28	
Lecturer	Prof. Bodo Fiedler	
Language	DE/EN	
Cycle	SoSe	
Content	Students get the task in the form of a customer request for the development and production of a MTB handlebar made of fiber composites. In the task technical and normative requirements (standards) are given, all other required information come from the lectures and tutorials, and the respective documents (electronically and in conversation).  The procedure is to specify in a milestone schedule and allows students to plan tasks and to work continuously. At project end, each group has a made handlebar with approved quality.  In each project meeting the design (discussion of the requirements and risks) are discussed. The calculations are analyzed, evaluated and established manufacturing methods are selected. Materials are selected bar will be produced. The quality and the mechanical properties are checked. At the end of the final report created (compilation of the results for the "customers").  After the test during the "customer / supplier conversation" there is a mutual feedback-talk ("lessons learned") in order to ensure the continuous improvement.	
Literature	Åström: Manufacturing of Polymer Composites, Chapman and Hall	

Module M1690: Aircra	aft Design II (Special Air Vehicle Design	1)		
Courses				
	gn of Rotorcraft, special operations aircraft, UAV) (L0844) gn of Rotorcraft, special operations aircraft, UAV) (L0847)	<b>Typ</b> Lecture Recitation Section (large)	Hrs/wk 3 2	<b>CP</b> 3 3
Module Responsible	Prof. Volker Gollnick			
Admission Requirements	None			
Recommended Previous	Aircraft Design I (Design of Transport Aircraft)			
Knowledge	Air Transportation Systems			
<b>Educational Objectives</b>	After taking part successfully, students have reached the	following learning results		
Professional Competence Knowledge				
	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 conc	eptual design	
	Intensified knowledge of performance design on various	air systems		
Skills	Understanding and application of design and calculation	methods		
	Understanding of interdisciplinary and integrative interde			
		pendencies		
	mission oriented technical definition of air systems			
	special conceptual calculation methods for special equip	ment characteristics		
	assessment of different design solutions			
Personal Competence				
Social Competence	Working in teams for focused solutions			
	communication, assertiveness, technical persuasion			
Autonomy	Organisation of worksflows and strategies for solutions			
	structured task analysis and definition of solutions			
Workload in Hours	Independent Study Time 110, Study Time in Lecture 70			
Credit points	6			
Course achievement	None			
Examination	Written exam			
Examination duration and scale	180 min			
	Aircraft Systems Engineering: Core Qualification: Elective	Compulsory		
Following Curricula			oulsory	
	Aeronautics: Core Qualification: Elective Compulsory	,	•	
	Product Development, Materials and Production: Specialis	sation Product Development: Elective	Compulsory	
	Product Development, Materials and Production: Specialis	•	•	
	Theoretical Mechanical Engineering: Specialisation Aircra	ft Systems Engineering: Elective Con	npulsory	

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

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

Module M1878: Susta	inable energy from wind and water			
Courses				
Title		Тур	Hrs/wk	СР
Offshore Geotechnical Engineering	(L0067)	Lecture	1	1
Hydro Power Use (L0013)		Lecture	1	1
Wind Turbine Plants (L0011) Wind Energy Use - Focus Offshore	10012)	Lecture Lecture	2 1	3 1
	Dr. Marvin Scherzinger	Eccture	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 have reached th	o following loarning results		
Educational Objectives Professional Competence	After taking part successfully, students have reached th	e ronowing rearring results		
Knowledge	By ending this module students can explain in detail	knowledge of wind turbines wi	ith a particular focus of	f wind energy use in
Momeage	offshore conditions and can critical comment these asp			
	to describe fundamentally the use of water power to ge			
	in the implementation of renewable energy projects in o	ountries outside Europe.		
	Through active discussions of various topics within th	e seminar of the module stu	dents improve their un	derstanding and the
	application of the theoretical background and are thus a			derstanding and the
		,,		
Skills	Students are able to apply the acquired theoretical for			
	assess technically the resulting relationships in the cor	- '		
	compare critically the special procedure for the implem in principle applied approach in Europe and can apply the		•	side Europe with the
	in principle applied approach in Europe and can apply a	is procedure on exemplary the	oretical projects.	
Personal Competence				
Social Competence	Students can discuss scientific tasks subjet-specificly a	nd multidisciplinary within a se	minar.	
Autonomy	Students can independently exploit sources in the cor	ntext of the emphasis of the le	ecture material to clear	the contents of the
	lecture and to acquire the particular knowledge about t	ne subject area.		
Workload in Hours	Independent Study Time 110, Study Time in Lecture 70			
Credit points	Independent Study Time 110, Study Time in Lecture 70			
Course achievement				
Examination				
Examination duration and	180 min			
scale				
Assignment for the	Civil Engineering: Specialisation Structural Engineering:	Elective Compulsory		
Following Curricula	Civil Engineering: Specialisation Geotechnical Engineeri	ng: Elective Compulsory		
	Civil Engineering: Specialisation Coastal Engineering: El	ective Compulsory		
	International Management and Engineering: Specialisat			Compulsory
	International Management and Engineering: Specialisat	**		
	Product Development, Materials and Production: Specia			
	Product Development, Materials and Production: Specia Product Development, Materials and Production: Specia			
	Renewable Energies: Core Qualification: Compulsory	nsacion materiais. Elective Com	ipaisui y	
	Theoretical Mechanical Engineering: Specialisation Ener	gy Systems: Elective Compulso	prv	
	Process Engineering: Specialisation Environmental Process			
	Water and Environmental Engineering: Specialisation Ci		-	
	Water and Environmental Engineering: Specialisation Er	vironment: Compulsory		

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

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	<ul> <li>Introduction, importance of water power in the national and global context</li> <li>Physical basics: Bernoulli's equation, usable height of fall, hydrological measures, loss mechanisms, efficiencies</li> <li>Classification of Hydropower: Flow and Storage hydropower, low and high pressure systems</li> <li>Construction of hydroelectric power plants: description of the individual components and their technical system interaction</li> <li>Structural engineering components; representation of dams, weirs, dams, power houses, computer systems, etc.</li> <li>Energy Technical Components: Illustration of the different types of hydraulic machinery, generators and grid connection</li> <li>Hydropower and the Environment</li> <li>Examples from practice</li> </ul>
Literature	<ul> <li>Schröder, W.; Euler, G.; Schneider, K.: Grundlagen des Wasserbaus; Werner, Düsseldorf, 1999, 4. Auflage</li> <li>Quaschning, V.: Regenerative Energiesysteme: Technologie - Berechnung - Simulation; Carl Hanser, München, 2011, 7. Auflage</li> <li>Giesecke, J.; Heimerl, S.; Mosony, E.: Wasserkraftanlagen - Planung, Bau und Betrieb; Springer, Berlin, Heidelberg, 2009, 5. Auflage</li> <li>von König, F.; Jehle, C.: Bau von Wasserkraftanlagen - Praxisbezogene Planungsunterlagen; C. F. Müller, Heidelberg, 2005, 4. Auflage</li> <li>Strobl, T.; Zunic, F.: Wasserbau: Aktuelle Grundlagen - Neue Entwicklungen; Springer, Berlin, Heidelberg, 2006</li> </ul>

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

FIOUUCLIOII						
Module M1894: Autor	nation Technology	and Systems				
Courses						
Title				Тур	Hrs/wk	СР
Automation Technology and Syster	ns (L2329)			Lecture	4	4
Automation Technology and Syster				Project-/problem-based Learning	1	1
Automation Technology and Syster	ms (L2330)			Recitation Section (small)	1	1
Module Responsible	Prof. Thorsten Schüppstuhl					
Admission Requirements	None					
Recommended Previous	without major course asses	sment				
Knowledge	.,,					
Educational Objectives	After taking part successful	llv. students have re	ached the following	ng learning results		
Professional Competence	Titel taking part saccessia	ny, scadents nave re	deried the followin	.g .cug .cou.co		
•	Students					
Knowledge	Students					
	<ul> <li>know the characteris</li> </ul>	stic components of a	n automation syst	ems and have good understand	ling of their int	eraction
	<ul> <li>know methods for a</li> </ul>	systematical analysi	s of automation to	asks and are able to use them		
	<ul> <li>have special compet</li> </ul>	ences in industrial re	obot based autom	ation systems		
Skills	Students are able to					
	analyze complex Aut	tomation tasks				
	develop application		solutions			
	<ul> <li>design subsystems a</li> </ul>					
	investigate and eval					
	create simple progra			controllers		
	design of circuit for particular for particula					
Personal Competence						
Social Competence	Students are able to					
	- find solutions for automat	ion and handling tas	ke in groupe			
	- Illia solutions for automat	ion and nanding tas	ks III groups			
	- develop solutions in a pro	duction environmer	nt with qualified pe	ersonnel at technical level and r	epresent decis	ions.
	6					
Autonomy	Students are able to					
	<ul> <li>analyze automation</li> </ul>	tasks independently				
	<ul> <li>generate programs f</li> </ul>	or robots and progra	mmable logic dev	vices autonomously		
	<ul> <li>develop solutions for</li> </ul>					
	design safety concer					
	assess consequence	s of their profession	al actions and res	oonsibilities		
Workload in Hours	Independent Study Time 96	5, Study Time in Lect	ture 84			
Credit points	6					
Course achievement	Compulsory Bonus Form		Description			
		ject theoretical		eistung umfasst die Ergebniss		sierten Anteile des
	·	ctical work	Moduls sowie	der Präsentation in der Gruppe.	•	
	Written exam					
Examination duration and	120 min					
scale						
Assignment for the	International Management	and Engineering: Sp	ecialisation II. Pro	duct Development and Production	on: Elective Co	mpulsory
Following Curricula	Mechatronics: Core Qualific			•		-
•			-	roduct Development: Elective Co	ompulsory	
	Product Development, Mate		•	·	p	
	·		•	aterials: Elective Compulsory		
				opment and Production: Elective	e Compulsory	
	o. caca recharical Eng	,zaringi opecialisat			_ 50pai501 y	

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

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

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

Module M0563: Robot	tics						
Courses							
Title Robotics: Modelling and Control (L0 Robotics: Modelling and Control (L1					Typ Integrated Lecture Project-/problem-based Learning	Hrs/wk 4 2	<b>CP</b> 4 2
Module Responsible					3		
Admission Requirements	None						
Recommended Previous	Fundamentals of elect	trical engine	ering				
Knowledge	Donald Incombada a second						
	Broad knowledge of m	nechanics					
	Fundamentals of cont	rol theory					
<b>Educational Objectives</b>	After taking part succ	essfully, stu	dents have re	ached the following	ng learning results		
Professional Competence							
					and solution approaches for mult	iple problems i	n robotics.
Skills	Students are able to o	lerive and s	olve equation	s of motion for va	rious manipulators.		
	Students can generate	e trajectorie	s in various c	oordinate systems	5.		
	Students can design l	inear and na	artially nonline	ear controllers for	robotic manipulators		
	Students can design i	inear and pe	arcially Horning	car controllers for	Tobotic manipulators.		
Personal Competence							
· ·	Students are able to work goal-oriented in small mixed groups.  Students are able to recognize and improve knowledge deficits independently.						
Autonomy	Students are able to r	ecognize an	id improve kn	owledge deficits i	ndependently.		
	With instructor assista	ance, studer	nts are able to	evaluate their ov	vn knowledge level and define a	further course	of study.
Workload in Hours	Independent Study Ti	me 96, Stud	y Time in Lec	ture 84			
Credit points	6						
Course achievement	Compulsory Bonus	Form	#l 1	Description	- DDI Sinhaitan assis Sania	C	and the second state
	Yes None	Subject practical w	theoretical	jeweiligen Se	n PBL-Einheiten sowie Erreic	nen des Ges	amizieis und der
Examination	Written exam	practical		je.rege.r se	55.011 2.10.10		
Examination duration and	120 min						
scale							
Assignment for the	Aircraft Systems Engi	neering: Cor	e Qualificatio	n: Elective Compu	ilsory		
Following Curricula	-				duct Development and Producti		mpulsory
	-				chatronics: Elective Compulsory		
	Aeronautics: Core Qua			-	mpulcon/		
	Mechanical Engineering Mechatronics: Core Quality	-	-	z Qualilication: CC	niipui50ly		
				n: Specialisation P	roduct Development: Elective Co	ompulsory	
				•	roduction: Elective Compulsory	, .,	
	Product Development	, Materials a	and Production	n: Specialisation M	laterials: Elective Compulsory		
		-			lopment and Production: Electiv		
	Theoretical Mechanica	al Engineerir	ng: Specialisa	tion Robotics and	Computer Science: Elective Con	npulsory	

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

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

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				
<b>Educational Objectives</b>	After taking part successfully, students have reach	ed the following learning results		
Professional Competence				
Knowledge				
Skills				
Personal Competence				
Social Competence				
Autonomy				
Workload in Hours	Independent Study Time 110, Study Time in Lectur	re 70		
Credit points	6			
Course achievement	None			
Examination	Written exam			
Examination duration and	90 min			
scale				
Assignment for the	Civil Engineering: Specialisation Water and Traffic:	Elective Compulsory		
Following Curricula	Bioprocess Engineering: Specialisation C - Bioe	conomic Process Engineering, Focus	Management and 0	Controlling: Elective
	Compulsory			
	Environmental Engineering: Specialisation Energy	and Resources: Elective Compulsory		
	International Management and Engineering: Specia	lisation II. Energy and Environmental E	ngineering: Elective (	Compulsory
	Product Development, Materials and Production: Sp	pecialisation Product Development: Elec	ctive Compulsory	
	Product Development, Materials and Production: Sp	pecialisation Production: Elective Comp	ulsory	
	Product Development, Materials and Production: Sp	pecialisation Materials: Elective Compul	sory	
	Renewable Energies: Specialisation Bioenergy Syst	ems: Elective Compulsory		
	Process Engineering: Specialisation Environmental	Process Engineering: Elective Compulse	ory	
	Water and Environmental Engineering: Specialisati	on Environment: Compulsory		
	Water and Environmental Engineering: Specialisati	on Cities: Compulsory		

Course L0387: Health, Safety	y and Environmental Management
Тур	Integrated Lecture
Hrs/wk	3
СР	3
Workload in Hours	Independent Study Time 48, Study Time in Lecture 42
Lecturer	Hans-Joachim Nau
Language	EN
Cycle	WiSe
Content	<ul> <li>Objectives of and benefit from HSE management</li> <li>From dilution and end-of-pipe technology to eco-efficiency and eco-effectiveness Behaviour control: regulations, economic instruments and voluntary initiatives</li> <li>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</li> <li>Crisis management</li> </ul>
Literature	C. Stephan: Industrial Health, Safety and Environmental Management, MV-Verlag, Münster, 2007/2012 (can be found in the library under GTG 315)  Exercises can be downloaded from StudIP

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

Module M1909: Syste	m Simulation			
Courses				
Title		Тур	Hrs/wk	СР
System Simulation Modul (L3150)		Lecture	2	3
System Simulation Modul (L3151)		Recitation Section (large)	2	3
Module Responsible	Prof. Arne Speerforck			
Admission Requirements	None			
<b>Recommended Previous</b>	Mathematics I-III, Computer Sciense, Engineering Thermo	odynamics I, II, Fluid Dynamics, Heat	Transfer, Control	Systems
Knowledge				
<b>Educational Objectives</b>	After taking part successfully, students have reached the	following learning results		
<b>Professional Competence</b>				
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	e Compulsory		
	Aeronautics: Core Qualification: Elective Compulsory			
	Product Development, Materials and Production: Speciali	sation Product Development: Elective	e Compulsory	
	Product Development, Materials and Production: Speciali	sation Production: Elective Compulso	ry	
	Product Development, Materials and Production: Speciali	sation Materials: Elective Compulsory	/	
	Renewable Energies: Specialisation Bioenergy Systems: I	' '		
	Renewable Energies: Specialisation Solar Energy System	s: Elective Compulsory		
	Renewable Energies: Specialisation Wind Energy Systems	• •		
	Theoretical Mechanical Engineering: Specialisation Simul		ry	
	Theoretical Mechanical Engineering: Specialisation Energ	y Systems: Elective Compulsory		

	Theoretical Company of the Company o
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	<ol> <li>Modelica Association: "Modelica Language Specification - Version 3.5", Linköping, Sweden, 2021.</li> <li>OpenModelica: OpenModelica 1.17.0, https://www.openmodelica.org (siehe Download), 2021.</li> <li>M. Tiller: "Modelica by Example", https://book.xogeny.com, 2014.</li> <li>M. Otter, H. Elmqvist, et al.: "Objektorientierte Modellierung Physikalischer Systeme", at- Automatisierungstechnik (german), Teil 1 - 17, Oldenbourg Verlag, 1999 - 2000.</li> <li>P. Fritzson: "Principles of Object-Oriented Modeling and Simulation with Modelica 3.3", Wiley-IEEE Press, New York, 2015.</li> <li>P. Fritzson: "Introduction to Modeling and Simulation of Technical and Physical Systems with Modelica", Wiley, New York, 2011.</li> </ol>

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

Production				
Module M0771: Flight	t Physics			
Courses				
Title		Тур	Hrs/wk	СР
Aerodynamics and Flight Mechanic	s I (L0727)	Lecture	3	3
light Mechanics II (L0730)		Lecture	2	2
light Mechanics II (L0731)		Recitation Section (large)	1	1
Module Responsible	Prof. Frank Thielecke			
Admission Requirements	None			
Recommended Previous	Basic knowledge in:			
Knowledge	Mathematics			
	Mechanics			
	Thermodynamics			
	Aviation			
	Aviation			
<b>Educational Objectives</b>	After taking part successfully, students have reached the	he following learning results		
Professional Competence				
Knowledge	Students are able to			
	Describe the fundamental equations of aerodyna	amics for compressible incompressible	and frictional flo	NW.
	Explain the principles of wings and profiles		aco.iai iic	
	Explain the aircraft equations of motion			
	Evaluate aircraft performance and stability			
	Describe the dynamics of the longitudinal and la	teral motion		
	Describe methods of flight simulation and airbor			
		,		
Skills	Students are able to			
	Perform flight mechanic simulations			
	Derive flight mechanic relations from virtual and	real flight test data		
Personal Competence				
Social Competence	Students are able to:			
	- Doufours simulations in averue and discuss requite	-		
	Perform simulations in groups and discuss result     Tuglished flight test data in groups discuss and make the control of			
	Evaluate flight test data in groups, discuss and p	present the results		
Autonomy	Students are able to:			
	Drococc toaching content independently:			
	Process teaching content independently     Propers, work out and process simulation model	s independently		
	<ul> <li>Prepare, work out and process simulation model</li> <li>Apply teaching content on virtual and real flight</li> </ul>			
	Apply teaching content on virtual and rear night	test data		
Workload in Hours	Independent Study Time 96, Study Time in Lecture 84			
Credit points				
Course achievement				
Examination	Written exam			
Examination duration and	160 Minutes			
scale				
Assignment for the	Aircraft Systems Engineering: Core Qualification: Comp	pulsory		
Following Curricula	International Management and Engineering: Specialisat	tion II. Aviation Systems: Elective Com	pulsory	
	Aeronautics: Core Qualification: Compulsory			
	Product Development, Materials and Production: Specia	alisation Product Development: Electiv	e Compulsory	
	Product Development, Materials and Production: Specia	alisation Production: Elective Compulso	ory	
	Product Development, Materials and Production: Specia	alisation Materials: Elective Compulsor	у	
	Theoretical Mechanical Engineering: Specialisation Airc	raft Systems Engineering: Elective Cor	mpulsory	

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	<ul> <li>Aerodynamics (fundamental equations of aerodynamics; compressible and incompressible flows; airfoils and wings; viscous flows)</li> <li>Flight Mechanics (Equations of motion; flight performance; control surfaces; derivatives; lateral stability and control; trim conditions; flight maneuvers)</li> </ul>
Literature	<ul> <li>Schlichting, H.; Truckenbrodt, E.: Aerodynamik des Flugzeuges I und II</li> <li>Etkin, B.: Dynamics of Atmospheric Flight</li> <li>Sachs/Hafer: Flugmechanik</li> <li>Brockhaus: Flugregelung</li> <li>J.D. Anderson: Introduction to flight</li> </ul>

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

Course L0731: Flight Mechan	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				
Educational Objectives	After taking part successfully, students have reach	ned the following learning results		
<b>Professional Competence</b>				
Knowledge	Students will gain insights into:			
	Product Planning			
	Process			
	Methods			
	Design thinking			
	Process			
	Methods			
	User integration			
	- OSCI Integration			
Skills	Students will gain deep insights into:			
	Product Planning			
	Process-related aspects			
	<ul> <li>Organisational-related aspects</li> </ul>			
	Human-Ressource related aspects			
	Working-tools, methods and instruments	ents		
	o			
Personal Competence				
Social Competence	Interact within a team			
	<ul> <li>Raise awareness for globabl issues</li> </ul>			
Autonomy	Gain access to knowledge sources			
	Interpret complex cases			
	Develop presentation skills			
West II	Indianandark Charles Time 220 Ct. L. T	70		
Workload in Hours	Independent Study Time 110, Study Time in Lecture	ire /U		
Credit points	6 Compulsory Bonus Form	Description		
Course achievement	Compulsory Bonus Form  Yes 20 % Subject theoretical an			
	practical work	u .		
Examination				
	90 minutes			
scale	Jo Himates			
Assignment for the	Global Innovation Management: Core Qualification	: Compulsory		
Following Curricula	International Management and Engineering: Speci	, -	mnulson	
i onowing curricula			привогу	
	Mechanical Engineering and Management: Special		ompules	
	Product Development, Materials and Production: S	•	ompuisory	
	Product Development, Materials and Production: S	•		
	Product Development, Materials and Production: S Theoretical Mechanical Engineering: Specialisation		o Compulson	
	medical mechanical Engineering. Specialisation	Trioduct Development and Production: Electiv	e compuisory	

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

Course L0853: Product Planning Seminar		
Тур	Project-/problem-based Learning	
Hrs/wk	2	
СР	3	
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28	
Lecturer	Prof. Cornelius Herstatt	
Language	EN	
Cycle	WiSe	
Content	Seminar is integrative part of the Module Product Planning (for content see lecture) and can not be choosen independently.	
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 Lecture	2	3
Environment and Sustainability (L0		Lecture	2	3
Module Responsible				
Admission Requirements				
Recommended Previous	none			
Knowledge				
Educational Objectives	After taking part successfully, students have	reached the following learning results		
Professional Competence	Charles and able to decoding single took	ciana and to also an according for the field	-66-b d:-l	
Knowleage	*	niques and to give an overview for the field	of safety and risk as	sessment as well as
	environmental and sustainable engineering	g, in detail:		
	<ul> <li>basics in safety and reliability of tech</li> </ul>	hnical facilities		
	<ul> <li>safety and reliability analysis method</li> </ul>	ds		
	<ul> <li>risk assessment</li> </ul>			
	<ul> <li>Production and usage of bio-char</li> </ul>			
	<ul> <li>energy production and supply</li> </ul>			
	<ul> <li>sustainable product design</li> </ul>			
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				
Autonomy	Students can gain knowledge of the subje	ect area from given sources and transform it	to new questions. Fu	rthermore, they can
	define targets for new application or resea	rch-oriented duties in for risk management ar	nd sustainability conce	epts accordance with
	the potential social, economic and cultural	impact.		
Workload in Hours	Independent Study Time 124, Study Time i	n Locture E6		
Credit points		II FECTULE 20		
Course achievement	None			
Examination	Written elaboration			
		n groups)		
scale	Elaboration and presentation (45 minutes i	n groups)		
Assignment for the	Civil Engineering: Core Qualification: Comp	ulcory		
Following Curricula		- Bioeconomic Process Engineering, Focus	Management and	Controlling: Flective
. onowing curricula	Compulsory	2.0000000000 Frocess Engineering, Focus		cocoming. Liective
	, ,	g: Specialisation II. Civil Engineering: Elective (	Compulsory	
		ction: Specialisation Product Development: Ele		
	•	ction: Specialisation Production: Elective Com	, ,	
	•	ction: Specialisation Materials: Elective Compu	•	
	Water and Environmental Engineering: Cor-			
	3 22 3 22	. ,		

Course L1145: Safety, Reliab	ility and Risk Assessment
Тур	Seminar
Hrs/wk	2
СР	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Dr. Marco Ritzkowski
Language	DE
Cycle	WiSe
	An introduction in safety and risk assessment is given and some typical problems of structural and environmental engineering are treated:  • basics in safety and reliability of technical facilities • safety and reliability analysis methods • risk assessment • practical examples and excursions • discussions and presentations
Literature	- Vorlesungsunterlagen - Schneider, J., Schlatter, H.P.: Sicherheit und Zuverlässigkeit im Bauwesen. www.risksafety.ch/files/ <b>sicherheit_</b> 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: Meth	ods of Product Development			
Courses				
Title		Тур	Hrs/wk	СР
Methods of Product Development (	L1254)	Lecture	3	3
Methods of Product Development (	L1255)	Project-/problem-based Learning	2	3
Module Responsible	Prof. Dieter Krause			
Admission Requirements	None			
Recommended Previous	Basic knowledge of Integrated product development an	d applying CAE systems		
Knowledge				
<b>Educational Objectives</b>	After taking part successfully, students have reached th	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 managements are the second to the sec			
	describe current problems and the current state	of research of integrated product develop	oment.	
Skills	After passing the module students are able to:			
	<ul> <li>select and apply proper construction methods f</li> </ul>	or non-standardized solutions of problen	ns as well as	adapt new bounda
	conditions,			
	solve product development problems with the as			
	<ul> <li>choose and execute appropriate moderation tech</li> </ul>	iniques.		
Personal Competence				
Social Competence	After passing the module students are able to:			
	prepare and lead team meetings and moderation	processes,		
	<ul> <li>work in teams on complex tasks,</li> <li>represent problems and solutions and advance id</li> </ul>	loss		
	represent problems and solutions and advance to	leds.		
Autonomy	After passing the module students are able to:			
		and and		
	give a structured feedback and accept a critical f     implement the accepted feedback autopapeaus	ееараск,		
	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			on: Elective Co	ompulsory
3	Aeronautics: Core Qualification: Elective Compulsory			. ,
	Mechatronics: Specialisation System Design: Elective Co	ompulsory		
	Mechatronics: Core Qualification: Elective Compulsory	•		
	Product Development, Materials and Production: Specia	lisation Product Development: Compulso	ry	
	Product Development, Materials and Production: Specia	·	-	
	Product Development, Materials and Production: Specia			
	Theoretical Mechanical Engineering: Specialisation Prod	uct Development and Production: Electiv	e Compulsory	
		·		

ourse L1254: Methods of Product Development		
	Lecture	
Hrs/wk		
CP		
	Independent Study Time 48, Study Time in Lecture 42	
	Prof. Dieter Krause	
Language		
Cycle		
Content	The lecture extends and enhances the learned content of the module "Integrated Product Development and lightweight design" and is based on the knowledge and skills acquired there.  Topics of the course include in particular:  Methods of product development, Presentation techniques, Industrial Design, Design for variety Modularization methods, Design catalogs, Adapted QFD matrix, Systematic material selection, Assembly oriented design,  Construction management CE mark, declaration of conformity including risk assessment, Patents, patent rights, patent monitoring Project management (cost, time, quality) and escalation principles, Development management for mechatronics, Technical Supply Chain Management.	
	In the exercise the content presented in the lecture "Integrated Product Development II" and methods of product development and design management will be enhanced.  Students learn an independently moderated and workshop based approach through industry related practice examples to solv complex and currently existing issues in product development. They will learn the ability to apply important methods of product development and design management autonomous and acquire further expertise in the field of integrated product development Besides personal skills, such as teamwork, guiding discussions and representing work results will be acquired through the	
Literature	<ul> <li>Andreasen, M.M., Design for Assembly, Berlin, Springer 1985.</li> <li>Ashby, M. F.: Materials Selection in Mechanical Design, München, Spektrum 2007.</li> <li>Beckmann, H.: Supply Chain Management, Berlin, Springer 2004.</li> <li>Hartmann, M., Rieger, M., Funk, R., Rath, U.: Zielgerichtet moderieren. Ein Handbuch für Führungskräfte, Berater und Trainer, Weinheim, Beltz 2007.</li> <li>Pahl, G., Beitz, W.: Konstruktionslehre, Berlin, Springer 2006.</li> <li>Roth, K.H.: Konstruieren mit Konstruktionskatalogen, Band 1-3, Berlin, Springer 2000.</li> <li>Simpson, T.W., Siddique, Z., Jiao, R.J.: Product Platform and Product Family Design. Methods and Applications, New York,</li> </ul>	

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

Springer 2013.

Module M1025: Fluidi	cs			
Courses				
Title Fluidics (L1256) Fluidics (L1371)		Typ Lecture Project-/problem-based Learning Positation Section (Javas)	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), fluid	d mechanics, and
<b>Educational Objectives</b>	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 are perform numerical simulations of hydraulic systems base	ulic systems,  5,  5,  6 orque converters, brakes and clut  6 and systems,  6 applications,	iches as well as	centrifugal pumps
Personal Competence Social Competence	select and adapt pump characteristic curves for hydraulic     dimension hydrodynamic torque converters and brakes for  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		vdrostatischer Systems		
Examination	Yes None Attestation Simulation h Written exam	ydrostatischer 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		npulsory
	Product Development, Materials and Production: Specialisation of Product Development, Materials and Production: Specialisation of Theoretical Mechanical Engineering: Specialisation Product Development	Materials: Elective Compulsory	e Compulsory	

Production"	
Course L1256: Fluidics	
Тур	Lecture
Hrs/wk	2
СР	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Prof. Dieter Krause
Language	DE
Cycle	
	Lecture
Content	Lecture
	Hydrostatics
	physical fundamentals
	hydraulic fluids
	hydrostatic machines
	• valves
	• components
	hydrostatic transmissions
	examples from industry
	Pneumatics
	generation of compressed air
	pneumatic motors
	Examples of use
	Hydrodynamics
	physical fundamentals
	hydraulic continous-flow machines
	hydrodynamic transmissions
	interoperation of motor and transmission
	Exercise
	Hydrostatics
	reading and design of hydraulic diagrams
	dimensioning of hydrostatic traction and working drives
	performance calculation
	Hydrodynamics
	calculation / dimensioning of hydrodynamic torque converters
	calculation / dimensioning of centrifugal pumps     careting and reading of characteristic surrous of pumps and sustained.
	creating and reading of characteristic curves of pumps and systems
	Field trip
	field trip to a regional company from the hydraulic industry.
	Exercise
	Numerical simulation of hydrostatic systems
	getting to know a numerical simulation environment for hydraulic systems
	transformation of a task into a simulation model
	simulation of common components
	variation of simulation parameters
	using simulations for system dimensioning and optimisation
	(partly) self-organised teamwork
Literature	Bücher
	Murrenhoff, H.: Grundlagen der Fluidtechnik - Teil 1: Hydraulik, Shaker Verlag, Aachen, 2011
	Murrenhoff, H.: Grundlagen der Fluidtechnik - Teil 1: Hydradlik, 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	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

TitleTypHrs/wkCPcircraft Cabin Systems (L1545)Lecture34	Production"				
Tree in the properties in 1546)  Module Responsible   Performance   Perf	Module M1155: Aircra	aft Cabin Systems			
Tree in the properties in 1546)  Module Responsible   Performance   Perf					
interest (1.548b)   Section (1.549c)   Rectation Section (Garge)   1   2    Module Responsible   Module Responsible   Module (Responsible   Module (Responsible (Res	Courses				
Modular Reposable   no. TAIT God    Admission Requirements   No. TAIT God    Admission Requirements   Sack knowledge   Modernations   Moderna	Title		Тур	Hrs/wk	СР
Module Responsibile Admission Requirements Recommended Pravious Bisch knowledge in: Knowledge Pravious Sisch Recommended Pravious Sisch Recommended Pravious Sisch Recommended Pravious Sisch Sischerical Fedineering - Control Systems - Recommended Pravious Sischerical Fedineering - Control Systems - Recommended Recommender - Annowledge - Control Systems - Septial Competence - Annowledge - Social Competence	Aircraft Cabin Systems (L1545)				
Admission Requirements  Recommended Previous Sack Introviledge in:  Knowledge  Allocations of Security	Aircraft Cabin Systems (L1546)		Recitation Section (large)	1	2
Recommended Previous   asia: knowledge in: Knowledge   Mechanics	Module Responsible	Prof. Ralf God			
Knowledge - Mathematics - Thermodynamics - Electrical Engineering - Control Systems	Admission Requirements	None			
# Mechanics - Themodynamics - Electrical Engineering - Control Systems - Control Systems - Students are able to: - describe cabin operations, equipment in the cabin and cabin Systems - describe cabin operations, equipment in the cabin and cabin Systems - describe cabin operations, equipment in the cabin and cabin Systems - describe cabin operations, equipment in the cabin and cabin Systems - describe cabin operations, equipment in the cabin and cabin Systems - design cabin Systems - describe cabin operations, equipment in the cabin and cabin Systems - design cabin Systems of cabin operation systems and emergency Systems - design cabin Systems and emergency Systems - design cabin Systems on the cabin systems of a sign cabin systems of cabin operations - design cabin systems for safe operations - design cabin systems for safe operations - design emergency systems for safe operations - design cabin systems for safe operations - describe systems as able to: - compensed consisting system solutions and explain them on the basis of existing requirements - describe systems as is  - Autonomy - Students are able to: - independently reflect on lecture content and expert presentations - independently reflect on lecture content and expert presentations - independently reflect on lecture content and expert presentations - describe systems as is  - Workload in Hours - independently reflect on lecture content and expert presentations - independently reflect on lecture content and expert presentations - describe systems are able to: - independently reflect on lecture content and expert presentations - describe systems are able to: - independently reflect on lecture content and expert presentations - describe systems are able to: - independently reflect on lecture	Recommended Previous	Basic knowledge in:			
Educational Objective Professional Competence Removing a After taking part successfully, students have reached the following learning results  Educational Objective Removing a After taking part successfully, students have reached the following learning results  After taking part successfully, students have reached the following learning results  Advantage  - describe cobin operations, equipment in the cabin and cabin Systems - explain the functional and non-functional requirements for cabin Systems - explain the functional and non-functional requirements for cabin Systems - elucidate the necessity of cabin operations, systems and emergency Systems - elucidate the necessity of cabin operations or a stable newtronment  Sitis Students are able to: - design a cabin layout for a given business model of an Alfrice - design cabin systems for safe operations - design emergency systems for safe man-machine interaction - solve comfort needs and entertainment requirements in the cabin  Personal Competence  Social Competence  Social Competence - Social Competenc	Knowledge	Mathematics			
Educational Objectives After taking part successfully, students have reached the following learning results  Professional Competence Anonineties  Authority of the cabin operations, equipment in the cabin and cabin Systems - explain the functional and non-functional requirements for cabin Systems - explain the functional and non-functional requirements for cabin Systems - explain the functional and non-functional requirements for cabin Systems - explain the functional and non-functional requirements for cabin Systems - explain the functional and non-functional requirements for cabin Systems - explain the functional and non-functional requirements for cabin Systems - explain as cabin leto: - explain cabin systems for safe operations - design cabin systems for safe operations - design emergency systems for safe operations - design cabin system for safe operations - design cabin system for safe operations - design competence - Social socia		Mechanics			
Educational Objectives After taking part successfully, students have reached the following learning results  Professional Competence Knowledge  **Country Systems**  **Learning the functional and non-functional requirements for cabin Systems  **Learning the functional and non-functional requirements for cabin Systems  **Learning the functional and non-functional requirements for cabin Systems  **Learning the functional and non-functional requirements for cabin Systems  **Learning the functional and non-functional requirements for cabin Systems  **Learning the functional and non-functional requirements for cabin Systems  **Learning the functional and non-functional requirements for cabin Systems  **Learning the functional and systems for safe operations  **Learning cost in Systems for a given business model of an Airline  **Learning cost in Systems for a given business model of an Airline  **Learning cost in Systems for a given business model of an Airline  **Learning cost in Systems for a given business model of an Airline  **Learning cost in Systems for a given business model of an Airline  **Learning cost in Systems for a given business model of an Airline  **Learning cost in Systems for a given business model of an Airline  **Learning cost in Systems for a given business model of an Airline  **Learning cost in Systems for a given business model of an Airline  **Learning cost in Systems for given business model of an Airline  **Learning cost in Systems and Exercisements in the cabin  **Learning competence**  **Learning					
Educational Objectives   After taking part successfully, students have reached the following learning results					
Professional Competence  Knowledge  Students are able to:  describe cabin operations, equipment in the cabin and cabin Systems explain the functional and non-functional requirements for cabin Systems elucidate the necessity of cabin operations ystems an emergency Systems assess the challenges human factors integration in a cabin environment  Sistilis  Students are able to:  design acid systems for safe operations design acid systems for safe operations elucidate the recessity of safe operations design acid systems for safe operations design emergency systems for safe operations design acid systems for safe operations design acid systems for safe operations design acid systems for safe operations design emergency systems for safe operations design acid systems for safe man-machine interaction solve comfort needs and entertainment requirements in the cabin  Personal Competence  Students are able to:  comprehend existing system solutions and explain them on the basis of existing requirements discuss with experts in technical language explain system functions describe systems as is   Autonomy  Students are able to: Independently reflect on lecture content and expert presentations independently reflect on lecture content and expert presentations describe systems as is   Workload in Hours Independently reflect on lecture content and expert presentations describe systems as is  Workload in Hours Independently reflect on lecture content and expert presentations describe systems are able to:  Course achievement None  Examination Murater example of the presentation of the presentations of the presentation of		Control Systems			
Autonomy	Educational Objectives	After taking part successfully, students have reached the foll	owing learning results		
describe cabin operations, equipment in the cabin and cabin systems     explain the functional and non-functional requirements for cabin Systems     elucidate the necessity of cabin operating systems and emergency Systems     assess the challenges human factors integration in a cabin environment    Still   Students are able to:	Professional Competence				
describe cabin operations, equipment in the cabin and cabin systems     explain the functional and non-functional requirements for cabin Systems     elucidate the necessity of cabin operating systems and emergency Systems     assess the challenges human factors integration in a cabin environment    Still   Students are able to:	Knowledge	Students are able to:			
elucidate the necessity of cabin operating systems and emergency Systems	-		in Systems		
- assess the challenges human factors integration in a cabin environment  Skills  Students are able to:  - design cabin systems for safe operations - design energency systems for safe operations - design emergency systems for safe man-machine interaction - solve comfort needs and entertainment requirements in the cabin  Personal Competence  Social Competence  Social Competence  Social Students are able to: - (comprehend existing system solutions and explain them on the basis of existing requirements - discuss with experts in technical language - explain system functions - classify the criticality of functions - describe systems as is  Autonomy  Students are able to: - independently reflect on lecture content and expert presentations - independently develop more in-depth content - recognize further areas of knowledge  Workload in Hours - independent Study Time 124, Study Time in Lecture 56  Credit points - Credit points - Course achievement - None  Examination - Examination - Written exam  Examination duration and - Scale  Assignment for the - Following Curricula - Alcraft Systems Engineering: Specialisation Control and Power Systems Engineering: Elective Compulsory - Aeronautics: Core Qualification: Compulsory - Product Development, Materials and Production: Specialisation Product Development: Elective Compulsory - Product Development, Materials and Production: Specialisation Production: Elective Compulsory - Product Development, Materials and Production: Specialisation Production: Elective Compulsory - Product Development, Materials and Production: Specialisation Production: Elective Compulsory - Product Development, Materials and Production: Specialisation Production: Elective Compulsory		• explain the functional and non-functional requirements for	cabin Systems		
Skills  Students are able to:  design a cabin layout for a given business model of an Airline design cabin systems for safe operations design emergency systems for safe man-machine interaction solve comfort needs and entertainment requirements in the cabin  Personal Competence  Social Competence  Social Competence  Social Competence  - comprehend existing system solutions and explain them on the basis of existing requirements discuss with experts in technical language explain system functions - classify the criticality of functions - describe systems as is  Autonomy  Students are able to: - independently reflect on lecture content and expert presentations - independently reflect on lecture content and expert presentations - independently develop more in-depth content - recognize further areas of knowledge  Workload in Hours  Independent Study Time 124, Study Time in Lecture 56  Credit points  Course achievement None  Examination Written exam  Examination Written exam  Examination duration and Scale  Assignment for the Electrical Engineering: Specialisation Control and Power Systems Engineering: Elective Compulsory Aeronautics: Core Qualification: Compulsory Product Development, Materials and Production: Specialisation Product Development: Elective Compulsory Product Development, Materials and Production: Specialisation Product Development: Elective Compulsory Product Development, Materials and Production: Specialisation Product Concellography		• elucidate the necessity of cabin operating systems and em	ergency Systems		
design a cabin layout for a given business model of an Airline     design acabin systems for safe operations     design energroup systems for safe operations     design energroup systems for safe man-machine interaction     solve comfort needs and entertainment requirements in the cabin  Personal Competence  Social Competence  Social Competence  Students are able to:     comprehend existing system solutions and explain them on the basis of existing requirements     discuss with experts in technical language     explain system functions     classify the criticality of functions     describe systems as is   Autonomy  Students are able to:     independently reflect on lecture content and expert presentations     independently develop more in-depth content     recognize further areas of knowledge  Workload in Hours     independently develop more in-depth content     recognize further areas of knowledge  Workload in Hours     independently territory     independently territory     independently develop more in-depth content     recognize further areas of knowledge  Workload in Hours     independently develop more in-depth content     recognize further areas of knowledge  Workload in Hours     independently develop more in-depth content     recognize further areas of knowledge  Vortical to the production of the product Development, Waterials and Production: Specialisation Product Development: Elective Compulsory     Product Development, Materials and Production: Specialisation Production: Elective Compulsory     Product Development, Materials and Production: Specialisation Production: Elective Compulsory		assess the challenges human factors integration in a cabin	environment		
design a cabin layout for a given business model of an Airline     design acabin systems for safe operations     design energroup systems for safe operations     design energroup systems for safe man-machine interaction     solve comfort needs and entertainment requirements in the cabin  Personal Competence  Social Competence  Social Competence  Students are able to:     comprehend existing system solutions and explain them on the basis of existing requirements     discuss with experts in technical language     explain system functions     classify the criticality of functions     describe systems as is   Autonomy  Students are able to:     independently reflect on lecture content and expert presentations     independently develop more in-depth content     recognize further areas of knowledge  Workload in Hours     independently develop more in-depth content     recognize further areas of knowledge  Workload in Hours     independently territory     independently territory     independently develop more in-depth content     recognize further areas of knowledge  Workload in Hours     independently develop more in-depth content     recognize further areas of knowledge  Workload in Hours     independently develop more in-depth content     recognize further areas of knowledge  Vortical to the production of the product Development, Waterials and Production: Specialisation Product Development: Elective Compulsory     Product Development, Materials and Production: Specialisation Production: Elective Compulsory     Product Development, Materials and Production: Specialisation Production: Elective Compulsory	Clilla	Chudanka aya abla ka			
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  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  Classify the criticality of functions  independently reflect on lecture content and expert presentations  independently develop more in-depth content  recognize further areas of knowledge   Workload in Hours  Independent Study Time 124, Study Time in Lecture 56  Credit points  Course achievement  None  Examination  Written exam  Examination  Written exam  Examination duration and  Social  Assignment for the  Following Curricula  Aircraft Systems Engineering: Specialisation Control and Power Systems Engineering: Elective Compulsory  Aeronautics: Core Qualification: Compulsory  Product Development, Materials and Production: Specialisation Product Development: Elective Compulsory  Product Development, Materials and Production: Specialisation Production: Elective Compulsory  Product Development, Materials and Production: Specialisation Production: Elective Compulsory	SKIIIS		no		
• design emergency systems for safe man-machine interaction • solve comfort needs and entertainment requirements in the cabin  Social Competence  Social Competence  Social Competence  Social Competence  Social Competence  **Competence 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   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  More  Course achievement  Course achievement  None  Examination  Written exam  120 Minutes  Scale  Assignment for the Following Curricula  Following Curricula  Aircraft Systems Engineering: Specialisation Control and Power Systems Engineering: Elective Compulsory  Aeronautics: Core Qualification: Compulsory  Product Development, Materials and Production: Specialisation Product Development: Elective Compulsory  Product Development, Materials and Production: Specialisation Product Development: Elective Compulsory  Product Development, Materials and Production: Specialisation Product Development: Elective Compulsory  Product Development, Materials and Production: Specialisation Product Development: Elective Compulsory  Product Development, Materials and Production: Specialisation Production: Elective Compulsory  Product Development, Materials and Production: Specialisation Product Development: Elective Compulsory			ne .		
Personal Competence Social Competence Social Competence Social Competence  Social Competence  **Comprehend existing system solutions and explain them on the basis of existing requirements - discuss with experts in technical language - explain system functions - classify the criticality of functions - classify the criticality of functions - independently reflect on lecture content and expert presentations - independently reflect on lecture content and expert presentations - independently develop more in-depth content - recognize further areas of knowledge  Workload in Hours - credit points  Course achievement Credit points  Course achievement Examination Examination Examination Examination Examination Examination duration and scale  Assignment for the Following Curricula Aircraft Systems Engineering: Specialisation Control and Power Systems Engineering: Elective Compulsory Aeronautics: Core Qualification: Compulsory Product Development, Materials and Production: Specialisation Product Development: Elective Compulsory Product Development, Materials and Production: Specialisation Product Development: Elective Compulsory Product Development, Materials and Production: Specialisation Product Development: Elective Compulsory Product Development, Materials and Production: Specialisation Product Compulsory Product Development, Materials and Production: Specialisation Product Compulsory Product Development, Materials and Production: Specialisation Product Compulsory			on		
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   Students are able to:  - independently reflect on lecture content and expert presentations  - independently reflect on lecture content and expert presentations  - independently develop more in-depth content  - recognize further areas of knowledge   Workload in Hours  Independently develop more in-depth content  - recognize further areas of knowledge  Workload in Hours  Independent Study Time 124, Study Time in Lecture 56  Credit points  - Course achievement  None  Examination  Examination duration and  120 Minutes  Scale  Assignment for the Following Curricula  Aircraft Systems Engineering: Specialisation Control and Power Systems Engineering: Elective 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 Product Development. Elective Compulsory  Product Development, Materials and Production: Specialisation Product Development. Elective Compulsory					
Social Competence  Competence  Students are able to:  Competence  Autonomy  Students are able to:  Calssify the criticality of functions  Calssify the critical industry  Calssify the					
* 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     * 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     * None  Examination  Examination Written exam  Examination duration and scale  Assignment for the Following Curriculal Aircraft Systems Engineering: Specialisation Control and Power Systems Engineering: Elective Compulsory     International Management and Engineering: Specialisation II. Aviation Systems: Elective Compulsory     Product Development, Materials and Production: Specialisation Product Development: Elective Compulsory     Product Development, Materials and Production: Specialisation Product Development: Elective Compulsory     Product Development, Materials and Production: Specialisation Product Development: Elective Compulsory					
* discuss with experts in technical language     * explain system functions     * classify the criticality of functions     * classify the criticality of functions     * describe systems as is  Autonomy  Students are able to:     * independently reflect on lecture content and expert presentations     * independently develop more in-depth content     * recognize further areas of knowledge  Workload in Hours     * independent Study Time 124, Study Time in Lecture 56  Credit points     * Credit points     * One  Examination Written exam  Examination duration and 120 Minutes  Examination duration and 120 Minutes  Following Curricula Aircraft Systems Engineering: Specialisation Control and Power Systems Engineering: Elective Compulsory     International Management and Engineering: Specialisation II. Aviation Systems: Elective Compulsory     Product Development, Materials and Production: Specialisation Product Development: Elective Compulsory     Product Development, Materials and Production: Specialisation Product Development: Elective Compulsory     Product Development, Materials and Production: Specialisation Product Development: Elective Compulsory	Social Competence				
explain system functions     classify the criticality of functions     describe systems as is   Autonomy  Students are able to:     independently reflect on lecture content and expert presentations     independently develop more in-depth content     recognize further areas of knowledge  Workload in Hours  Independent Study Time 124, Study Time in Lecture 56  Credit points     Credit points     6  Course achievement     None  Examination duration and scale  Assignment for the Following Curricula Assignment for the Following Curricula Arcraft Systems Engineering: Specialisation Control and Power Systems Engineering: Elective 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 Product Compulsory Product Development, Materials and Production: Specialisation Production: Elective Compulsory Product Development, Materials and Production: Specialisation Production: Elective Compulsory Product Development, Materials and Production: Specialisation Production: Elective Compulsory			n the basis of existing requiremen	nts	
* classify the criticality of functions     * describe systems as is  **  **  **  **  **  **  **  **  **					
Autonomy 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 recognize further areas of knowledge  6 Credit points Course achievement None Examination Examination Examination duration and scale Assignment for the Following Curricula Aircraft Systems Engineering: Specialisation Control and Power Systems Engineering: Elective 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 Product Development: Elective Compulsory Product Development, Materials and Production: Specialisation Product Development: Elective Compulsory					
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 Examination Written exam  Examination duration and scale  Assignment for the Following Curricula Independent Study Time 124, Study Time in Lecture 56  Course achievement Virten exam  Examination duration and scale  Assignment for the Following Curricula Independent Study Time 124, Study Time in Lecture 56  Course achievement Virten exam  Examination Independent Study Time 124, Study Time in Lecture 56  Course achievement Virten exam  Examination Virten exam  Examination duration and Scale  Assignment for the Following Curricula Independent Study Time 124, Study Time in Lecture 56  Course achievement Virten exam  Examination and Scale  Assignment for the Following Curricula Independent Study Time 124, Study Time in Lecture 56  Course achievement Virten exam  Examination Virten exam  Examination duration and Scale  Assignment for the Following Curricula Independent Study Time 124, Study Time in Lecture 56  Course achievement Virten exam  Independent Study Time 124, Study Time in Lecture 56  Course achievement Virten exam  Independent Study Time 124, Study Time in Lecture 56  Course achievement Virten exam  Independent Study Time 124, Study Time in Lecture 56  Course achievement Virten exam  Independent Study Time 124, Study Time in Lecture 56  Course achievement Virten exam  Independent Study Time 124, Study Time in Lecture 56  Course achievement Virten exam  Independent Study Time 124, Study Time in Lecture 56  Course achievement Virten exam  Independent Study Time 124, Study Time in Lecture 56  Course achievement Virten exam  Independent Study Time 124, Study Time in Lecture 56  Course achievement Virten exam  Independent Study Time 124, Study Time in Lecture 56  Course achievement Virten exam  Independent Study Time 124, Study Time in Lecture 56  Course		• describe systems as is			
• 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 Examination Written exam  Examination duration and scale  Assignment for the Following Curricula Independent Study Time 124, Study Time in Lecture 56  Course achievement Virten exam  Examination duration and scale  Assignment for the Following Curricula Independent Study Time 124, Study Time in Lecture 56  Course achievement Virten exam  Examination Independent Study Time 124, Study Time in Lecture 56  Course achievement Virten exam  Examination Virten exam  Examination duration and Scale  Assignment for the Following Curricula Independent Study Time 124, Study Time in Lecture 56  Course achievement Virten exam  Examination and Scale  Assignment for the Following Curricula Independent Study Time 124, Study Time in Lecture 56  Course achievement Virten exam  Examination Virten exam  Examination duration and Scale  Assignment for the Following Curricula Independent Study Time 124, Study Time in Lecture 56  Course achievement Virten exam  Independent Study Time 124, Study Time in Lecture 56  Course achievement Virten exam  Independent Study Time 124, Study Time in Lecture 56  Course achievement Virten exam  Independent Study Time 124, Study Time in Lecture 56  Course achievement Virten exam  Independent Study Time 124, Study Time in Lecture 56  Course achievement Virten exam  Independent Study Time 124, Study Time in Lecture 56  Course achievement Virten exam  Independent Study Time 124, Study Time in Lecture 56  Course achievement Virten exam  Independent Study Time 124, Study Time in Lecture 56  Course achievement Virten exam  Independent Study Time 124, Study Time in Lecture 56  Course achievement Virten exam  Independent Study Time 124, Study Time in Lecture 56  Course achievement Virten exam  Independent Study Time 124, Study Time in Lecture 56  Course					
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• 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 scale Following Curricula Assignment for the Following Curricula Assignment for the Following Curricula Aircraft Systems Engineering: Specialisation Control and Power Systems Engineering: Elective 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	Autonomy	Students are able to:			
• 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 scale 120 Minutes  Following Curricula Aircraft Systems Engineering: Specialisation Control and Power Systems Engineering: Elective 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		independently reflect on lecture content and expert present	tations		
Workload in Hours Independent Study Time 124, Study Time in Lecture 56  Credit points 6  Course achievement None  Examination Written exam  Examination duration and scale  Assignment for the Following Curricula Aircraft Systems Engineering: Specialisation Control and Power Systems Engineering: Elective 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					
Credit points 6  Course achievement None  Examination Written exam  Examination duration and scale  Assignment for the Following Curricula Aircraft Systems Engineering: Specialisation Control and Power Systems Engineering: Elective 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		recognize further areas of knowledge			
Credit points 6  Course achievement None  Examination Written exam  Examination duration and scale  Assignment for the Following Curricula Aircraft Systems Engineering: Specialisation Control and Power Systems Engineering: Elective 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					
Credit points 6  Course achievement None  Examination Written exam  Examination duration and scale  Assignment for the Following Curricula Aircraft Systems Engineering: Specialisation Control and Power Systems Engineering: Elective 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					
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Course achievement None  Examination Written exam  120 Minutes  scale  Assignment for the Following Curricula Aircraft Systems Engineering: Specialisation Control and Power Systems Engineering: Elective 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					
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Aeronautics: Core Qualification: Compulsory Product Development, Materials and Production: Specialisation Product Development: Elective Compulsory Product Development, Materials and Production: Specialisation Production: Elective Compulsory	ronowing curricula			nulsorv	
Product Development, Materials and Production: Specialisation Product Development: Elective Compulsory Product Development, Materials and Production: Specialisation Production: Elective Compulsory			Aviation Systems, Elective Com	puisoi y	
Product Development, Materials and Production: Specialisation Production: Elective Compulsory			on Product Development: Flective	e Compulsory	
Theoretical Mechanical Engineering: Specialisation Aircraft Systems Engineering: Elective Compulsory					

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

Course L1546: Aircraft Cabin	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	

Courses				
		T	Hee hole	CD.
<b>Fitle</b> Structure and Properties of Polyme	rs (1.0389)	<b>Typ</b> Lecture	Hrs/wk 2	<b>CP</b> 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. sustain	ability, environment
	protection).			
Skills	Students are capable of			
	- using standardized calculation methods in	a given context to mechanical prope	erties (modulus, streng	gtn) to calculate an
	evaluate the different materials.			
	- selecting appropriate solutions for mechanic	cal recycling problems and sizing example	e stiffness, corrosion re	esistance.
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.			
	- ussess 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				
Examination	Written exam			
Examination duration and	180 min			
scale				
Assignment for the	Materials Science and Engineering: Specialisa		buisory	
Following Curricula	Materials Science: Specialisation Engineering Biomedical Engineering: Specialisation Implar			
	Biomedical Engineering: Specialisation Artifici		ective Compulsory	
	Biomedical Engineering: Specialisation Manag			
	Biomedical Engineering: Specialisation Medica			
	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 weilhght distribution	
	- Morphology	
	amorph, crystalline, blends	
	- Properties	
	Elasticity, plasticity, viscoelacity	
	- Thermal properties	
	- Electrical properties	
	- Theoretical modelling	
	- Applications	
Literature	Ehrenstein: Polymer-Werkstoffe, Carl Hanser Verlag	

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

Module M1170: Pheno	omena and Methods in Materials	Science		
Courses				
Title		Тур	Hrs/wk	СР
Experimental Methods for the Characterization of Materials (L1580)		Lecture	2	2
Phase equilibria and transformation		Lecture	2	2
Übung zu Phänomene und Methode	n der Materialwissenschaft (L2991)	Recitation Section (large)	2	2
Module Responsible	Prof. Jörg Weißmüller			
Admission Requirements	None			
Recommended Previous	Basic knowledge in Materials Science, e.g. Werks	stoffwissenschaft I/II		
Knowledge				
Educational Objectives	After taking part successfully, students have rea	ched the following learning results		
Professional Competence				
Knowledge	The students will be able to explain the properti	es of advanced materials along with the	eir applications in tec	hnology, in particular
	metallic, ceramic, polymeric, semiconductor, mo	dern composite materials (biomaterials)	and nanomaterials.	
Skills	The students will be able to select material co	*		
	materials considering architectural principles for			
	modern materials science, which enables the	iem to select optimum materials co	ombinations depend	ing on the technical
	applications.			
Personal Competence				
Social Competence	The students are able to present solutions to spe	cialists and to develop ideas further.		
Autonomy	The students are able to			
	assess their own strengths and weaknesse			
	<ul> <li>gather new necessary expertise by their or</li> </ul>	wn.		
Workload in Hours	Independent Study Time 96, Study Time in Lectu	re 84		
Credit points	6			
Course achievement	None			
Examination	Written exam			
Examination duration and	90 min			
scale				
Assignment for the	Chemical and Bioprocess Engineering: Specialisa	tion General Process Engineering: Electi	ve Compulsory	
-	Chemical and Bioprocess Engineering: Specialisa			
	International Management and Engineering: Spe			Compulsory
	Materials Science: Core Qualification: Compulsor	•		
	Product Development, Materials and Production:	Specialisation Product Development: Ele	ective Compulsory	
	Product Development, Materials and Production:	Specialisation Production: Elective Com	pulsory	
	Product Development, Materials and Production:	Specialisation Materials: Compulsory		
	Theoretical Mechanical Engineering: Specialisation	on Materials Science: Elective Compulso	ry	

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	<ul> <li>Structural characterization by photons, neutrons and electrons (in particular X-ray and neutron scattering, electron microscopy, tomography)</li> <li>Mechanical and thermodynamical characterization methods (indenter measurements, mechanical compression and tension tests, specific heat measurements)</li> <li>Characterization of optical, electrical and magnetic properties (spectroscopy, electrical conductivity and magnetometry)</li> </ul>
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		
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	Hrs/wk 2		
СР	<b>CP</b> 2		
Workload in Hours	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	ts		
Courses				
<b>Title</b> Fundamentals of Maintenance, Rep Fundamentals of Maintenance, Rep		<b>Typ</b> Lecture Recitation Section (large)	Hrs/wk 3 1	<b>CP</b> 4 2
Module Responsible	Prof. Gerko Wende			
Admission Requirements	None			
	We recommend knowledge in the areas of general engineering sciences, aeronautics and aircraft systems engineering. Technical fields like mechanical engineering, mechatronics and production engineering will be introduced into the relevant aeronautical content.			
Educational Objectives	After taking part successfully, students have reach	ned the following learning results		
Professional Competence				
Knowledge	The students are able to describe fundamental cor approaches for complex optimization problems.	rrelations for the sustainable operation of	technical 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 environment of multiple stakeholders.	s with a clear focus on the approached	solutions by resp	pecting the complex
Autonomy	The students are enabled to find solutions for optimization problems and to take required decision for the assessment of determining factors independently.			
Workload in Hours	Independent Study Time 124, Study Time in Lectu	re 56		
Credit points	6			
Course achievement	None			
Examination	Oral exam			
Examination duration and	30 min			
scale				
Assignment for the	Aircraft Systems Engineering: Core Qualification: E	Elective Compulsory		
Following Curricula	Aeronautics: Core Qualification: Elective Compulso	pry		
	Mechatronics: Specialisation Intelligent Systems a	nd Robotics: Elective Compulsory		
	Mechatronics: Specialisation System Design: Elect			
	Mechatronics: Core Qualification: Elective Compuls	•		
	Product Development, Materials and Production: S			
	Product Development, Materials and Production: S		-	
	Product Development, Materials and Production: S			
	Theoretical Mechanical Engineering: Specialisation			
	Theoretical Mechanical Engineering: Specialisation	i Aircraft Systems Engineering: Elective Co	лприіѕогу	

Course L3160: Fundamentals of Maintenance, Repair and Overhaul (MRO)			
Тур	ture		
Hrs/wk			
СР			
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):		
	<ul> <li>Life cycle analytics</li> <li>Material circularity and service products</li> <li>Rules and regulations</li> <li>Processes and production methods</li> <li>Tools and technologies</li> <li>Data handling and usage</li> <li>Design for maintenance</li> <li>Self-healing technical systems</li> </ul>		
Literature	-		

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

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

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

#### **Specialization Materials**

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

Module M0763: Aircra	aft Energy Systems			
Courses				
<b>Title</b> Aircraft Energy Systems (L0735)		<b>Typ</b> Lecture	Hrs/wk 3	<b>CP</b> 4
Aircraft Energy Systems (L0733)		Recitation Section (large)	2	2
	Duef Frank Thiologica	Recitation Section (large)	2	2
Module Responsible				
Admission Requirements				
Recommended Previous	Basic knowledge in:			
Knowledge	Mathematics			
	Mechanics			
	Thermodynamics			
	Electrical Engineering			
	Fluid mechanics			
Educational Objectives	After taking part successfully students have reached the	o following loarning results		
	After taking part successfully, students have reached th	e following learning results		
Professional Competence				
Knowieage	Students are able to:			
	Assess challenges during the design of aircraft er	ergy systems		
	Describe essential components and design points	of hydraulic and electrical supply sys	stems	
	Give an overview of the functionality of air condit	ioning systems		
	Describe different system concepts for de-icing			
	<ul> <li>Identify constraints for the electrification of aircra</li> </ul>	ft systems, and evaluate possible cor	ncepts and limita	tions
	Describe architectures for fuel supply systems an	d illustrate design examples		
	Explain possible approaches for the integration of	fuel cell systems and evaluate zero-	emission concept	S
Skille	Students are able to:			
Skilis	Students are able to.			
	<ul> <li>Design hydraulic and electric supply systems of a</li> </ul>	ircrafts		
	<ul> <li>Analyze the thermodynamic behavior of air condi</li> </ul>	tioning systems		
	Design ice protection systems			
	<ul> <li>Apply possible electrification concepts to existing</li> </ul>	aircraft systems		
	Design fuel supply systems			
	Perform the design of a fuel cell system			
Personal Competence				
•	Students are able to:			
	<ul> <li>Perform system design in groups and present and</li> </ul>	discuss results		
	Present systems engineering problems and discu	ss solutions with experts		
Autonomy	Students are able to:			
,				
	Reflect on the content of lectures autonomously			
	Apply methods learned in the course of exercises	·		
	Identify complex system dependencies autonomo	ously and abstract simplified models a	nd design proces	sses
Workload in Hours	Independent Study Time 110, Study Time in Lecture 70			
Credit points				
Course achievement				
Examination	Written exam			
Examination duration and				
scale	105 Finitives			
	Energy Systems: Specialisation Energy Systems: Electiv	e Compulsory		
Following Curricula	Aircraft Systems Engineering: Core Qualification: Compu			
Following Curricula	International Management and Engineering: Specialisati	•	nulsony	
	Aeronautics: Core Qualification: Compulsory	on in Aviation Systems. Elective Com	puisoi y	
	Product Development, Materials and Production: Specia	isation Product Development: Floctive	e Compulsory	
	Product Development, Materials and Production: Special Product Development, Materials and Product Development Product Dev			
	Product Development, Materials and Production: Special Product Development, Materials and Product Development Product Dev			
	Theoretical Mechanical Engineering: Specialisation Aircr			
		are 3,3ccm3 Engineering. Elective Col		

Course L0735: Aircraft Energy 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	WiSe	
Content	<ul> <li>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)</li> <li>Electric Energy Systems (Generators; constant-speed-drives; DC and AC converters; electrical power distribution; bus systems; monitoring; load analysis)</li> <li>High Lift Systems (Principles; investigation of loads and system actuation power; principles and sizing of actuation and positioning systems; safety requirements and devices)</li> <li>Environmental Control Systems (Thermodynamic analysis; expansion and compression cooling systems; control strategies; cabin pressure control systems)</li> </ul>	
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 M1141: Selected Topics of Product Development, Materials Science and Production (Alternative A: 12 LP)

Courses				
litle .		Тур	Hrs/wk	СР
Applied Automation (L1592)		Project-/problem-based Learning	3	3
Advanced Training Course SE-ZERT (L2739)		Project-/problem-based Learning	2	3
Elements of Integrated Production Systems (L0927)		Project-/problem-based Learning	2	3
Development Management for Mechatronics (L1512)		Lecture	2	3
Development Management for Mechatronics (L1512) Fatigue & Damage Tolerance (L0310)		Lecture	2	3
		Lecture	3	3
ndustry 4.0 for Engineers (L2012)		Lecture	2	3
nnovation and Product Manageme	ent (L2168)	Seminar	2	3
ightweight Design Practical Cours		Project-/problem-based Learning	3	3
	ials Testing - from the viewpoint of product development and Failure	Lecture	2	2
nalysis (L0950)			_	_
licrosystems Technology (L0724)		Lecture	2	4
ustainable Industrial Production (	2863)	Lecture	2	4
roductivity Management (L0928)	,	Project-/problem-based Learning	2	2
roductivity Management (L0931)		Recitation Section (small)	1	1
eedback Control in Medical Techr	ology (1,0664)	Lecture	2	3
structural Mechanics of Fibre Rein		Lecture	2	3
echnical Design (L1513)	orcea composites (LISI4)	Lecture	2	3
=	pint of industrial application (L0949)	Lecture	2	2
= -			2	2
eliability in Engineering Dynamic		Lecture	1	2
eliability in Engineering Dynamic		Recitation Section (small)		
eliability of Aircraft Systems (L07				
		Lecture	2	3
Module Responsible	Prof. Dieter Krause	Lecture	2	3
Module Responsible Admission Requirements	Prof. Dieter Krause None	Lecture	2	3
Module Responsible	Prof. Dieter Krause None	Lecture	2	3
Module Responsible Admission Requirements	Prof. Dieter Krause None	Lecture	2	3
Module Responsible Admission Requirements Recommended Previous	Prof. Dieter Krause None None		2	3
Module Responsible Admission Requirements Recommended Previous Knowledge	Prof. Dieter Krause None None		2	3
Module Responsible Admission Requirements Recommended Previous Knowledge Educational Objectives Professional Competence	Prof. Dieter Krause  None  None  After taking part successfully, students have reached the follow		2	3
Module Responsible Admission Requirements Recommended Previous Knowledge Educational Objectives	Prof. Dieter Krause  None  None  After taking part successfully, students have reached the follow	ring learning results		
Module Responsible Admission Requirements Recommended Previous Knowledge Educational Objectives Professional Competence	Prof. Dieter Krause  None  None  After taking part successfully, students have reached the follow	ring learning results		
Module Responsible Admission Requirements Recommended Previous Knowledge Educational Objectives Professional Competence	Prof. Dieter Krause  None  None  After taking part successfully, students have reached the follow  • Students are able to express their extended knowledge areas of product development, materials and production	ring learning results and discuss the connection of dif		
Module Responsible Admission Requirements Recommended Previous Knowledge Educational Objectives Professional Competence	Prof. Dieter Krause  None  None  After taking part successfully, students have reached the follow  • Students are able to express their extended knowledge	ring learning results and discuss the connection of dif		
Module Responsible Admission Requirements Recommended Previous Knowledge Educational Objectives Professional Competence	Prof. Dieter Krause  None  None  After taking part successfully, students have reached the follow  • Students are able to express their extended knowledge areas of product development, materials and production  • Students are qualified to connect different special fields to	ring learning results and discuss the connection of dir with each other	fferent specia	
Module Responsible Admission Requirements Recommended Previous Knowledge Educational Objectives Professional Competence Knowledge	Prof. Dieter Krause  None  None  After taking part successfully, students have reached the follow  • Students are able to express their extended knowledge areas of product development, materials and production  • Students are qualified to connect different special fields to	ring learning results and discuss the connection of dir with each other	fferent specia	
Module Responsible Admission Requirements Recommended Previous Knowledge Educational Objectives Professional Competence Knowledge	Prof. Dieter Krause  None  None  After taking part successfully, students have reached the follow  • Students are able to express their extended knowledge areas of product development, materials and production  • Students are qualified to connect different special fields to	ring learning results  and discuss the connection of diswith each other  ew scientific methods in selected	fferent specia areas	l fields or applicat
Module Responsible Admission Requirements Recommended Previous Knowledge Educational Objectives Professional Competence Knowledge	Prof. Dieter Krause  None  None  After taking part successfully, students have reached the follow  • Students are able to express their extended knowledge areas of product development, materials and production  • Students are qualified to connect different special fields of the students are qualified to connect different special fields of the students are qualified to connect different special fields of the students can apply specialized solution strategies and not seem to be successful.	ring learning results  and discuss the connection of diswith each other  ew scientific methods in selected	fferent specia areas	l fields or applicat
Module Responsible Admission Requirements Recommended Previous Knowledge Educational Objectives Professional Competence Knowledge	Prof. Dieter Krause  None  None  After taking part successfully, students have reached the follow  • Students are able to express their extended knowledge areas of product development, materials and production  • Students are qualified to connect different special fields of the students are qualified to connect different special fields of the students are qualified to connect different special fields of the students can apply specialized solution strategies and not seem to be successful.	ring learning results  and discuss the connection of diswith each other  ew scientific methods in selected	fferent specia areas	l fields or applicat
Module Responsible Admission Requirements Recommended Previous Knowledge Educational Objectives Professional Competence Knowledge	Prof. Dieter Krause  None  None  After taking part successfully, students have reached the follow  • Students are able to express their extended knowledge areas of product development, materials and production  • Students are qualified to connect different special fields of the students are apply specialized solution strategies and ne students are able to transfer learned skills to new and un	ring learning results  and discuss the connection of diswith each other  ew scientific methods in selected	fferent specia areas	l fields or applicat
Module Responsible Admission Requirements Recommended Previous Knowledge Educational Objectives Professional Competence Knowledge	Prof. Dieter Krause  None  None  After taking part successfully, students have reached the follow  • Students are able to express their extended knowledge areas of product development, materials and production  • Students are qualified to connect different special fields with the contract of the contr	and discuss the connection of diswith each other  with each other  ew scientific methods in selected aknown problems and can develop	fferent special areas p own solutior	l fields or applicat
Module Responsible Admission Requirements Recommended Previous Knowledge Educational Objectives Professional Competence Knowledge Skills Personal Competence	Prof. Dieter Krause  None  None  After taking part successfully, students have reached the follow  • Students are able to express their extended knowledge areas of product development, materials and production  • Students are qualified to connect different special fields of the students are apply specialized solution strategies and ne of the students are able to transfer learned skills to new and under the students are able to transfer learned skills to new and under the students are able to transfer learned skills to new and under the students are able to transfer learned skills to new and under the students are able to transfer learned skills to new and under the students are able to transfer learned skills to new and under the students are able to transfer learned skills to new and under the students are able to transfer learned skills to new and under the students are able to transfer learned skills to new and under the students are able to transfer learned skills to new and under the students are able to transfer learned skills to new and under the students are able to transfer learned skills to new and under the students are able to transfer learned skills to new and under the students are able to transfer learned skills to new and under the students are able to transfer learned skills to new and under the students are able to transfer learned skills to new and under the students are able to transfer learned skills to new and under the students are able to transfer learned skills to new and under the students are able to transfer learned skills to new and under the students are able to transfer learned skills to new and under the students are able to transfer learned skills to new and under the students are able to transfer learned skills to new and under the students are able to transfer learned skills to new and under the students are able to transfer learned skills to new and under the students are able to transfer learned skills to new and under the students are also the students are able to transfer	and discuss the connection of diswith each other  with each other  ew scientific methods in selected aknown problems and can develop	fferent special areas p own solutior	l fields or applicat
Module Responsible Admission Requirements Recommended Previous Knowledge Educational Objectives Professional Competence Knowledge Skills Personal Competence Social Competence	Prof. Dieter Krause  None  None  After taking part successfully, students have reached the follow  • Students are able to express their extended knowledge areas of product development, materials and production  • Students are qualified to connect different special fields of the students are apply specialized solution strategies and notes are able to transfer learned skills to new and ure students are able to develop their knowledge and skills to the students are able to	and discuss the connection of diswith each other  with each other  ew scientific methods in selected aknown problems and can develop	fferent special areas p own solutior	l fields or applicat
Module Responsible Admission Requirements Recommended Previous Knowledge Educational Objectives Professional Competence Knowledge Skills Personal Competence Social Competence Autonomy Workload in Hours	Prof. Dieter Krause  None  None  After taking part successfully, students have reached the follow  • Students are able to express their extended knowledge areas of product development, materials and production  • Students are qualified to connect different special fields with the students are apply specialized solution strategies and new the students are able to transfer learned skills to new and ure the students are able to develop their knowledge and skills to Depends on choice of courses	and discuss the connection of diswith each other  with each other  ew scientific methods in selected aknown problems and can develop	fferent special areas p own solutior	l fields or applicat
Module Responsible Admission Requirements Recommended Previous Knowledge Educational Objectives Professional Competence Knowledge  Skills  Personal Competence Social Competence Autonomy Workload in Hours Credit points	Prof. Dieter Krause  None  None  After taking part successfully, students have reached the follow  • Students are able to express their extended knowledge areas of product development, materials and production  • Students are qualified to connect different special fields with the students are apply specialized solution strategies and new Students are able to transfer learned skills to new and ure students are able to develop their knowledge and skills to Depends on choice of courses	and discuss the connection of diswith each other  ew scientific methods in selected aknown problems and can develop	fferent special areas p own solution	l fields or applicat
Module Responsible Admission Requirements Recommended Previous Knowledge Educational Objectives Professional Competence Knowledge  Skills  Personal Competence Social Competence Autonomy Workload in Hours Credit points Assignment for the	Prof. Dieter Krause  None  None  After taking part successfully, students have reached the follow  • Students are able to express their extended knowledge areas of product development, materials and production  • Students are qualified to connect different special fields of the students are apply specialized solution strategies and network of the students are able to transfer learned skills to new and ure the students are able to develop their knowledge and skills to be pends on choice of courses  12  Product Development, Materials and Production: Specialisation	and discuss the connection of diswith each other  ew scientific methods in selected aknown problems and can develop  by autonomous election of course	fferent special areas p own solution	l fields or applicat
Module Responsible Admission Requirements Recommended Previous Knowledge Educational Objectives Professional Competence Knowledge  Skills  Personal Competence Social Competence Autonomy Workload in Hours Credit points	Prof. Dieter Krause  None  None  After taking part successfully, students have reached the follow  • Students are able to express their extended knowledge areas of product development, materials and production  • Students are qualified to connect different special fields with the students are apply specialized solution strategies and new the students are able to transfer learned skills to new and ure the students are able to develop their knowledge and skills to be pends on choice of courses  12  Product Development, Materials and Production: Specialisation	and discuss the connection of diswith each other  ew scientific methods in selected aknown problems and can develop  by autonomous election of course	fferent special areas p own solution	l fields or applicat

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	ourse L2739: Advanced Training Course SE-ZERT		
Тур	Project-/problem-based Learning		
Hrs/wk			
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 - Generat	tional Sheet-Metal Development
Тур	Lecture
Hrs/wk	3
СР	3
Workload in Hours	Independent Study Time 48, Study Time in Lecture 42
Examination Form	Mündliche Prüfung
Examination duration and	30 min
scale	
Lecturer	Prof. Dr. Nikola Bursac
Language	DE
Cycle	WiSe
Content	Experience in mechanical engineering design and the fundamentals of manufacturing engineering
	After successful completion of the course, students will be able to explain development projects using the theory of product generation engineering and explain design rules for sheet metal development.
	After successful completion of the course, students will be able to apply the theory of product generation engineering to development tasks and develop sheet-metal products suitable for production.
	After successful completion of the course, students will be able to develop a product in a team and to compete against other teams.
	After successful completion of the course, students will be able to independently access knowledge required for sheet metal development.
Literature	

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

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

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

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	<ul> <li>E. Macherauch: Praktikum in Werkstoffkunde, Vieweg</li> <li>G. E. Dieter: Mechanical Metallurgy, McGraw-Hill</li> <li>R. Bürgel: Lehr- und Übungsbuch Festigkeitslehre, Vieweg</li> <li>R. Bürgel: Werkstoffe sícher beurteilen und richtig einsetzen, Vieweg</li> </ul>

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	<ul> <li>Introduction (historical view, scientific and economic relevance, scaling laws)</li> <li>Semiconductor Technology Basics, Lithography (wafer fabrication, photolithography, improving resolution, next-generation lithography, nano-imprinting, molecular imprinting)</li> <li>Deposition Techniques (thermal oxidation, epitaxy, electroplating, PVD techniques: evaporation and sputtering; CVD techniques: APCVD, LPCVD, PECVD and LECVD; screen printing)</li> <li>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)</li> <li>Surface Micromachining and alternative Techniques (sacrificial etching, film stress, stiction: theory and counter measures; Origami microstructures, Epi-Poly, porous silicon, SOJ, SCREAM process, LIGA, SUB, rapid prototyping)</li> <li>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)</li> <li>Mechanical Sensors (strain based and stress based principle, capacitive readout, piezoresistivity, pressure sensor: piezoresistive, capacitive and fabrication process;</li> <li>Magnetic Sensors (galvanomagnetic sensors: spinning current Hall sensor and magneto-transistor; magnetoresistive sensors: magneto resistance, AMR and GMR, fluxgate magnetometer)</li> <li>Chemical and Bio Sensors (thermal gas sensors: spinning current Hall sensor and magneto-transistor; magnetoresistive sensors semiconductor gas sensor, capacitive, micrographic semiconductor gas sensor, organic semiconductor gas sensors, principle of biosensor, Llark elect</li></ul>
Literature	M. Madou: Fundamentals of Microfabrication, CRC Press, 2002
	N. Schwesinger: Lehrbuch Mikrosystemtechnik, Oldenbourg Verlag, 2009  T. M. Adams, R. A. Layton:Introductory MEMS, Springer, 2010
	G. Gerlach; W. Dötzel: Introduction to microsystem technology, Wiley, 2008

Course L2863: Sustainable In	ndustrial Production
Тур	Lecture
Hrs/wk	2
СР	4
Workload in Hours	Independent Study Time 92, Study Time in Lecture 28
Examination Form	
Examination duration and	
scale	
Lecturer	Dr. Simon Markus Kothe
Language	DE
Cycle	SoSe
Content	
	processes that change the form and physical properties of raw materials. Manufacturing is a central driver of economi development and has a major impact on the well-being of humanity. However, the scale of current manufacturing activities result: in enormous global energy and material demands that are harmful to both the environment and people. Historically, industria activities were mostly oriented towards economic constraints, while social and environmental consequences were only hardl considered. As a result, today's global consumption rates of many resources and associated emissions often exceed the natural regeneration rate of our planet. In this respect, current industrial production can mostly be described as unsustainable. This is emphasized each year by the Earth Overshoot Day, which marks the day when humanity's ecological footprint exceeds the Earth' annual regenerative capacity.
	This lecture aims to provide the motivation, analytical methods as well as approaches for sustainable industrial production and t clarify the influence of the production phase in relation to the raw material, use and recycling phases in the entire life cycle of products. For this, the following topics will be highlighted:
	- Motivation for sustainable production, the 17 Sustainable Development Goals (SDGs) of the UN and their relevance for tomorrow's manufacturing;
	- raw material vs. production phase vs. use phase vs. recycling/end-of-life phase: importance of the production phase for th environmental impact of manufactured products;
	- Typical energy- and resource-intensive processes in industrial production and innovative approaches to increase energy and resource efficiency;
	- Methodology for optimizing the energy and resource efficiency of industrial manufacturing chains with the three steps of modeling (1), evaluating (2) and improving (3);
	- Resource efficiency of industrial manufacturing value chains and its assessment using life cycle analysis (LCA);
	- Exercise: LCA analysis of a manufacturing process (thermoplastic joining of an aircraft fuselage segment) as part of a product lif cycle assessment.
Literature	Literatur:
	- Stefan Alexander (2020): Resource efficiency in manufacturing value chains. Cham: Springer International Publishing.
	- Hauschild, Michael Z.; Rosenbaum, Ralph K.; Olsen, Stig Irving (Hg.) (2018): Life Cycle Assessment. Theory and Practice. Cham Springer International Publishing.
	- Kishita, Yusuke; Matsumoto, Mitsutaka; Inoue, Masato; Fukushige, Shinichi (2021): EcoDesign and sustainability. Singapore Springer.
	- Schebek, Liselotte; Herrmann, Christoph; Cerdas, Felipe (2019): Progress in Life Cycle Assessment. Cham: Springer International Publishing.
	- Thiede, Sebastian; Hermann, Christoph (2019): Eco-factories of the future. Cham: Springer Nature Switzerland AG.
	- Vorlesungsskript.

Course L0928: Productivity Management	
Тур	Project-/problem-based Learning
Hrs/wk	2
СР	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Examination Form	Klausur
Examination duration and	90 Minuten
scale	
Lecturer	5
Language	
Cycle	SoSe
Content	<ul> <li>Principles of productivity management</li> <li>Shop floor management and standardisation</li> <li>Takt analysis and design of manual operations</li> <li>Maintenance Principles</li> <li>Total Productive Maintenance (TPM)</li> <li>Optimisation of set-up operations</li> <li>Analysis of interlinked production systems</li> </ul>
Literature	Bokranz, R.; Landau, K.:Produktivitätsmanagement von Arbeitssystemen. Schäffer-Poeschel, Stuttgart, 2006.  Takeda, H.: Das synchrone Produktionssystem: Just-in-Time für das ganze Unternehmen. 5. Aufl., mi-Wirtschaftsbuch, FinanzBuch Verlag, München, 2006.  Nakajima, S.: Management der Produktionseinrichtungen (Total Productive Maintenance). Campus Verlag, New York, 1995.  Shingo, S.: A Revolution in Manufacturing: The SMED System. Productivity, Inc., 1985

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

Course L0664: Feedback Control in Medical Technology			
Тур	ecture		
Hrs/wk			
СР			
Workload in Hours	ndependent Study Time 62, Study Time in Lecture 28		
Examination Form	lündliche 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	<ul> <li>Leonhardt, S., &amp; Walter, M. (2016). Medizintechnische Systeme. Berlin, Heidelberg: Springer Vieweg.</li> <li>Werner, J. (2005). Kooperative und autonome Systeme der Medizintechnik. München: Oldenbourg.</li> <li>Oczenski, W. (2017). Atmen: Atemhilfen; Atemphysiologie und Beatmungstechnik: Georg Thieme Verlag KG.</li> </ul>		

Course L1514: Structural Mechanics of Fibre Reinforced Composites		
Тур	Lecture	
Hrs/wk	2	
CP	3	
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28	
Examination Form	ündliche Prüfung	
Examination duration and	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	<ul> <li>Schürmann, H., "Konstruieren mit Faser-Kunststoff-Verbunden", Springer, Berlin, aktuelle Auflage.</li> <li>Wiedemann, J., "Leichtbau Band 1: Elemente", Springer, Berlin, Heidelberg, , aktuelle Auflage.</li> <li>Reddy, J.N., "Mechanics of Composite Laminated Plates and Shells", CRC Publishing, Boca Raton et al., current edition.</li> <li>Jones, R.M., "Mechanics of Composite Materials", Scripta Book Co., Washington, current edition.</li> <li>Timoshenko, S.P., Gere, J.M., "Theory of elastic stability", McGraw-Hill Book Company, Inc., New York, current edition.</li> <li>Turvey, G.J., Marshall, I.H., "Buckling and postbuckling of composite plates", Chapman and Hall, London, current edition.</li> <li>Herakovich, C.T., "Mechanics of fibrous composites", John Wiley and Sons, Inc., New York, current edition.</li> <li>Mittelstedt, C., Becker, W., "Strukturmechanik ebener Laminate", aktuelle Auflage.</li> </ul>	

Course L1513: Technical Design	
Тур	Lecture
Hrs/wk	2
СР	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Examination Form	Schriftliche Ausarbeitung

Lecturer	Prof. Werner Granzeier, Prof. Dieter Krause
Language	DE
Cycle	SoSe
Content	<ul> <li>Basics with analysis, concept, proposal drawings and sketches</li> <li>Samples from practice of technical industrial design</li> <li>Product concept with new ideas and package</li> <li>ID proposal with structural concept and external product ergonomics</li> <li>Visualisation and presentation of the overall concept</li> <li>Realization as individual case studies</li> </ul>
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

TTOGGCCIOTI	
	german magasin,
	(erscheint monatlich)
	md - möbel interior design, Konradin-Verlag
	Robert Kohlhammer GmbH, 7022 Leinfelden-Echterdingen
	(erscheint monatlich)
	CAR STYLING, Car Styling Publishing Co. 4-8-16-11F,
	Kitashinjuku, Shinjuku-ku, Tokio 160, Japan
	(erscheint vierteljährlich in japanischer und englischer Sprache, in Hamburg erhältlich bei: Overseas Courier Service Deutschland GmbH,
	Auto & Design,
	Corso Frabcia 161, 10139 Torino, Italia
	(erscheint vierteljährlich in italienischer und englischer Sprache alle zwei
	Monate , erhältlich am HBF Hamburg
	AERO International,
	Magazin für Zivilluftfahrt
	(erscheint monatlich)
	Aircraft interior international
	Engl. magasin for Aircraft cabin interior
	(erscheint 2 monatlich)
	aerotec
	Technik- und Branchenmagazin für die Luft- und Raumfahrtindustrie

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

Course L2994: Reliability in Engineering Dynamics		
Тур	Lecture	
Hrs/wk	2	
СР	2	
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28	
Examination Form	Klausur	
Examination duration and	90 min	
scale		
	Dr. Eric Groß, Prof. Benedikt Kriegesmann	
Language		
Cycle		
Content	Method for calculation and testing of reliability of dynamic machine systems	
	Modeling	
	System identification	
	Simulation	
	Processing of measurement data	
	Damage accumulation	
	Test planning and execution	
Literature	Bertsche, B.: Reliability in Automotive and Mechanical Engineering. Springer, 2008. ISBN: 978-3-540-33969-4	
	Inman, Daniel J.: Engineering Vibration. Prentice Hall, 3rd Ed., 2007. ISBN-13: 978-0132281737	
	Dresig, H., Holzweißig, F.: Maschinendynamik, Springer Verlag, 9. Auflage, 2009. ISBN 3540876936.	
	VDA (Hg.): Zuverlässigkeitssicherung bei Automobilherstellern und Lieferanten. Band 3 Teil 2, 3. überarbeitete Auflage, 2004. ISSN 0943-9412	

Course L2995: Reliability in I	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

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

Course L0749: Reliability of Aircraft Systems		
Тур	Lecture	
Hrs/wk	2	
СР	3	
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28	
Examination Form	Klausur	
Examination duration and	90 Minuten	
scale		
Lecturer	Prof. Frank Thielecke, Dr. Andreas Vahl, Dr. Uwe Wieczorek	
Language	DE	
Cycle	WiSe	
Content	<ul> <li>Functions of reliability and safety (regulations, certification requirements)</li> <li>Basics methods of reliability analysis (FMEA, fault tree, functional hazard assessment)</li> <li>Reliability analysis of electrical and mechanical systems</li> </ul>	
Literature	• CS 25.1309 • SAE ARP 4754 • SAE ARP 4761	

#### Module M1209: Selected Topics of Product Development, Materials Science and Production (Alternative B: 6 LP)

Courses				
Title		Тур	Hrs/wk	СР
pplied Automation (L1592)		Project-/problem-based Learning	3	3
Advanced Training Course SE-ZERT (L2739)		Project-/problem-based Learning	2	3
Elements of Integrated Production Systems (L0927)		Project-/problem-based Learning	2	3
Development Management for Mechatronics (L1512)		Lecture	2	3
Fatigue & Damage Tolerance (L0310)		Lecture	2	3
GSD - Generational Sheet-Metal Development (L3064)		Lecture	3	3
Industry 4.0 for Engineers (L2012)		Lecture	2	3
nnovation and Product Manageme	ent (L2168)	Seminar	2	3
ightweight Design Practical Cours	e (L1258)	Project-/problem-based Learning	3	3
Mechanisms and Systems of Mate	rials Testing - from the viewpoint of product development and Failure	Lecture	2	2
Analysis (L0950)				
Microsystems Technology (L0724)		Lecture	2	4
Sustainable Industrial Production (	L2863)	Lecture	2	4
Productivity Management (L0928)		Project-/problem-based Learning	2	2
Productivity Management (L0931)		Recitation Section (small)	1	1
eedback Control in Medical Techr	ology (L0664)	Lecture	2	3
Structural Mechanics of Fibre Rein	forced Composites (L1514)	Lecture	2	3
Fechnical Design (L1513)		Lecture	2	3
Materials Testing - from the viewp	pint of industrial application (L0949)	Lecture	2	2
Reliability in Engineering Dynamic	s (L2994)	Lecture	2	2
Reliability in Engineering Dynamic	s (L2995)	Recitation Section (small)	1	2
Reliability of Aircraft Systems (L07	49)	Lecture	2	3
Module Responsible	Prof. Dieter Krause			
Admission Requirements	None			
Recommended Previous	None			
Knowledge				
Educational Objectives	After taking part successfully, students have reached the follow	ving loarning results		
Professional Competence		ing learning results		
•				
Knowledge	Students are able to express their extended knowledge	and discuss the connection of di	fferent special	l fields or applica
Knowieage	Students are able to express their extended knowledge		fferent specia	l fields or applica
Knowieage	<ul> <li>Students are able to express their extended knowledge areas of product development, materials and production</li> </ul>		fferent special	l fields or applica
Knowledge	Students are able to express their extended knowledge		fferent special	l fields or applica
Knowiedge Skills	<ul> <li>Students are able to express their extended knowledge areas of product development, materials and production</li> <li>Students are qualified to connect different special fields v</li> </ul>		fferent specia	l fields or applica
	<ul> <li>Students are able to express their extended knowledge areas of product development, materials and production</li> <li>Students are qualified to connect different special fields v</li> </ul>	with each other	·	l fields or applica
	Students are able to express their extended knowledge areas of product development, materials and production     Students are qualified to connect different special fields to	with each other ew scientific methods in selected	areas	
Skills	Students are able to express their extended knowledge areas of product development, materials and production Students are qualified to connect different special fields were students can apply specialized solution strategies and need to students are able to transfer learned skills to new and under the students are able to transfer learned skills to new and under the students are able to transfer learned skills to new and under the students are able to transfer learned skills to new and under the students are able to transfer learned skills to new and under the students are able to transfer learned skills to new and under the students are able to transfer learned skills to new and under the students are able to transfer learned skills to new and under the students are able to transfer learned skills to new and under the students are able to transfer learned skills to new and under the students are able to transfer learned skills to new and under the students are able to transfer learned skills to new and under the students are able to transfer learned skills to new and under the students are able to transfer learned skills to new and under the students are able to transfer learned skills to new and under the students are able to transfer learned skills to new and under the students are able to transfer learned skills to new and under the students are able to transfer learned skills to new and under the students are able to transfer learned skills to new and under the students are able to transfer learned skills to new and under the students are able to transfer learned skills to new and under the students are able to transfer learned skills to new and under the students are able to transfer learned skills to new and under the students are able to transfer learned skills to the students are able to transfer learned skills to new and the students are able to transfer learned skills to the skill the skills are able to transfer learned skill the skills are able to transfer learned skills are able to transfer learned	with each other ew scientific methods in selected	areas	
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Skills  Personal Competence  Social Competence  Autonomy	Students are able to express their extended knowledge areas of product development, materials and production Students are qualified to connect different special fields to Students can apply specialized solution strategies and nee Students are able to transfer learned skills to new and ur  Students are able to develop their knowledge and skills be Depends on choice of courses	with each other ew scientific methods in selected nknown problems and can develo	areas p own solutior	
Skills  Personal Competence Social Competence Autonomy  Workload in Hours  Credit points	Students are able to express their extended knowledge areas of product development, materials and production Students are qualified to connect different special fields to Students can apply specialized solution strategies and nee Students are able to transfer learned skills to new and ur  Students are able to develop their knowledge and skills be Depends on choice of courses	with each other  ew scientific methods in selected nknown problems and can develop  by autonomous election of course	areas p own solutior s.	
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Skills  Personal Competence Social Competence Autonomy  Workload in Hours  Credit points	Students are able to express their extended knowledge areas of product development, materials and production Students are qualified to connect different special fields was students are apply specialized solution strategies and nees to students are able to transfer learned skills to new and urest of the students are able to develop their knowledge and skills be because of the product Development, Materials and Production: Specialisation Product Development, Materials and Production: Specialisation	with each other  ew scientific methods in selected nknown problems and can develop  by autonomous election of course  Product Development: Elective Corpoduction: Elective Compulsory	areas p own solutior s.	
Personal Competence Social Competence Autonomy Workload in Hours Credit points Assignment for the	Students are able to express their extended knowledge areas of product development, materials and production Students are qualified to connect different special fields was students are apply specialized solution strategies and nees to students are able to transfer learned skills to new and urest of the students are able to develop their knowledge and skills be because on choice of courses  Beginning to extra the students are able to develop their knowledge and skills be because of the students are able to develop their knowledge and skills be because of the students are able to develop their knowledge and skills be because of the students are able to develop their knowledge and skills be because of the students are able to develop their knowledge and skills be because of the students are able to develop their knowledge and skills be because of the students are able to develop their knowledge and skills be because of the students are able to develop their knowledge and skills be because of the students are able to develop their knowledge and skills be because of the students are able to develop their knowledge and skills be because of the students are able to develop their knowledge and skills be because of the students are able to develop their knowledge and skills be because of the students are able to develop their knowledge.	with each other  ew scientific methods in selected nknown problems and can develop  by autonomous election of course  Product Development: Elective Corpoduction: Elective Compulsory  Materials: Elective Compulsory	areas p own solution s. ompulsory	

Course L1592	2: Applied Automation
Тур	Project-/problem-based Learning
Hrs/wk	3
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	<ul> <li>Processes and methods of product development - from idea to market launch</li> <li>identification of market and technology potentials</li> <li>development of a common product architecture</li> <li>Synchronized product development across all engineering disciplines</li> <li>product validation incl. customer view</li> <li>Steering and optimization of product development</li> <li>Design of processes for product development</li> <li>IT systems for product development</li> <li>Establishment of management standards</li> <li>Typical types of organization</li> </ul>
Literature	<ul> <li>Bender: Embedded Systems - qualitätsorientierte Entwicklung</li> <li>Ehrlenspiel: Integrierte Produktentwicklung: Denkabläufe, Methodeneinsatz, Zusammenarbeit</li> <li>Gausemeier/Ebbesmeyer/Kallmeyer: Produktinnovation - Strategische Planung und Entwicklung der Produkte von morgen</li> <li>Haberfellner/de Weck/Fricke/Vössner: Systems Engineering: Grundlagen und Anwendung</li> <li>Lindemann: Methodische Entwicklung technischer Produkte: Methoden flexibel und situationsgerecht anwenden</li> <li>Pahl/Beitz: Konstruktionslehre: Grundlagen erfolgreicher Produktentwicklung. Methoden und Anwendung</li> <li>VDI-Richtlinie 2206: Entwicklungsmethodik für mechatronische Systeme</li> </ul>

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

Course L3064: GSD - Generational Sheet-Metal Development	
Тур	Lecture
Hrs/wk	3
СР	3
Workload in Hours	Independent Study Time 48, Study Time in Lecture 42
Examination Form	Mündliche Prüfung
Examination duration and	30 min
scale	
Lecturer	Prof. Dr. Nikola Bursac
Language	DE
Cycle	WiSe
Content	Experience in mechanical engineering design and the fundamentals of manufacturing engineering
	After successful completion of the course, students will be able to explain development projects using the theory of product generation engineering and explain design rules for sheet metal development.
	After successful completion of the course, students will be able to apply the theory of product generation engineering to development tasks and develop sheet-metal products suitable for production.
	After successful completion of the course, students will be able to develop a product in a team and to compete against other teams.
	After successful completion of the course, students will be able to independently access knowledge required for sheet metal development.
Literature	

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

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

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

Course L0950: Mechanisms a	and Systems of Materials Testing - from the viewpoint of product development and Failure Analysis
Тур	Lecture
Hrs/wk	2
СР	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Examination Form	Klausur
Examination duration and	90 Minuten
scale	
Lecturer	Dr. Jan Oke Peters
Language	DE
Cycle	SoSe
Content	Application, analysis and discussion of basic and advanced testing methods to ensure correct selection of applicable testing
	procedure for investigation of part/materials deficiencies
	Stress-strain relationships
	Strain gauge application
	Visko elastic behavior
	Tensile test (strain hardening, necking, strain rate)
	Compression test, bending test, torsion test
	Crack growth upon static loading (J-Integral)
	Crack growth upon cyclic loading (micro- und macro cracks)
	Effect of notches
	Creep testing (physical creep test, influence of stress and temperature, Larson Miller parameter)
	Wear testing
	Non destructive testing application for overhaul of jet engines
Literature	
	E. Macherauch: Praktikum in Werkstoffkunde, Vieweg
	G. E. Dieter: Mechanical Metallurgy, McGraw-Hill     D. Börnel Habra and Übenschade Festinkeitelden Affrica
	R. Bürgel: Lehr- und Übungsbuch Festigkeitslehre, Vieweg      R. Bürgel: Weglebeffe gebes hautellen und richtig einenbage 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	<ul> <li>Introduction (historical view, scientific and economic relevance, scaling laws)</li> <li>Semiconductor Technology Basics, Lithography (wafer fabrication, photolithography, improving resolution, next-generation lithography, nano-imprinting, molecular imprinting)</li> <li>Deposition Techniques (thermal oxidation, epitaxy, electroplating, PVD techniques: evaporation and sputtering; CVD techniques: APCVD, LPCVD, PECVD and LECVD; screen printing)</li> <li>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)</li> <li>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)</li> <li>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;</li> <li>Magnetic Sensors (galvanomagnetic sensors: spinning current Hall sensor and magneto-transistor; magnetoresistive sensors: magneto resistance, AMR and GMR, fluxgate magnetometer)</li> <li>Chemical and Bio Sensors (thermal gas sensors: plistor and thermal conductivity sensor; metal oxide semiconduct</li></ul>
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	5
Language	
Cycle	SoSe
Content	<ul> <li>Principles of productivity management</li> <li>Shop floor management and standardisation</li> <li>Takt analysis and design of manual operations</li> <li>Maintenance Principles</li> <li>Total Productive Maintenance (TPM)</li> <li>Optimisation of set-up operations</li> <li>Analysis of interlinked production systems</li> </ul>
Literature	Bokranz, R.; Landau, K.:Produktivitätsmanagement von Arbeitssystemen. Schäffer-Poeschel, Stuttgart, 2006.  Takeda, H.: Das synchrone Produktionssystem: Just-in-Time für das ganze Unternehmen. 5. Aufl., mi-Wirtschaftsbuch, FinanzBuch Verlag, München, 2006.  Nakajima, S.: Management der Produktionseinrichtungen (Total Productive Maintenance). Campus Verlag, New York, 1995.  Shingo, S.: A Revolution in Manufacturing: The SMED System. Productivity, Inc., 1985

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

Course L0664: Feedback Con	trol in Medical Technology		
Тур	ecture		
Hrs/wk			
СР			
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28		
Examination Form	Mündliche Prüfung		
Examination duration and	20 min		
scale			
Lecturer	Johannes Kreuzer, Christian Neuhaus		
Language	E		
Cycle	ioSe		
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	<ul> <li>Leonhardt, S., &amp; Walter, M. (2016). Medizintechnische Systeme. Berlin, Heidelberg: Springer Vieweg.</li> <li>Werner, J. (2005). Kooperative und autonome Systeme der Medizintechnik. München: Oldenbourg.</li> <li>Oczenski, W. (2017). Atmen: Atemhilfen; Atemphysiologie und Beatmungstechnik: Georg Thieme Verlag KG.</li> </ul>		

Course L1514: Structural Mechanics of Fibre Reinforced Composites			
Тур	Lecture		
Hrs/wk			
CP			
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	<ul> <li>Schürmann, H., "Konstruieren mit Faser-Kunststoff-Verbunden", Springer, Berlin, aktuelle Auflage.</li> <li>Wiedemann, J., "Leichtbau Band 1: Elemente", Springer, Berlin, Heidelberg, , aktuelle Auflage.</li> <li>Reddy, J.N., "Mechanics of Composite Laminated Plates and Shells", CRC Publishing, Boca Raton et al., current edition.</li> <li>Jones, R.M., "Mechanics of Composite Materials", Scripta Book Co., Washington, current edition.</li> <li>Timoshenko, S.P., Gere, J.M., "Theory of elastic stability", McGraw-Hill Book Company, Inc., New York, current edition.</li> <li>Turvey, G.J., Marshall, I.H., "Buckling and postbuckling of composite plates", Chapman and Hall, London, current edition.</li> <li>Herakovich, C.T., "Mechanics of fibrous composites", John Wiley and Sons, Inc., New York, current edition.</li> <li>Mittelstedt, C., Becker, W., "Strukturmechanik ebener Laminate", aktuelle Auflage.</li> </ul>		

Course L1513: Technical Design	
Тур	Lecture
Hrs/wk	2
СР	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Examination Form	Schriftliche Ausarbeitung

Lecturer	Prof. Werner Granzeier, Prof. Dieter Krause
Language	DE
Cycle	SoSe
Content	<ul> <li>Basics with analysis, concept, proposal drawings and sketches</li> <li>Samples from practice of technical industrial design</li> <li>Product concept with new ideas and package</li> <li>ID proposal with structural concept and external product ergonomics</li> <li>Visualisation and presentation of the overall concept</li> <li>Realization as individual case studies</li> </ul>
Literature	Literatur über technisches Produktdesign
	Technisches Rendering und Präsentation
	Zeichnen und perspektivisches Entwerfen
	Literaturhinweise
	What is Product Design ?
	Laura Slack
	RotoVision Schweiz 2006
	Product Design Now
	Design and Scetches
	CollinsDesign and maomao publications Spanien 2006
	Ronald B. Kemnitzer, Rendering With Markers - Definitive Techniques
	for Designers, Illustrators and Architects,
	Watson, Guptil Puplications,a division of Billboard Publications Inc.,
	New York 1983
	Creative Techniques
	DRAWING
	Barons Educational Series
	ISBN-13: 978-0-7641-6182-7
	Joseph Ungar, Rendering In Mixed Media - Techniques for Concept
	Presentation for Designers and Illustrators
	Watson-Guptil Publication a division of Billboard Publications Inc.,
	New York 1985
	AIRWORLD
	Design und Architektur für die Flugreise
	Vitra Design Stiftung Weil am Rhein 2004
	Airline Design
	Perter Deslius Jacek Slaski te Neues 2005
	Technik und Sicherheit von Passagierflugzeugen
	Frank Littek
	Motorbuch Verlag 2003
	Jetliner Cabins
	Jennifer Coutts Clay
	Cs books England 2006
	BOEING Widebodies
	Michael Haenggi motorbooks international USA 2003
	form - Zeitschrift für Gestaltung, Verlag form GmbH,
	Hofgut Ober-Berrbach, 6104 Seeheim-Jugenheim
	(erscheint vierteljährlich, Verlag form GmbH )
	design report

Production"	
	german magasin,
	(erscheint monatlich)
	md - möbel interior design, Konradin-Verlag
	Robert Kohlhammer GmbH, 7022 Leinfelden-Echterdingen
	(erscheint monatlich)
	CAR STYLING, Car Styling Publishing Co. 4-8-16-11F,
	Kitashinjuku, Shinjuku-ku, Tokio 160, Japan
	(erscheint vierteljährlich in japanischer und englischer Sprache, in Hamburg erhältlich bei: Overseas Courier Service Deutschland GmbH,
	Auto & Design,
	Corso Frabcia 161, 10139 Torino, Italia
	(erscheint vierteljährlich in italienischer und englischer Sprache alle zwei
	Monate , erhältlich am HBF Hamburg
	AERO International,
	Magazin für Zivilluftfahrt
	(erscheint monatlich)
	Aircraft interior international
	Engl. magasin for Aircraft cabin interior
	(erscheint 2 monatlich)
	aerotec
	Technik- und Branchenmagazin für die Luft- und Raumfahrtindustrie

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

Course L2994: Reliability in Engineering Dynamics		
Тур	Lecture	
Hrs/wk	2	
СР	2	
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28	
Examination Form	Klausur	
Examination duration and	90 min	
scale		
Lecturer	Dr. Eric Groß, Prof. Benedikt Kriegesmann	
Language	EN	
Cycle	SoSe	
Content	Method for calculation and testing of reliability of dynamic machine systems	
	Modeling	
	System identification	
	Simulation	
	Processing of measurement data	
	Damage accumulation	
	Test planning and execution	
Literature	Bertsche, B.: Reliability in Automotive and Mechanical Engineering. Springer, 2008. ISBN: 978-3-540-33969-4	
	Inman, Daniel J.: Engineering Vibration. Prentice Hall, 3rd Ed., 2007. ISBN-13: 978-0132281737	
	Dresig, H., Holzweißig, F.: Maschinendynamik, Springer Verlag, 9. Auflage, 2009. ISBN 3540876936.	
	VDA (Hg.): Zuverlässigkeitssicherung bei Automobilherstellern und Lieferanten. Band 3 Teil 2, 3. überarbeitete Auflage, 2004. ISSN 0943-9412	

Course L2995: Reliability in I	
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

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

Course L0749: Reliability of Aircraft Systems			
Тур	Lecture		
Hrs/wk	2		
СР			
Workload in Hours	dependent Study Time 62, Study Time in Lecture 28		
Examination Form	ausur		
Examination duration and	) Minuten		
scale			
Lecturer	Prof. Frank Thielecke, Dr. Andreas Vahl, Dr. Uwe Wieczorek		
Language	DE		
Cycle	WiSe		
Content	<ul> <li>Functions of reliability and safety (regulations, certification requirements)</li> <li>Basics methods of reliability analysis (FMEA, fault tree, functional hazard assessment)</li> <li>Reliability analysis of electrical and mechanical systems</li> </ul>		
	* Tellability unlarysis of electrical and mechanical systems		
Literature	<ul> <li>CS 25.1309</li> <li>SAE ARP 4754</li> <li>SAE ARP 4761</li> </ul>		

Module M1193: Cabin	Systems Engineering				
Courses					
Courses					
Title			Тур	Hrs/wk	СР
	nnology in cabin electronics and avionics (L1557)		Lecture	2 1	2
Model-Based Systems Engineering	nnology in cabin electronics and avionics (L1558)		Recitation Section (small) Project-/problem-based Learning	3	1
			rroject-/problem-based Learning	3	3
Module Responsible					
Admission Requirements	None				
Recommended Previous Knowledge					
Kilowiedge	Mechanics				
	Thermodynamics				
	Electrical Engineering				
	Control Systems				
	- Control Systems				
	Previous knowledge in:				
	Systems Engineering				
Educational Objectives	After taking part successfully students have reach	ad the followi	na learning results		
Educational Objectives	After taking part successfully, students have reach	ea the followi	ng learning results		
Professional Competence	Charles to a second to				
Knowieage	Students are able to:		_		
	describe the structure and operation of computer     avalage the structure and operation of digital computer				
	explain the structure and operation of digital com			Camanauniaati	an Naturali (ADCN)
	explain architectures of cabin electronics, integra				
	understand the approach of Model-Based System	ms Engineer	ing (MBSE) in the design of ha	raware and s	software-based cabii
	systems				
Skills	Students are able to:				
	understand, operate and maintain a Minicompute	r			
	build up a network communication and communication	cate with other	er network participants		
	• connect a minicomputer with a cabin management system (A380 CIDS) and communicate over a AFDX®-Network				etwork
	model system functions by means of formal language	uages SysML/	UML and generate software code	e from the mo	dels
	execute software code on a minicomputer				
Personal Competence					
	Students are able to:				
30ciai Competence		al work			
	<ul> <li>form teams of two or small groups for the practic</li> <li>work out partial results themselves and combine</li> </ul>		hors to form an overall solution		
	represent and contribute their own solution	them with oth	ners to form an overall solution		
	take over the guidance of the team				
	contribute in the team				
	contribute in the team				
Autonomy	Students are able to:				
	organize and plan their practical tasks				
	further develop their own skills				
	take their own initiative				
	explore their own new ways of solving problems				
Workload in Hours	Independent Study Time 96, Study Time in Lecture	84			
Credit points	6				
Course achievement					
Examination	Written exam				
Examination duration and	120 minutes				
scale					
Assignment for the	Aircraft Systems Engineering: Core Qualification: El	ective Comp	ulsory		
Following Curricula	International Management and Engineering: Specia		•	sory	
<b>J</b>	Aeronautics: Core Qualification: Elective Compulsor		,	•	
	Product Development, Materials and Production: Sp		Product Development: Elective C	ompulsory	
	Product Development, Materials and Production: Sp		·	i	
	Product Development, Materials and Production: Sp				
	Theoretical Mechanical Engineering: Specialisation			ulsory	
		c. aic by ste	Lingcompt		

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

	Positivities Continue (continue)
Typ	Recitation Section (small)
Hrs/wk	
СР	
	Independent Study Time 16, Study Time in Lecture 14
Lecturer	Prof. Ralf God
Language	
Cycle	WiSe
Content	The objective of the lecture with the corresponding exercise is the acquisition of knowledge of computer and communication technology in electronic systems in the cabin and in aircraft. For the system engineer the strong interaction of software mechanical and electronic system components nowadays requires a basic understanding of cabin electronics and avionics.
	The course teaches the basics of design and functionality of computers and data networks. Subsequently it focuses on current principles and applications in integrated modular avionics (IMA), aircraft data communication networks (ADCN), cabin electronics and cabin networks:
	History of computer and network technology
	Layer model in computer technology
	Computer architectures (PC, IPC, Embedded Systems)
	BIOS, UEFI and operating system (OS)
	Programming languages (machine code and high-level languages)
	Applications and Application Programming Interfaces  Figure 1 interfaces (parish USD Ethornot)
	External interfaces (serial, USB, Ethernet)      Laura model in petropole trackpolery:
	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

,	udy Time in Lecture 42
CP 3  Workload in Hours Independent Study Time 48, St  Lecturer Prof. Ralf God  Language DE  Cycle SoSe  Content Objectives of the problem-orion	
Workload in Hours Independent Study Time 48, St  Lecturer Prof. Ralf God  Language DE  Cycle SoSe  Content Objectives of the problem-orion	
Lecturer Prof. Ralf God  Language DE  Cycle SoSe  Content Objectives of the problem-orion	
Language DE Cycle SoSe Content Objectives of the problem-orion	
Cycle SoSe Content Objectives of the problem-orio	
Content Objectives of the problem-orion	
'	
SycMI /IMI loarning about too	ented course are the acquisition of knowledge on system design using the formal languages
SysML/OML, learning about too	ls for modeling and finally the implementation of a project with methods and tools of Model-Based
Systems Engineering (MBSE) or	n a realistic hardware platform (e.g. Arduino®, Raspberry Pi®):
• What is a model?	
What is Systems Engineering	?
Survey of MBSE methodologic	es
The modelling languages System	ML /UML
Tools for MBSE	
Best practices for MBSE	
Requirements specification, for	unctional architecture, specification of a solution
From model to software code	
Validation and verification: Xi	L methods
Accompanying MBSE project	
<b>Literature</b> - Skript zur Vorlesung	
- Weilkiens, T.: Systems Engine	ering mit SysML/UML: Modellierung, Analyse, Design. 2. Auflage, dpunkt.Verlag, 2008
- Holt, J., Perry, S.A., Brownswo	rd, M.: Model-Based Requirements Engineering. Institution Engineering & Tech, 2011

ics and Navigation in Medi	cine			
	Тур	Hrs/wk	СР	
(L0335)	Lecture	2	3	
(L0338)	Project Seminar	2	2	
(L0336)	Recitation Section (small)	1	1	
Prof. Alexander Schlaefer				
None				
<ul> <li>principles of math (algebra, analy</li> </ul>	ysis/calculus)			
<ul><li>principles of programming, e.g., i</li><li>solid R or Matlab skills</li></ul>	in Java or C++			
After taking part successfully, students	have reached the following learning results			
The students can explain kinematics and tracking systems in clinical contexts and illustrate systems and their components in				
detail. Systems can be evaluated with respect to collision detection and safety and regulations. Students can assess typical				
s The students are able to design and evaluate navigation systems and robotic systems for medical applications.				
The students are able to grasp practic	al tasks in groups, develop solution strategies i	ndependently, define	work processes and	
work on them collaboratively.  The students are able to collaboratively organize their work processes and software solutions using virtual communication an				
	the results of other groups, make constructive	suggestions for imp	provement, and also	
neorporate arem mas arem own works				
Autonomy  The students can assess their level of knowledge and independently control their learning processes on this bas				
nanner to the other groups.				
Independent Study Time 110, Study Tin	ne in Lecture 70			
6				
6 Compulsory Bonus Form	Description			
6 Compulsory Bonus Form Yes 10 % Written elaborat	Description			
6  Compulsory Bonus Form  Yes 10 % Written elaborat  Yes 10 % Presentation	Description			
6 Compulsory Bonus Form Yes 10 % Written elaborat	Description			
6  Compulsory Bonus Form  Yes 10 % Written elaborat  Yes 10 % Presentation	Description			
Compulsory Bonus Form Yes 10 % Written elaborat Yes 10 % Presentation Written exam 90 minutes	<b>Description</b> ion			
Compulsory Bonus Form Yes 10 % Written elaborat Yes 10 % Presentation Written exam 90 minutes  Computer Science: Specialisation II: Inte	Description ion elligence Engineering: Elective Compulsory			
Compulsory Bonus Form Yes 10 % Written elaborat Yes 10 % Presentation Written exam 90 minutes	Description ion elligence Engineering: Elective Compulsory			
Compulsory Bonus Form Yes 10 % Written elaborat Yes 10 % Presentation Written exam 90 minutes  Computer Science: Specialisation II: Inte	Description ion  elligence Engineering: Elective Compulsory tions: Elective Compulsory			
Compulsory Bonus Form Yes 10 % Written elaborat Yes 10 % Presentation Written exam 90 minutes  Computer Science: Specialisation III: Inte Data Science: Specialisation III. Applicat Data Science: Specialisation IV. Special	Description ion  elligence Engineering: Elective Compulsory tions: Elective Compulsory			
Compulsory Bonus Form Yes 10 % Written elaborat Yes 10 % Presentation Written exam 90 minutes  Computer Science: Specialisation III: Inte Data Science: Specialisation IV. Special Electrical Engineering: Specialisation Me	Description ion  elligence Engineering: Elective Compulsory tions: Elective Compulsory Focus Area: Elective Compulsory	Isory		
Compulsory Bonus Form Yes 10 % Written elaborat Yes 10 % Presentation Written exam 90 minutes  Computer Science: Specialisation III. Integrate Data Science: Specialisation IV. Special Electrical Engineering: Specialisation McComputer Science in Engineering: Specialisation	Description ion  elligence Engineering: Elective Compulsory tions: Elective Compulsory Focus Area: Elective Compulsory edical Technology: Elective Compulsory	,		
Compulsory Bonus Form Yes 10 % Written elaborat Yes 10 % Presentation Written exam 90 minutes  Computer Science: Specialisation III: Inte Data Science: Specialisation IV. Special Electrical Engineering: Specialisation Mc Computer Science in Engineering: Specialisation Mc Computer Science in Engineering: Specialisetion Mc Computer Science in Engineering in Engin	Description  ion  elligence Engineering: Elective Compulsory tions: Elective Compulsory Focus Area: Elective Compulsory edical Technology: Elective Compulsory ialisation II. Engineering Science: Elective Compu	tive Compulsory	Compulsory	
Compulsory Bonus Form Yes 10 % Written elaborat Yes 10 % Presentation Written exam 90 minutes  Computer Science: Specialisation III: Inte Data Science: Specialisation IV. Special Electrical Engineering: Specialisation Mc Computer Science in Engineering: Specialisation Mc Computer Science in Engineering: Specialisetion Mc Computer Science in Engineering in Engin	Description  ion  elligence Engineering: Elective Compulsory tions: Elective Compulsory Focus Area: Elective Compulsory edical Technology: Elective Compulsory ialisation II. Engineering Science: Elective Compu ring: Specialisation II. Electrical Engineering: Elec ring: Specialisation II. Process Engineering and Bi	tive Compulsory	Compulsory	
Compulsory Bonus Form Yes 10 % Written elaborat Yes 10 % Presentation Written exam 90 minutes  Computer Science: Specialisation III: Inte Data Science: Specialisation IV. Special Electrical Engineering: Specialisation Mc Computer Science in Engineering: Special International Management and Enginee International Management and Enginee Mechatronics: Core Qualification: Elective	Description  ion  elligence Engineering: Elective Compulsory tions: Elective Compulsory Focus Area: Elective Compulsory edical Technology: Elective Compulsory ialisation II. Engineering Science: Elective Compu ring: Specialisation II. Electrical Engineering: Elec ring: Specialisation II. Process Engineering and Bi	tive Compulsory otechnology: Elective	Compulsory	
Compulsory Bonus Form Yes 10 % Written elaborat Yes 10 % Presentation Written exam 90 minutes  Computer Science: Specialisation III: Inte Data Science: Specialisation IV. Special Electrical Engineering: Specialisation Mc Computer Science in Engineering: Specialisation Management and Enginee International Management and Enginee Mechatronics: Core Qualification: Electiv Biomedical Engineering: Specialisation Management and Enginee	Description ion  elligence Engineering: Elective Compulsory tions: Elective Compulsory Focus Area: Elective Compulsory edical Technology: Elective Compulsory ialisation II. Engineering Science: Elective Compu ring: Specialisation II. Electrical Engineering: Elec ring: Specialisation II. Process Engineering and Bi we Compulsory	tive Compulsory otechnology: Elective tive Compulsory	Compulsory	
Compulsory Bonus Form Yes 10 % Written elaborat Yes 10 % Presentation Written exam 90 minutes  Computer Science: Specialisation III: Inte Data Science: Specialisation IV. Special Electrical Engineering: Specialisation Mc Computer Science in Engineering: Specialisation Management and Enginee International Management and Enginee International Management and Enginee Mechatronics: Core Qualification: Electiv Biomedical Engineering: Specialisation Management Sp	Description ion  elligence Engineering: Elective Compulsory tions: Elective Compulsory Focus Area: Elective Compulsory edical Technology: Elective Compulsory ialisation II. Engineering Science: Elective Compu ring: Specialisation II. Electrical Engineering: Elec ring: Specialisation II. Process Engineering and Bi we Compulsory Artificial Organs and Regenerative Medicine: Elec	tive Compulsory otechnology: Elective tive Compulsory ry	Compulsory	
Compulsory Bonus Form Yes 10 % Written elaborat Yes 10 % Presentation Written exam 90 minutes  Computer Science: Specialisation II: Inte Data Science: Specialisation III. Applicat Data Science: Specialisation IV. Special Electrical Engineering: Specialisation Mc Computer Science in Engineering: Specialisation Mc International Management and Enginee International Management and Enginee International Management and Enginee Mechatronics: Core Qualification: Electiv Biomedical Engineering: Specialisation Management Specialisation Management Specialisation Management Specialisation III.	Description ion  elligence Engineering: Elective Compulsory tions: Elective Compulsory Focus Area: Elective Compulsory edical Technology: Elective Compulsory ialisation II. Engineering Science: Elective Compu ring: Specialisation II. Electrical Engineering: Elec ring: Specialisation II. Process Engineering and Bi we Compulsory Artificial Organs and Regenerative Medicine: Elec Implants and Endoprostheses: Elective Compulsor	tive Compulsory otechnology: Elective tive Compulsory ry Compulsory	Compulsory	
Compulsory Bonus Form Yes 10 % Written elaborat Yes 10 % Presentation Written exam  90 minutes  Computer Science: Specialisation III: Inte Data Science: Specialisation III. Applicat Data Science: Specialisation IV. Special Electrical Engineering: Specialisation Mc Computer Science in Engineering: Specialisation Mc Homography Specialisation Management and Enginee International Management and Enginee International Management and Enginee Mechatronics: Core Qualification: Electivation III. Electiv	Description ion  elligence Engineering: Elective Compulsory tions: Elective Compulsory Focus Area: Elective Compulsory edical Technology: Elective Compulsory ialisation II. Engineering Science: Elective Compu ring: Specialisation II. Electrical Engineering: Elec ring: Specialisation II. Process Engineering and Bi we Compulsory Artificial Organs and Regenerative Medicine: Elec Implants and Endoprostheses: Elective Compulsor Medical Technology and Control Theory: Elective	tive Compulsory otechnology: Elective tive Compulsory ry Compulsory ve Compulsory	Compulsory	
Compulsory Bonus Form Yes 10 % Written elaborat Yes 10 % Presentation Written exam  90 minutes  Computer Science: Specialisation III: Inte Data Science: Specialisation III. Applicat Data Science: Specialisation IV. Special Electrical Engineering: Specialisation Mc Computer Science in Engineering: Specialisation Mc Computer Science in Engineering: Specialisation Mc International Management and Enginee International Management and Enginee Mechatronics: Core Qualification: Electiv Biomedical Engineering: Specialisation I Broduct Development, Materials and Product Development Pro	Description  ion  elligence Engineering: Elective Compulsory tions: Elective Compulsory Focus Area: Elective Compulsory edical Technology: Elective Compulsory ialisation II. Engineering Science: Elective Compu ring: Specialisation II. Electrical Engineering: Elec ring: Specialisation II. Process Engineering and Bi ve Compulsory Artificial Organs and Regenerative Medicine: Elec Implants and Endoprostheses: Elective Compulso Medical Technology and Control Theory: Elective Management and Business Administration: Elective	tive Compulsory otechnology: Elective tive Compulsory ry Compulsory ve Compulsory ective Compulsory	Compulsory	
Compulsory Bonus Form Yes 10 % Written elaborat Yes 10 % Presentation Written exam  90 minutes  Computer Science: Specialisation III: Inte Data Science: Specialisation III. Applicat Data Science: Specialisation IV. Special Electrical Engineering: Specialisation Mc Computer Science in Engineering: Specialisation Mc Computer Science in Engineering: Specialisation Mc International Management and Enginee International Management and Enginee Mechatronics: Core Qualification: Electiv Biomedical Engineering: Specialisation I Broduct Development, Materials and Pro	Description  ion  elligence Engineering: Elective Compulsory tions: Elective Compulsory Focus Area: Elective Compulsory edical Technology: Elective Compulsory ialisation II. Engineering Science: Elective Compu ring: Specialisation II. Electrical Engineering: Elec ring: Specialisation II. Process Engineering and Bi ve Compulsory Artificial Organs and Regenerative Medicine: Elec Implants and Endoprostheses: Elective Compulso Medical Technology and Control Theory: Elective Management and Business Administration: Elective duction: Specialisation Product Development: Elective	tive Compulsory otechnology: Elective tive Compulsory ry Compulsory ve Compulsory ective Compulsory pulsory	Compulsory	
	(L0338) (L0336)  Prof. Alexander Schlaefer  None  • principles of math (algebra, analy • principles of programming, e.g., i • solid R or Matlab skills  After taking part successfully, students  The students can explain kinematics and detail. Systems can be evaluated with systems regarding design and limitation  The students are able to design and evaluated with systems are able to collaborative software management tools.  The students are able to collaborative software management tools.  The students can critically reflect on incorporate them into their own work.	(L0335) Lecture (L0338) Project Seminar (L0336) Recitation Section (small)  Prof. Alexander Schlaefer  None  • principles of math (algebra, analysis/calculus) • principles of programming, e.g., in Java or C++ • solid R or Matlab skills  After taking part successfully, students have reached the following learning results  The students can explain kinematics and tracking systems in clinical contexts and ill detail. Systems can be evaluated with respect to collision detection and safety and systems regarding design and limitations.  The students are able to design and evaluate navigation systems and robotic systems for the students are able to collaboratively organize their work processes and software software management tools.  The students can critically reflect on the results of other groups, make constructive incorporate them into their own work.	(L0335) (L0338) Prof. Alexander Schlaefer  None  • principles of math (algebra, analysis/calculus) • principles of math (algebra, analysis/calculus) • principles of programming, e.g., in Java or C++ • solid R or Matlab skills  After taking part successfully, students have reached the following learning results  The students can explain kinematics and tracking systems in clinical contexts and illustrate systems and detail. Systems can be evaluated with respect to collision detection and safety and regulations. Student systems regarding design and limitations.  The students are able to design and evaluate navigation systems and robotic systems for medical applications work on them collaboratively.  The students are able to collaboratively organize their work processes and software solutions using virtual software management tools.  The students can critically reflect on the results of other groups, make constructive suggestions for improporate them into their own work.	

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

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

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

Production				
Module M0764: Flight	t Control Systems			
Courses				
Title		Torre	Han hade	CD
Flight Control Systems (L0736)		Typ Lecture	Hrs/wk 3	<b>CP</b> 4
Flight Control Systems (L0740)		Recitation Section (large)	2	2
Module Responsible	Prof. Frank Thielecke			
Admission Requirements				
Recommended Previous				
Knowledge				
	mathematics			
	mechanics			
	thermo dynamics     electronics			
	• fluid mechanics			
	control theory			
	control tricoly			
<b>Educational Objectives</b>	After taking part successfully, students have reached the follow	ing learning results		
<b>Professional Competence</b>				
Knowledge	Students are able to			
	describe the structure and the functioning of primary flig	ht control systems as well as	actuation avior	nic high lift systems
	of aircrafts in general along with corresponding propertie			,g 2, 2.2
	give an overview over the functioning and the structure of		ear systems	
	explain different configurations and designs and their original designs.	gins		
61.71				
Skills	Students are able to			
	size primary flight control actuation systems			
	perform a controller design process for the flight control a	actuators		
	<ul> <li>design high-lift systems and high-lift kinematics</li> </ul>			
	size landing gear components			
Personal Competence				
Social Competence	Students are able to:			
	Develop joint solutions in mixed teams			
	<ul> <li>Present and explain developed solutions in front of other</li> </ul>	students		
	Discuss developed solutions with experts			
Autonomy	Students are able to:			
	derive requirements and perform appropriate yet simplif	ied design processes for aircr	aft systems from	complex issues and
	circumstances in a self-reliant manner			
	apply new skills and methods in the context of exercises	in a self-reliant manner		
Workload in Hours	Independent Study Time 110, Study Time in Lecture 70			
Credit points				
Course achievement				
	Written exam			
Examination duration and scale				
-	Aircraft Systems Engineering: Core Qualification: Compulsory	iation Systems: Floctive Com-	nulsory	
Following Curricula	International Management and Engineering: Specialisation II. Av Aeronautics: Core Qualification: Compulsory	iacion bystems. Elective Comp	ouisui y	
	Product Development, Materials and Production: Specialisation	Product Development: Flective	Compulsory	
	Product Development, Materials and Production: Specialisation   Product Development, Materials and Production: Specialisation			
	Product Development, Materials and Production: Specialisation   Product Development, Materials and Production: Specialisation			
	Theoretical Mechanical Engineering: Specialisation Aircraft Syst			
	Theoretical Mechanical Engineering, Specialisation All Claft Syst	and Engineering. Elective Coll	тратэот у	

Course L0736: Flight Control	Systems
Тур	Lecture
Hrs/wk	3
СР	4
Workload in Hours	Independent Study Time 78, Study Time in Lecture 42
Lecturer	Prof. Frank Thielecke
Language	DE
Cycle	SoSe SoSe
Content	<ul> <li>Actuation (Principles of actuators; electro-mechanical actuators; modeling, analysis and sizing of position control systems; hydro-mechanic actuation systems)</li> <li>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)</li> <li>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)</li> <li>Fuel Systems (Architectures; aviation fuels; system components; fueling system; tank inerting system; fuel management; trim tank)</li> <li>De- and Anti-Ice Systems: (Atmospheric icing conditions; principles of de- and anti-ice systems)</li> </ul>
Literature	<ul> <li>Moir, Seabridge: Aircraft Systems</li> <li>Torenbek: Synthesis of Subsonic Airplane Design</li> <li>Curry: Aircraft Landing Gear Design: Principles and Practices</li> </ul>

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

Module M0811: Medio	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				
<b>Educational Objectives</b>	After taking part successfully, students have reached the following learning results			
<b>Professional Competence</b>				
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:			
	<ul> <li>Explain the physical processes of images and assign to the systems the basic mathematical or physical equations required</li> <li>Calculate the parameters of imaging systems using the mathematical or physical equations;</li> <li>Determine the influence of different system components on the spatial and temporal resolution of imaging systems;</li> <li>Explain the importance of different imaging systems for a number of clinical applications;</li> </ul>			
Damanal Carrier	Select a suitable imaging system for an application.			
Personal Competence				
Social Competence	Students can:			
Autonomy	Students can.			
	Understand which physical effects are used in medical imaging;			
	Decide independently for which clinical issue a measuring system can be used.			
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56			
Credit points	6			
Course achievement	None			
Examination	Written exam			
Examination duration and	90 min			
scale				
Assignment for the	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.		

Production				
Module M1156: Syste	ms Engineering			
Courses				
Title		Тур	Hrs/wk	СР
Systems Engineering (L1547)		Lecture	3	4
Systems Engineering (L1548)		Recitation Section (large)	1	2
Module Responsible	Prof. Ralf God			
Admission Requirements	None			
Recommended Previous	Basic knowledge in:			
Knowledge	Mathematics			
	Mechanics			
	Thermodynamics			
	Electrical Engineering			
	Control Systems			
	Previous knowledge in:			
	Aircraft Cabin Systems			
	- Aircraft Cabin Systems			
<b>Educational Objectives</b>	After taking part successfully, students have reached the f	ollowing learning results		
Professional Competence				
Knowledge	Students are able to:			
	understand systems engineering process models, method	ds and tools for the development o	f complex Systen	ns
	describe innovation processes and the need for technological	gy Management		
	explain the aircraft development process and the process	of type certification for aircraft		
	explain the system development process, including requi	rements for systems reliability		
	identify environmental conditions and test procedures fo	airborne Equipment		
	value the methodology of requirements-based engineering	ng (RBE) and model-based requirer	nents engineering	g (MBRE)
Skille	Students are able to:			
Skills	plan the process for the development of complex System	c		
	organize the development phases and development Task			
	assign required business activities and technical Tasks	3		
	apply systems engineering methods and tools			
	appry systems originations means and accompany			
Personal Competence				
Social Competence	Students are able to:			
	understand and accept their tasks within a development			
	be comfortable with their role their tasks within the overa			
	understand and serve their suppliers and customers in large projects			
	assume responsibility for people and technology in the d	evelopment of safety-critical system	ns	
Autonomy	Students are able to:			
,	• interact and communicate in a development team with d	vision of tasks.		
	independently research and identify certification specific			
	formulate requirements on their own			
	create test plans on their own and accompany certification	n processes		
184	Indonordant Chiefe Time 104 Chiefe T			
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	Aircraft Systems Engineering: Care Qualification: Care de	P1 /		
Assignment for the Following Curricula		•	aulcory	
ronowing Curricula	International Management and Engineering: Specialisation	-	-	ompulsory
	International Management and Engineering: Specialisation Aeronautics: Core Qualification: Compulsory	ii. Froduct Development and Produ	iction. Elective Co	ompuisory
	Mechatronics: Core Qualification: Compulsory  Mechatronics: Core Qualification: Elective Compulsory			
	Product Development, Materials and Production: Specialisa	tion Product Development: Compu	Isory	
	Product Development, Materials and Production: Specialisa Product Development, Materials and Production: Specialisa			
	Product Development, Materials and Production: Specialisa Product Development, Materials and Production: Specialisa			
	Theoretical Mechanical Engineering: Specialisation Aircraft			
	medical mechanical Engineering. Specialisation All Claft	5,5 cm 5 Engineering, Liective Col	iipaisoi y	

Course L1547: Systems Engi	neering
Тур	Lecture
Hrs/wk	3
СР	4
Workload in Hours	Independent Study Time 78, Study Time in Lecture 42
Lecturer	Prof. Ralf God
Language	DE
Cycle	SoSe
Content	The objective of the lecture with the corresponding exercise is to accomplish the prerequisites for the development and integration of complex systems using the example of commercial aircraft and cabin systems. Competences in the systems engineering process, tools and methods is to be achieved. Regulations, guidelines and certification issues will be known.  Key aspects of the course are processes for innovation and technology management, system design, system integration and
	certification as well as tools and methods for systems engineering:  Innovation processes  IP-protection  Technology management  Systems engineering  Aircraft program  Certification issues  Systems development  Safety objectives and fault tolerance  Environmental and operating conditions  Tools for systems engineering  Requirements-based engineering (RBE)  Model-based requirements engineering (MBRE)
Literature	- Skript zur Vorlesung - diverse Normen und Richtlinien (EASA, FAA, RTCA, SAE) - Hauschildt, J., Salomo, S.: Innovationsmanagement. Vahlen, 5. Auflage, 2010 - NASA Systems Engineering Handbook, National Aeronautics and Space Administration, 2007 - Hinsch, M.: Industrielles Luftfahrtmanagement: Technik und Organisation luftfahrttechnischer Betriebe. Springer, 2010 - De Florio, P.: Airworthiness: An Introduction to Aircraft Certification. Elsevier Ltd., 2010 - Pohl, K.: Requirements Engineering. Grundlagen, Prinzipien, Techniken. 2. korrigierte Auflage, dpunkt. Verlag, 2008

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

Module M1161: Turbo	omachinery			
Courses				
Title		Тур	Hrs/wk	СР
Turbomachines (L1562)		Lecture	3	4
Turbomachines (L1563)		Recitation Section (large)	1	2
Module Responsible	Prof. Markus Schatz			
Admission Requirements	None			
Recommended Previous	Technical Thermodynamics I, II, Fluid Dynamics, Heat Transfer			
Knowledge				
<b>Educational Objectives</b>	After taking part successfully, students have reached the follow	wing learning results		
Professional Competence				
Knowledge	The students can			
	distinguish the physical phenomena of conversion of en-	erav		
	understand the different mathematic modelling of turbo			
	calculate and evaluate turbomachinery.	machinery,		
	Calculate and evaluate turbonnachinery.			
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			
	<ul> <li>develop a complex problem self-consistent,</li> </ul>			
	analyse the results in a critical way,			
	<ul> <li>have an qualified exchange with other students.</li> </ul>			
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56			
Credit points				
•				
Examination	Written exam			
Examination duration and	90 min			
scale				
Assignment for the	Energy Systems: Specialisation Energy Systems: Elective Com	pulsory		
Following Curricula		•		
	Product Development, Materials and Production: Specialisation		e Compulsory	
	Product Development, Materials and Production: Specialisation			
	Product Development, Materials and Production: Specialisation	•	•	
	Theoretical Mechanical Engineering: Specialisation Energy Sys			
	<del>-</del>			

ourse L1562: Turbomachines		
Тур	Lecture	
Hrs/wk		
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:	
	<ul> <li>Application cases of turbomachinery</li> <li>Fundamentals of thermodynamics and fluid mechanics</li> <li>Design fundamentals of turbomachinery</li> <li>Introduction to the theory of turbine stage</li> <li>Design and operation of the turbocompressor</li> <li>Design and operation of the steam turbine</li> <li>Design and operation of the gas turbine</li> <li>Physical limits of the turbomachines</li> </ul>	
Literature	<ul> <li>Traupel: Thermische Turbomaschinen, Springer. Berlin, Heidelberg, New York</li> <li>Bräunling: Flugzeuggasturbinen, Springer., Berlin, Heidelberg, New York</li> <li>Seume: Stationäre Gasturbinen, Springer., Berlin, Heidelberg, New York</li> <li>Menny: Strömungsmaschinen, Teubner., Stuttgart</li> </ul>	

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

Module M1226: Mech	anical Properties			
Courses				
Title		Тур	Hrs/wk	СР
Mechanical Behaviour of Brittle Mat		Lecture	2	3
Dislocation Theory of Plasticity (L16	662)	Lecture	2	3
Module Responsible	Prof. Shan Shi			
Admission Requirements	None			
Recommended Previous	Basics in Materials Science I/II			
Knowledge				
Educational Objectives	After taking part successfully, students have reached t	he following learning results		
<b>Professional Competence</b>				
Knowledge	Students can explain basic principles of crystallograph	phy, statics (free body diagram	s, tractions) and therm	nodynamics (energy
	minimization, energy barriers, entropy)	minimization, energy barriers, entropy)		
Chille	Charles to a complete of a circumstant and a classical and a circumstant and a circu			
SKIIIS	Students are capable of using standardized calculation methods: tensor calculations, derivatives, integrals, tensor transformations			
Personal Competence				
Social Competence	Students can provide appropriate feedback and handle feedback on their own performance constructively.			
Autonomy	Students are able to			
	- assess their own strengths and weaknesses	Is assess their own strengths and weaknesses		
	- assess their own state of learning in specific terms an	nd to define further work steps or	n this basis guided by te	achers.
	- work independently based on lectures and notes to so	olve problems, and to ask for hel	p or clarifications when	needed
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56	6		
Credit points	6			
Course achievement	None			
Examination	Written exam			
Examination duration and	180 min			
scale				
Assignment for the	Materials Science: Core Qualification: Compulsory			
Following Curricula	Mechanical Engineering and Management: Specialisation	on Materials: Elective Compulsor	у	
	Product Development, Materials and Production: Specia	alisation Product Development: E	Elective Compulsory	
	Product Development, Materials and Production: Specia	alisation Production: Elective Cor	mpulsory	
	Product Development, Materials and Production: Specia	alisation Materials: Compulsory		
	Theoretical Mechanical Engineering: Specialisation Mat	terials Science: Elective Compuls	ory	

Course L1661: Mechanical Be	ehaviour of Brittle Materials
Тур	Lecture
Hrs/wk	2
СР	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Prof. Gerold Schneider
Language	DE/EN
Cycle	SoSe
Content	Theoretical Strength
	Of a perfect crystalline material, theoretical critical shear stress
	Real strength of brittle materials
	Energy release reate, stress intensity factor, fracture criterion
	Scattering of strength of brittle materials
	Defect distribution, strength distribution, Weibull distribution
	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
-	

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

Module M0840: Optin	nal and Robust Control			
Courses				
Title		Tun	Hrs/wk	СР
Optimal and Robust Control (L0658	()	<b>Typ</b> Lecture	2	3
Optimal and Robust Control (L0659		Recitation Section (small)	2	3
Module Responsible	NN			
Admission Requirements	None			
Recommended Previous				
Knowledge	Classical control (frequency response, root locus)			
	State space methods			
	Linear algebra, singular value decomposition			
Educational Objectives	After taking part successfully, students have reached the	following learning results		
Professional Competence				
Knowledge				
_	Students can explain the significance of the matrix			
	They can explain the duality between optimal state			
	They can explain how the H2 and H-infinity norms     They can explain how an LOC design problem and			
	<ul> <li>They can explain how an LQG design problem can</li> <li>They can explain how model uncertainty can be re</li> </ul>			
	They can explain now model uncertainty can be it     They can explain how - based on the small gain t			
	an uncertain plant.	a robust controller can ga	arantee stability	and performance to
	They understand how analysis and synthesis cond	tions on feedback loops can be repr	esented as linear	matrix inequalities.
				·
Skills	<ul> <li>Students are capable of designing and tuning LQG</li> </ul>	controllers for multivariable plant m	nodels.	
	<ul> <li>They are capable of representing a H2 or H-infinity</li> </ul>			nd of using standard
	software tools for solving it.			
	<ul> <li>They are capable of translating time and frequen</li> </ul>	cy domain specifications for control	loops into const	raints on closed-loop
	sensitivity functions, and of carrying out a mixed-s	ensitivity design.		
	<ul> <li>They are capable of constructing an LFT uncerta</li> </ul>	inty model for an uncertain system	n, and of designin	ng a mixed-objective
	robust controller.			
	They are capable of formulating analysis and synt	hesis conditions as linear matrix inc	equalities (LMI), a	nd of using standard
	LMI-solvers for solving them.			
	<ul> <li>They can carry out all of the above using standard</li> </ul>	software tools (Matlab robust contro	oi toolbox).	
Personal Competence				
Social Competence	Students can work in small groups on specific problems t	o arrive at joint solutions.		
Autonomy	Students are able to find required information in sources	provided (lecture notes, literature,	software docume	ntation) and use it to
	solve given problems.			
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56			
Credit points	6			
Course achievement	None			
Examination	Oral exam			
Examination duration and	30 min			
scale				
Assignment for the	Electrical Engineering: Specialisation Control and Power S	Systems Engineering: Elective Comp	ulsorv	
Following Curricula			alsol y	
	Aircraft Systems Engineering: Core Qualification: Elective			
	Aeronautics: Core Qualification: Elective Compulsory	, , , , ,		
	Mechatronics: Core Qualification: Elective Compulsory			
	Biomedical Engineering: Specialisation Artificial Organs a	nd Regenerative Medicine: Elective	Compulsory	
	Biomedical Engineering: Specialisation Implants and End	oprostheses: Elective Compulsory		
	Biomedical Engineering: Specialisation Medical Technology	gy and Control Theory: Elective Com	pulsory	
	Biomedical Engineering: Specialisation Management and	Business Administration: Elective Co	ompulsory	
	Product Development, Materials and Production: Specialis	sation Product Development: Electiv	e Compulsory	
	Product Development, Materials and Production: Specialis	sation Production: Elective Compulso	ory	
	Product Development, Materials and Production: Specialis	·	У	
	Theoretical Mechanical Engineering: Core Qualification: E	lective Compulsory		

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

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

Module M1343: Struct	ure and properties of fibre-	polymer-compos	ites		
Courses					
Title		-	Tyre	Hrs/wk	СР
Structure and properties of fibre-po	mer-composites (L1894)		<b>Typ</b> Lecture	<b>Hrs/wk</b> 2	3
Structure and properties of fibre-po			Project-/problem-based Learning	2	2
Structure and properties of fibre-po			Recitation Section (large)	1	1
Module Responsible					
Admission Requirements	None				
-		000			
Knowledge	Basics: chemistry / physics / materials sci	ence			
-	A financial discount of the second of the se	de la della d			
Educational Objectives	After taking part successfully, students ha	ave reached the following	g learning results		
Professional Competence  Knowledge	Students can use the knowledge of fiber necessary testing and analysis.	r-reinforced composites	(FRP) and its constituents to p	lay (fiber / ma	atrix) and define the
	They can explain the complex relationship	os structure-property rela	ationship and		
	the interactions of chemical structure on eighboring contexts (e.g. sustainability,			fiber types, i	ncluding to explain
Skills	Students are capable of				
	<ul> <li>using standardized calculation me evaluate the different materials.</li> <li>approximate sizing using the netwo</li> <li>selecting appropriate solutions for</li> </ul>	ork theory of the structur	ral elements implement and ev	aluate.	
Personal Competence					
Social Competence	Students can				
,					
	<ul> <li>arrive at funded work results in het</li> <li>provide appropriate feedback and l</li> </ul>			ely.	
Autonomy	Students are able to				
	assess their own strengths and weaknes	sses.			
	assess their own state of learning in spe		further work steps on this basi	S.	
	- assess possible consequences of their pi	rofessional activity.			
Workload in Hours	Independent Study Time 110, Study Time	in Lecture 70			
Credit points	6			_	
Course achievement	None				
	Written exam				
Examination duration and scale	90 min				
	Aircraft Systems Engineering: Core Qualifi	ication: Elective Compuls	sorv		
Following Curricula	International Management and Engineerin	·	•	nn: Flective Co	mnulsorv
. J	Aeronautics: Core Qualification: Elective C				r1
	Materials Science and Engineering: Specia	. ,	terials: Elective Compulsory		
	Materials Science: Specialisation Engineer	3 3	' '		
	Mechanical Engineering and Management	-	, ,		
	Product Development, Materials and Prod			ompulsorv	
	Product Development, Materials and Prod	·	·	y	
	Product Development, Materials and Prod	·	• •		
	Renewable Energies: Specialisation Bioen	·			
	Renewable Energies: Specialisation Bloch				
	Renewable Energies: Specialisation Solar		, ,		
	Theoretical Mechanical Engineering: Spec		, ,		
	meoreaca mechanica Engineering. Spec	nansacion materiais scier	ice. 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	
	Daniel, Ishai: Engineering Mechanics of Composites Materials, Oxford University Press	
	Mallick: Fibre-Reinforced Composites, Marcel Deckker, New York	

Course L2614: Structure and	properties of fibre-polymer-composites
Тур	Project-/problem-based Learning
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Prof. Bodo Fiedler
Language	DE/EN
Cycle	SoSe
Content	The students receive the assignment in the form of a material design for test bodies made of fibre composites. Technical and normative requirements are listed in the assignment, all other required information comes from the lectures and exercises or the respective documents (electronically and in conversation).  The procedure is specified in a milestone plan and enables the students to plan subtasks and thus work continuously. At the end of the project, different test specimens were tested in tensile or bending tests.  In the individual project meetings, the conception (discussion of requirements and risks) is scrutinised. The calculations are analysed, the production methods are evaluated and determined. Materials are selected and the test specimens are manufactured according to standards. The quality and mechanical properties are checked and classified. At the end, a final report is prepared and the results are presented to all participants in the form of a presentation and discussed.  Translated with www.DeepL.com/Translator (free version)
Literature	Hall, Clyne: Introduction to Composite materials, Cambridge University Press  Daniel, Ishai: Engineering Mechanics of Composites Materials, Oxford University Press  Mallick: Fibre-Reinforced Composites, Marcel Deckker, New York

Course L2613: Structure and	properties of fibre-polymer-composites
Тур	Recitation Section (large)
Hrs/wk	1
СР	1
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14
Lecturer	Prof. Bodo Fiedler
Language	EN
Cycle	SoSe
Content	The contents of the lecture are repeated and deepened using practical examples.
	Calculations are carried out together or individually, and the results are discussed critically.
Literature	Hall, Clyne: Introduction to Composite materials, Cambridge University Press
	Daniel, Ishai: Engineering Mechanics of Composites Materials, Oxford University Press
	Mallick: Fibre-Reinforced Composites, Marcel Deckker, New York

Module M1344: Proce	ssing of Fibre-Polymer-Compos	iites		
Courses				
Title		Тур	Hrs/wk	СР
Processing of fibre-polymer-compos	sites (L1895)	Lecture	2	3
From Molecule to Composites Part (	L1516)	Project-/problem-based Learn	ng 2	3
Module Responsible	Prof. Bodo Fiedler			
Admission Requirements	None			
<b>Recommended Previous</b>	Knowledge in the basics of chemistry / physic	s / materials science		
Knowledge				
<b>Educational Objectives</b>	After taking part successfully, students have	reached the following learning results		
<b>Professional Competence</b>				
Knowledge	Students are able to give a summary of the t	echnical details of the manufacturing processe	s composites an	d illustrate respective
	relationships. They are capable of describing	g and communicating relevant problems and	questions using	appropriate technical
	language. They can explain the typical proces	ss of solving practical problems and present rela	ted results.	
Skills	Students can use the knowledge of fiber-rein	forced composites (FRP) and its constituents (fi	ner / matrix) and	define the necessary
	testing and analysis.	·····	, ,	,
	3 · · · · · · · · · · · · · · · · · · ·			
	They can explain the complex structure-property	erty relationship and		
	the interactions of chemical structure of tl	ne polymers, their processing with the differ	ent fiber types,	including to explain
	neighboring contexts (e.g. sustainability, envi	· · · · · · · · · · · · · · · · · · ·		,
Personal Competence				
Social Competence	Students are able to cooperate in small, mixed-subject groups in order to independently derive solutions to given problems in the			
	context of civil engineering. They are able to	effectively present and explain their results al	one or in groups	in front of a qualified
	audience. Students have the ability to develo	p alternative approaches to an engineering pr	blem independe	ently or in groups and
	discuss advantages as well as drawbacks.			
Autonomy	Students are capable of independently solvi	ng mechanical engineering problems using pro	vided literature	. They are able to fill
	gaps in as well as extent their knowledge using	ng the literature and other sources provided by	the supervisor. I	Furthermore, they can
	meaningfully extend given problems and prag	gmatically solve them by means of corresponding	g solutions and	concepts.
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	90 min			
scale				
Assignment for the	Materials Science and Engineering: Specialisa	tion Engineering Materials: Elective Compulsory		
Following Curricula	Materials Science: Specialisation Engineering	Materials: Elective Compulsory		
	Mechanical Engineering and Management: Sp			
	•	on: Specialisation Product Development: Electiv		
	·	on: Specialisation Production: Elective Compuls	-	
	•	on: Specialisation Materials: Elective Compulsor	У	
	Theoretical Mechanical Engineering: Specialis	ation Materials Science: Elective Compulsory		

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

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

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

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

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	<ul> <li>Introduction, importance of water power in the national and global context</li> <li>Physical basics: Bernoulli's equation, usable height of fall, hydrological measures, loss mechanisms, efficiencies</li> <li>Classification of Hydropower: Flow and Storage hydropower, low and high pressure systems</li> <li>Construction of hydroelectric power plants: description of the individual components and their technical system interaction</li> <li>Structural engineering components; representation of dams, weirs, dams, power houses, computer systems, etc.</li> <li>Energy Technical Components: Illustration of the different types of hydraulic machinery, generators and grid connection</li> <li>Hydropower and the Environment</li> <li>Examples from practice</li> </ul>
Literature	<ul> <li>Schröder, W.; Euler, G.; Schneider, K.: Grundlagen des Wasserbaus; Werner, Düsseldorf, 1999, 4. Auflage</li> <li>Quaschning, V.: Regenerative Energiesysteme: Technologie - Berechnung - Simulation; Carl Hanser, München, 2011, 7. Auflage</li> <li>Giesecke, J.; Heimerl, S.; Mosony, E.: Wasserkraftanlagen - Planung, Bau und Betrieb; Springer, Berlin, Heidelberg, 2009, 5. Auflage</li> <li>von König, F.; Jehle, C.: Bau von Wasserkraftanlagen - Praxisbezogene Planungsunterlagen; C. F. Müller, Heidelberg, 2005, 4. Auflage</li> <li>Strobl, T.; Zunic, F.: Wasserbau: Aktuelle Grundlagen - Neue Entwicklungen; Springer, Berlin, Heidelberg, 2006</li> </ul>

Course L0011: Wind Turbine	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	<ul> <li>Introduction, importance of offshore wind power generation, Specific requirements for offshore engineering</li> <li>Physical fundamentals for utilization of wind energy</li> <li>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</li> <li>Foundation engineering, offshore site investigation, presentation of different concepts of offshore foundation structures, planning and fabrication of foundation structures</li> <li>Electrical infrastructure of an offshore wind farm, Inner Park cabling, offshore substation, grid connection</li> <li>Installation of offshore wind farms, installation techniques and auxiliary devices, construction logistics</li> <li>Development and planning of offshore wind farms</li> <li>Operation and optimization of offshore wind farms</li> <li>Day excursion</li> </ul>
Literature	<ul> <li>Gasch, R.; Twele, J.: Windkraftanlagen - Grundlagen, Entwurf, Planung und Betrieb; Vieweg + Teubner, Stuttgart, 2007, 7. Auflage</li> <li>Molly, J. P.: Windenergie - Theorie, Anwendung, Messung; C. F. Müller, Heidel-berg, 1997, 3. Auflage</li> <li>Hau, E.: Windkraftanalagen; Springer, Berlin, Heidelberg, 2008, 4.Auflage</li> <li>Heier, S.: Windkraftanlagen - Systemauslegung, Integration und Regelung; Vieweg + Teubner, Stuttgart, 2009, 5. Auflage</li> <li>Jarass, L.; Obermair, G.M.; Voigt, W.: Windenergie: Zuverlässige Integration in die Energieversorgung; Springer, Berlin, Heidelberg, 2009, 2. Auflage</li> </ul>

Production"					
Module M1894: Auton	nation Technology and Syste	ms			
Courses					
Title			Тур	Hrs/wk	СР
Automation Technology and Systen	ns (L2329)		Lecture	4	4
Automation Technology and System	ns (L2331)		Project-/problem-based Learning	1	1
Automation Technology and System	ns (L2330)		Recitation Section (small)	1	1
Module Responsible	Prof. Thorsten Schüppstuhl				
Admission Requirements	None				
Recommended Previous	without major course assessment				
Knowledge					
Educational Objectives	After taking part successfully, students have	ve reached the followi	ng learning results		
Professional Competence					
Knowledge	Students				
3					
	know the characteristic components			ling of their inte	eraction
	<ul> <li>know methods for a systematical an</li> </ul>				
	<ul> <li>have special competences in indust</li> </ul>	rial robot based auton	nation systems		
Skills	Students are able to				
	analyze complex Automation tasks				
	develop application based concepts	and solutions			
	design subsystems and integrate in				
	<ul> <li>investigate and evaluate safety of n</li> </ul>				
	<ul> <li>create simple programs for robots a</li> </ul>	nd programmable log	ic controllers		
	<ul> <li>design of circuit for pneumatic appli</li> </ul>				
Personal Competence					
Social Competence	Students are able to				
	- find solutions for automation and handlin	g tasks in groups			
	- develop solutions in a production environ	nment with qualified p	personnel at technical level and re	epresent decisi	ons.
Autonomy	Students are able to				
	<ul> <li>analyze automation tasks independent</li> </ul>	ently			
	<ul> <li>generate programs for robots and p</li> </ul>		vices autonomously		
	develop solutions for practice orient	ed tasks of automatio	n independently		
	<ul> <li>design safety concepts for automati</li> </ul>	on applications			
	<ul> <li>assess consequences of their profes</li> </ul>	ssional actions and res	sponsibilities		
Workload in Hours	Independent Study Time 96, Study Time in	ı Lecture 84			
Credit points		Description			
Course achievement	Compulsory Bonus Form  No 20 % Subject theoretic	Description  al and Die Studien	eistung umfasst die Ergebnisse	e der PRI had	ierten Anteile dec
	practical work		e der Präsentation in der Gruppe.		
Examination					
Examination duration and					
scale	220				
Assignment for the	International Management and Engineering	g: Specialisation II. Pro	oduct Development and Production	on: Elective Cor	mpulsorv
_	Mechatronics: Core Qualification: Elective			<u>2.000170</u> 001	
. ccg carricala	Product Development, Materials and Produ		Product Development: Elective Co	ompulsorv	
	Product Development, Materials and Product	•	•	pa.551 y	
	Product Development, Materials and Product	·			
	Theoretical Mechanical Engineering: Specia	•	. ,	e Compulsory	

Course L2329: Automation T	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 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

Fitle Robotics: Modelling and Control (Le							
Robotics: Modelling and Control (Li					Тур	Hrs/wk	СР
	Robotics: Modelling and Control (L0168)				Integrated Lecture	4	4
Robotics: Modelling and Control (L	1305)				Project-/problem-based Learning	2	2
Module Responsible	Dr. Martin Gomse						
Admission Requirements	None						
Recommended Previous	Fundamentals of elec	trical engine	eering				
Knowledge	Broad knowledge of r	mechanics					
	Fundamentals of con-	trol theory					
Educational Objectives	After taking part succ	essfully, stu	idents have re	ached the following	ng learning results		
Professional Competence							
Knowledge	Students are able to	describe fun	idamental pro	perties of robots a	nd solution approaches for mult	tiple problems	in robotics.
Skills	Students are able to	derive and s	olve equation	s of motion for vai	rious manipulators.		
	Students can general	to trajectorio	e in various c	nordinate systems	•		
	Students can general	te trajectorie	es ili various c	oordinate systems			
	Students can design	linear and pa	artially nonline	ear controllers for	robotic manipulators.		
Personal Competence							
Social Competence	Students are able to work goal-oriented in small mixed groups.						
Autonomy	Students are able to recognize and improve knowledge deficits independently.						
	With instructor assist	anco studo	nte aro ablo to	ovaluato thoir ow	un knowledge level and define a	further course	o of study
	With instructor assist	ance, stade	into are able to	evaluate their ow	in knowledge level and define a	ruitilei course	e or study.
Workload in Hours	Independent Study T	ime 96, Stud	dy Time in Lec	ture 84			
Credit points							
Course achievement			theoretical		n DDI Einheiten cowie Erreic	han das Ca	scamtzials und
	res None	•				lien des de	samitzieis und
Examination	Written exam	practical		jewege se	551011 21010		
Examination duration and							
scale							
Assignment for the	Aircraft Systems Eng	ineering: Co	re Qualificatio	n: Elective Compu	lsory		
Following Curricula	International Manage	ment and E	ngineering: Sp	ecialisation II. Pro	duct Development and Producti	on: Elective Co	ompulsory
	International Manage	ment and E	ngineering: Sp	ecialisation II. Me	chatronics: Elective Compulsory		
	Aeronautics: Core Qu			-			
	_	-	-	e Qualification: Co	mpulsory		
				v Enocialization D	roduct Dovolopment: Fleeting C	omnulcom:	
				•	·	ompuisory	
				•			
				•	lopment and Production: Electiv	e Compulsory	
Social Competence Autonomy  Workload in Hours Credit points Course achievement  Examination Examination duration and scale Assignment for the	Students are able to Students are able to With instructor assist Independent Study Ti 6 Compulsory Bonus Yes None Written exam 120 min Aircraft Systems Eng International Manage International Manage Aeronautics: Core Qu Mechanical Engineeri Mechatronics: Core Q Product Development	work goal-or recognize ar ance, studer ime 96, Studer ime 96, Studer ineering: Comment and Englatification: Englatification: Englatification: Englatification: Materials at t,	riented in smand improve kn ints are able to dy Time in Lec theoretical work  re Qualification ingineering: Sp ingineering: Sp ingineering: Sp ingineering: Comp agement: Cor Compulsory and Production and Production	Il mixed groups. owledge deficits in evaluate their ow ture 84  Description and Teilnahme a jeweiligen Se  n: Elective Compute cialisation II. Pro recialisation II. Medulsory e Qualification: Co n: Specialisation P n: Specialisation P	ndependently.  In knowledge level and define a  In PBL-Einheiten sowie Erreic  Ssion-Ziele  Ilsory  duct Development and Producti  chatronics: Elective Compulsory	chen des Ge	esamtziels und

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

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

Module M1185: 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	
<b>Educational Objectives</b>	After taking part successfully, students have reached the following learning results
<b>Professional Competence</b>	
Knowledge	see selected module according to FSPO
Skills	see selected module according to FSPO
Personal Competence	
Social Competence	see selected module according to FSPO
Autonomy	see selected module according to FSPO
Workload in Hours	Depends on choice of courses
Credit points	6
Assignment for the	Product Development, Materials and Production: Specialisation Product Development: Elective Compulsory
Following Curricula	Product Development, Materials and Production: Specialisation Production: Elective Compulsory
	Product Development, Materials and Production: Specialisation Materials: Elective Compulsory

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

Course L0387: Health, Safety	y and Environmental Management
Тур	Integrated Lecture
Hrs/wk	3
СР	3
Workload in Hours	Independent Study Time 48, Study Time in Lecture 42
Lecturer	Hans-Joachim Nau
Language	EN
Cycle	WiSe
Content	<ul> <li>Objectives of and benefit from HSE management</li> <li>From dilution and end-of-pipe technology to eco-efficiency and eco-effectiveness Behaviour control: regulations, economic instruments and voluntary initiatives</li> <li>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</li> <li>Crisis management</li> </ul>
Literature	C. Stephan: Industrial Health, Safety and Environmental Management, MV-Verlag, Münster, 2007/2012 (can be found in the library under GTG 315)  Exercises can be downloaded from StudIP

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

Module M1909: Syste	m Simulation			
Courses				
Title		Тур	Hrs/wk	СР
System Simulation Modul (L3150)		Lecture	2	3
System Simulation Modul (L3151)		Recitation Section (large)	2	3
Module Responsible	Prof. Arne Speerforck			
Admission Requirements	None			
Recommended Previous	Mathematics I-III, Computer Sciense, Engineering Thern	nodynamics I, II, Fluid Dynamics, Heat	Transfer, Contro	Systems
Knowledge				
<b>Educational Objectives</b>	After taking part successfully, students have reached th	e following learning results		
<b>Professional Competence</b>				
Knowledge				
Skills				
<b>Personal Competence</b>				
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: Electiv	ve Compulsory		
	Aeronautics: Core Qualification: Elective Compulsory			
	Product Development, Materials and Production: Specia	lisation Product Development: Elective	e Compulsory	
	Product Development, Materials and Production: Specia	lisation Production: Elective Compulso	ry	
	Product Development, Materials and Production: Specia	lisation Materials: Elective Compulsor	/	
	Renewable Energies: Specialisation Bioenergy Systems	Elective Compulsory		
	Renewable Energies: Specialisation Solar Energy System	ns: Elective Compulsory		
	Renewable Energies: Specialisation Wind Energy System	ns: Elective Compulsory		
	Theoretical Mechanical Engineering: Specialisation Simi	ulation Technology: Elective Compulso	ry	
	Theoretical Mechanical Engineering: Specialisation Energy	gy 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	<ol> <li>Modelica Association: "Modelica Language Specification - Version 3.5", Linköping, Sweden, 2021.</li> <li>OpenModelica: OpenModelica 1.17.0, https://www.openmodelica.org (siehe Download), 2021.</li> <li>M. Tiller: "Modelica by Example", https://book.xogeny.com, 2014.</li> <li>M. Otter, H. Elmqvist, et al.: "Objektorientierte Modellierung Physikalischer Systeme", at- Automatisierungstechnik (german), Teil 1 - 17, Oldenbourg Verlag, 1999 - 2000.</li> <li>P. Fritzson: "Principles of Object-Oriented Modeling and Simulation with Modelica 3.3", Wiley-IEEE Press, New York, 2015.</li> <li>P. Fritzson: "Introduction to Modeling and Simulation of Technical and Physical Systems with Modelica", Wiley, New York, 2011.</li> </ol>

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	

Production"				
Module M0771: Flight	t 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				
	Mathematics			
	Mechanics			
	Thermodynamics			
	Aviation			
Educational Objectives	After taking part successfully, students have reache	d the following learning results		
Professional Competence				
•	Students are able to			
3				
	Describe the fundamental equations of aerod	ynamics 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			
	<ul> <li>Describe methods of flight simulation and airl</li> </ul>	orne measurement technology		
Skills	Students are able to			
SKIIIS	Students are able to			
	<ul> <li>Perform flight mechanic simulations</li> </ul>			
	Derive flight mechanic relations from virtual a	and real flight test data		
Personal Competence				
	Students are able to:			
,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,				
	Perform simulations in groups and discuss res	ults		
	Evaluate flight test data in groups, discuss an	d present the results		
Autonomy	Students are able to:			
	Process teaching content independently			
	<ul> <li>Process teaching content independently</li> <li>Prepare, work out and process simulation mo</li> </ul>	dels independently		
	Apply teaching content on virtual and real flig			
	. Apply coaching content on virtual and real flig	cost data		
Workload in Hours	Independent Study Time 96, Study Time in Lecture 8	34		
Credit points	6			
Course achievement				
Examination	Written exam			
Examination duration and	160 Minutes			
scale				
Assignment for the	Aircraft Systems Engineering: Core Qualification: Co	•		
Following Curricula	International Management and Engineering: Special	sation II. Aviation Systems: Elective Com	pulsory	
	Aeronautics: Core Qualification: Compulsory			
	Product Development, Materials and Production: Spe	ecialisation Product Development: Elective	e Compulsory	
	Product Development, Materials and Production: Spe	·	-	
	Product Development, Materials and Production: Spe			
	Theoretical Mechanical Engineering: Specialisation A	ircraft Systems Engineering: Elective Cor	mpulsory	
		<del></del>	-	

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	<ul> <li>Aerodynamics (fundamental equations of aerodynamics; compressible and incompressible flows; airfoils and wings; viscous flows)</li> <li>Flight Mechanics (Equations of motion; flight performance; control surfaces; derivatives; lateral stability and control; trim conditions; flight maneuvers)</li> </ul>
Literature	<ul> <li>Schlichting, H.; Truckenbrodt, E.: Aerodynamik des Flugzeuges I und II</li> <li>Etkin, B.: Dynamics of Atmospheric Flight</li> <li>Sachs/Hafer: Flugmechanik</li> <li>Brockhaus: Flugregelung</li> <li>J.D. Anderson: Introduction to flight</li> </ul>

Course 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		
Cycle	SoSe SoSe	
Content	stationary asymmetric flight     dynamics of lateral movement     methods of flight simulation     eyperimental methods of flight mechanics     model validation using system identification     wind tunnel techniques	
Literature	<ul> <li>Schlichting, H.; Truckenbrodt, E.: Aerodynamik des Flugzeuges I und II</li> <li>Etkin, B.: Dynamics of Atmospheric Flight</li> <li>Sachs/Hafer: Flugmechanik</li> <li>Brockhaus: Flugregelung</li> <li>J.D. Anderson: Introduction to flight</li> </ul>	

Course L0731: Flight Mechan	ourse L0731: Flight Mechanics II	
Тур	Recitation Section (large)	
Hrs/wk	1	
СР		
Workload in Hours	dependent Study Time 16, Study Time in Lecture 14	
Lecturer	Prof. Frank Thielecke	
Language	DE	
Cycle	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			
	<ul> <li>Process</li> </ul>			
	<ul> <li>Methods</li> </ul>			
	Design thinking			
	<ul> <li>Process</li> </ul>			
	<ul> <li>Methods</li> </ul>			
	User integration			
Skills	Students will gain deep insights into:			
	Product Planning			
	<ul> <li>Process-related aspects</li> </ul>			
	<ul> <li>Organisational-related aspects</li> </ul>			
	<ul> <li>Human-Ressource related aspects</li> </ul>			
	<ul> <li>Working-tools, methods and instruments</li> </ul>			
	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 ckills			
	Develop presentation skills			
Workload in Hours	Independent Study Time 110, Study Time in Lecture 70			
Credit points	6			
Course achievement	Compulsory Bonus Form Descripti	on		
	Yes 20 % Subject theoretical and			
Promise Alexander	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	
. ccimig carricula	Mechanical Engineering and Management: Specialisation M		u.so. y	
	Product Development, Materials and Production: Specialisa		ompulsory	
	Product Development, Materials and Production: Specialisa		1	
	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.
Literature	Ulrich, K./Eppinger, S.: Product Design and Development, 2nd. Edition, McGraw-Hill 2010
	L Control of the Cont

Course L0853: Product Planning Seminar		
Тур	Project-/problem-based Learning	
Hrs/wk	2	
СР	3	
Workload in Hours	dependent Study Time 62, Study Time in Lecture 28	
Lecturer	of. Cornelius Herstatt	
Language	N The state of the	
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".	

Modulo M0967, Brode	ection Planning & Control and	Digital Enterprise		
Module MU867: Produ	iction Planning & Control and	Digital Enterprise		
Courses				
Title		Тур	Hrs/wk	СР
The Digital Enterprise (L0932)		Lecture	2	2
Production Planning and Control (Li	0929)	Lecture	2	2
Production Planning and Control (Li	0930)	Recitation Section (small)	1	1
Exercise: The Digital Enterprise (L0	933)	Recitation Section (small)	1	1
Module Responsible	Prof. Hermann Lödding			
<b>Admission Requirements</b>	None			
<b>Recommended Previous</b>	Fundamentals of Production and Quality Mar	nagement		
Knowledge				
<b>Educational Objectives</b>	After taking part successfully, students have	e reached the following learning results		
<b>Professional Competence</b>				
Knowledge	Students can explain the contents of the mo	Students can explain the contents of the module in detail and take a critical position to them.		
Skills	Students are capable of choosing and applying models and methods from the module to industrial problems.			
Personal Competence				
Social Competence	Students can develop joint solutions in mixe	d teams and present them to others.		
Autonomy	•			
Workload in Hours	Independent Study Time 96, Study Time in Lecture 84			
Credit points	6			
Course achievement	None			
Examination	Written exam			
Examination duration and	180 Minuten			
scale				
Assignment for the	International Management and Engineering:	Specialisation II. Product Development and Produ	ıction: Elective C	ompulsory
Following Curricula	Logistics, Infrastructure and Mobility: Specia	lisation Production and Logistics: Elective Compu	lsory	
	Biomedical Engineering: Specialisation Artifi	cial Organs and Regenerative Medicine: Elective (	Compulsory	
	Biomedical Engineering: Specialisation Implants and Endoprostheses: Elective Compulsory			
	Biomedical Engineering: Specialisation Medical Technology and Control Theory: Elective Compulsory			
	Biomedical Engineering: Specialisation Mana	agement and Business Administration: Compulsor	у	
	Product Development, Materials and Product	tion: Specialisation Product Development: Elective	e Compulsory	
	Product Development, Materials and Product	tion: Specialisation Production: Compulsory		
	Product Development, Materials and Product	tion: Specialisation Materials: Elective Compulsor	/	
	Theoretical Mechanical Engineering: Special	isation Product Development and Production: Elec	tive Compulsory	

Course L0932: The Digital En	iterprise
Тур	Lecture
Hrs/wk	2
СР	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Dr. Robert Rost
Language	DE
Cycle	WiSe
Content	Due to the developments of Industry 4.0, digitalization and interconnectivity become a strategic advantage for companies in the international competition. This lecture focuses on the relevant modules and enables the participants to evaluate current developments in this context. In particular, knowledge management, simulation, process modelling and virtual technologies are covered.  Content:  Business Process Management and Data Modelling, Simulation Knowledge and Competence Management Process Management (PPC, Workflow Management) Computer Aided Planning (CAP) and NC-Programming Virtual Reality (VR) and Augmented Reality (AR) Computer Aided Quality Management (CAQ) Industry 4.0
Literature	Scheer, AW.: ARIS - vom Geschäftsprozeß zum Anwendungssystem. Springer-Verlag, Berlin 4. Aufl. 2002  Schuh, G. et. al.: Produktionsplanung und -steuerung, Springer-Verlag. Berlin 3. Auflage 2006  Becker, J.; Luczak, H.: Workflowmanagement in der Produktionsplanung und -steuerung. Springer-Verlag, Berlin 2004  Pfeifer, T; Schmitt, R.: Masing Handbuch Qualitätsmanagement. Hanser-Verlag, München 5. Aufl. 2007  Kühn, W.: Digitale Fabrik. Hanser-Verlag, München 2006

Course L0929: Production Planning and Control		
Тур	ecture	
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	<ul> <li>Vorlesungsskript</li> <li>Lödding, H: Verfahren der Fertigungssteuerung, Springer 2008</li> <li>Nyhuis, P.; Wiendahl, HP.: Logistische Kennlinien, Springer 2002</li> </ul>	

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 Manageme	nt		
Courses				
Title		Тур	Hrs/wk	СР
Safety, Reliability and Risk Assessm		Seminar	2	3
Environment and Sustainability (L0)		Lecture	2	3
Module Responsible				
Admission Requirements				
Recommended Previous	none			
Knowledge				
Educational Objectives	After taking part successfully, students hav	e reached the following learning results		
Professional Competence				
Knowledge		niques and to give an overview for the field	of safety and risk as	sessment as well as
	environmental and sustainable engineering	, in detail:		
	basics in safety and reliability of tech	nnical facilities		
	safety and reliability analysis method	ds		
	<ul> <li>risk assessment</li> </ul>			
	<ul> <li>Production and usage of bio-char</li> </ul>			
	<ul> <li>energy production and supply</li> </ul>			
	<ul> <li>sustainable product design</li> </ul>			
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 Et	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 Quaimeacion. Compaisory		

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/ <b>sicherheit_</b> und_zuverlaessigkeit.pdf		

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

Module M1024: Metho	ods of Product Development			
Courses				
Title		Тур	Hrs/wk	СР
Methods of Product Development (	L1254)	Lecture	3	3
Methods of Product Development (	L1255)	Project-/problem-based Learning	2	3
Module Responsible	Prof. Dieter Krause			
Admission Requirements	None			
Recommended Previous	Basic knowledge of Integrated product development and	d applying CAE systems		
Knowledge				
<b>Educational Objectives</b>	After taking part successfully, students have reached th	e following learning results		
Professional Competence				
Knowledge	After passing the module students are able to:			
	<ul> <li>explain technical terms of design methodology,</li> </ul>			
	describe essential elements of construction mana	agement		
	describe essential elements of construction many     describe current problems and the current state (	·	ment.	
	2336133 carrent problems and the carrent state (	or medgrated product develop		
Skills	After passing the module students are able to:			
	select and apply proper construction methods for	or non-standardized solutions of problem	ns as well as :	adant new houndary
	conditions,	or non-standardized solutions of problem	is as well as	adapt new boundary
	•	<ul> <li>solve product development problems with the assistance of a workshop based approach,</li> </ul>		
	<ul> <li>solve product development problems with the assistance of a workshop based approach,</li> <li>choose and execute appropriate moderation techniques.</li> </ul>			
Personal Competence				
Social Competence	After passing the module students are able to:			
	<ul> <li>prepare and lead team meetings and moderation</li> </ul>	processes,		
	work in teams on complex tasks,	,		
	represent problems and solutions and advance id	leas.		
Autonomy	After passing the module students are able to:			
	give a structured feedback and accept a critical feedback.	eedback,		
	<ul> <li>implement the accepted feedback autonomous.</li> </ul>			
Workload in Hours	Independent Study Time 110, Study Time in Lecture 70			
Credit points	6			
Course achievement				
Examination				
Examination duration and	30 Minuten			
scale				
Assignment for the	, , , , , , , , , , , , , , , , , , , ,	, ,		
Following Curricula	International Management and Engineering: Specialisati	ion II. Product Development and Production	on: Elective Co	ompulsory
	Aeronautics: Core Qualification: Elective Compulsory			
	Mechatronics: Specialisation System Design: Elective Co	ompuisory		
	Mechatronics: Core Qualification: Elective Compulsory	ligation Deaduct Days laws at Care		
	Product Development, Materials and Production: Special		У	
	Product Development, Materials and Production: Specia			
	Product Development, Materials and Production: Special Theoretical Mechanical Engineering: Specialisation Prod		a Compulsory	
	Theoretical Prechaincal Engineering. Specialisation Frou	act Development and Froduction. Electivi	c compaisory	

Production"		
Course L1254: Methods of Pr	oduct Development	
Тур	Lecture	
Hrs/wk	3	
СР	3	
Workload in Hours	Independent Study Time 48, Study Time in Lecture 42	
Lecturer	Prof. Dieter Krause	
Language	DE	
Cycle	WiSe	
Content	Lecture	
	The lecture extends and enhances the learned content of the module "Integrated Product Development and lightweight design" and is based on the knowledge and skills acquired there.	
	Topics of the course include in particular:	
	Methods of product development,	
	Presentation techniques,	
	Industrial Design,	
	Design for variety	
	Modularization methods,     Design catalogs.	
	Design catalogs,     Adapted QFD matrix,	
	Systematic material selection,	
	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.	
	• 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	<ul> <li>Andreasen, M.M., Design for Assembly, Berlin, Springer 1985.</li> <li>Ashby, M. F.: Materials Selection in Mechanical Design, München, Spektrum 2007.</li> <li>Beckmann, H.: Supply Chain Management, Berlin, Springer 2004.</li> <li>Hartmann, M., Rieger, M., Funk, R., Rath, U.: Zielgerichtet moderieren. Ein Handbuch für Führungskräfte, Berater und Trainer, Weinheim, Beltz 2007.</li> <li>Pahl, G., Beitz, W.: Konstruktionslehre, Berlin, Springer 2006.</li> <li>Roth, K.H.: Konstruieren mit Konstruktionskatalogen, Band 1-3, Berlin, Springer 2000.</li> <li>Simpson, T.W., Siddique, Z., Jiao, R.J.: Product Platform and Product Family Design. Methods and Applications, New York,</li> </ul>	

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

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Module M1025: Fluidi	cs			
Courses				
Title Fluidics (L1256) Fluidics (L1371) Fluidics (L1377)		Typ Lecture Project-/problem-based Learning	Hrs/wk 2 1	<b>CP</b> 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, elastostation	cs, hydrostatics, kinematics and	kinetics), flui	d mechanics, and
<b>Educational Objectives</b>	After taking part successfully, students have reached the follow	wing learning results		
	After passing the module students are able to  explain structures and functionalities of hydrostatic, pneed explain the interaction of hydraulic components in hydraulic explain open and closed loop control of hydraulic systement of describe functioning and applications of hydrodynamic and aggregates in plant technology  After passing the module students are able to  analyse and assess hydraulic and pneumatic componened design and dimension hydraulic systems for mechanical perform numerical simulations of hydraulic systems based.	aulic systems, ns, torque converters, brakes and clui ts and systems, applications,	cches as well as	s centrifugal pumps
Personal Competence Social Competence	select and adapt pump characteristic curves for hydraul     dimension hydrodynamic torque converters and brakes  After passing the module students are able to     discuss and present functional context in groups,     organise teamwork autonomously.	ic systems	,	
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	hydrostatischer Systeme		
Examination	Yes None Attestation Simulation Written exam	hydrostatischer Systeme		
Examination duration and scale Assignment for the Following Curricula	90  International Management and Engineering: Specialisation II. N International Management and Engineering: Specialisation II. Product Development, Materials and Production: Specialisation Product Development, Materials and Production: Specialisation	Product Development and Production Product Development: Compulsor	on: Elective Cor	npulsory
	Product Development, Materials and Production: Specialisation  Theoretical Mechanical Engineering: Specialisation Product De	Materials: Elective Compulsory	e Compulsory	

Production"		
Course L1256: Fluidics		
Тур	Lecture	
Hrs/wk	2	
СР	3	
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28	
Lecturer	Prof. Dieter Krause	
Language	DE	
Cycle		
Content		
Content	Lecture	
	Hydrostatics	
	physical fundamentals	
	hydraulic fluids	
	hydrostatic machines	
	• valves	
	• components	
	hydrostatic transmissions	
	examples from industry	
	- Countries from madesty	
	Pneumatics	
	generation of compressed air	
	pneumatic motors	
	Examples of use	
	2 Exemples of GSE	
	Hydrodynamics	
	physical fundamentals	
	hydraulic continous-flow machines	
	hydrodynamic transmissions	
	interoperation of motor and transmission	
	- metoperation of motor and duffillibrion	
	Exercise	
	Hydrostatics	
	reading and design of hydraulic diagrams	
	dimensioning of hydrostatic traction and working drives	
	performance calculation	
	Hydrodynamics	
	calculation / dimensioning of hydrodynamic torque converters	
	calculation / dimensioning of centrifugal pumps	
	creating and reading of characteristic curves of pumps and systems	
	Field trip	
	field trip to a regional company from the hydraulic industry.	
	Francisco Control of the Control of	
	Exercise	
	Numerical simulation of hydrostatic systems	
	a politica to leave a numerical singulation equipment for budges lie quaterns	
	getting to know a numerical simulation environment for hydraulic systems	
	transformation of a task into a simulation model     simulation of common components.	
	simulation of common components     variation of simulation parameters	
	using simulations for system dimensioning and optimisation	
	(partly) self-organised teamwork	
	(pay, gamaca coamina (	
Literature	Bücher	
	Marriagh of the Considerate describible shall at the constant of the constant	
	Murrenhoff, H.: Grundlagen der Fluidtechnik - Teil 1: Hydraulik, Shaker Verlag, Aachen, 2011  Murrenhoff, H.: Grundlagen der Fluidtechnik - Teil 2: Programmid, Shaker Verlag, Aachen, 2006  Murrenhoff, H.: Grundlagen der Fluidtechnik - Teil 2: Programmid, Shaker Verlag, Aachen, 2006  Murrenhoff, H.: Grundlagen der Fluidtechnik - Teil 2: Programmid, Shaker Verlag, Aachen, 2006  Murrenhoff, H.: Grundlagen der Fluidtechnik - Teil 2: Programmid, Shaker Verlag, Aachen, 2006  Murrenhoff, H.: Grundlagen der Fluidtechnik - Teil 2: Programmid, Shaker Verlag, Aachen, 2006  Murrenhoff, H.: Grundlagen der Fluidtechnik - Teil 2: Programmid, Shaker Verlag, Aachen, 2006  Murrenhoff, H.: Grundlagen der Fluidtechnik - Teil 2: Programmid, Shaker Verlag, Aachen, 2006  Murrenhoff, H.: Grundlagen der Fluidtechnik - Teil 2: Programmid, Shaker Verlag, Aachen, 2006  Murrenhoff, H.: Grundlagen der Fluidtechnik - Teil 2: Programmid, Shaker Verlag, Aachen, 2006  Murrenhoff, H.: Grundlagen der Fluidtechnik - Teil 2: Programmid, Shaker Verlag, Aachen, 2006  Murrenhoff, H.: Grundlagen der Fluidtechnik - Teil 2: Programmid, Shaker Verlag, Aachen, 2006  Murrenhoff, H.: Grundlagen der Fluidtechnik - Teil 2: Programmid, Shaker Verlag, Aachen, 2006  Murrenhoff, H.: Grundlagen der Fluidtechnik - Teil 2: Programmid, Shaker Verlag, Aachen, 2006  Murrenhoff, H.: Grundlagen der Fluidtechnik - Teil 2: Programmid, Shaker Verlag, Aachen, 2006  Murrenhoff, H.: Grundlagen der Fluidtechnik - Teil 2: Programmid, Shaker Verlag, Aachen, 2006  Murrenhoff, H.: Grundlagen der Fluidtechnik - Teil 2: Programmid, Shaker Verlag, Aachen, 2006  Murrenhoff, H.: Grundlagen der Fluidtechnik - Teil 2: Programmid, Shaker Verlag, Aachen, 2006  Murrenhoff, H.: Grundlagen der Fluidtechnik - Teil 2: Programmid, Shaker Verlag, Aachen, 2006  Murrenhoff, H.: Grundlagen der Fluidtechnik - Teil 2: Programmid, Murrenhoff, Mur	
	Murrenhoff, H.: Grundlagen der Fluidtechnik - Teil 2: Pneumatik, Shaker Verlag, Aachen, 2006      Matthia H.I. Braine K.Th. Fieffihaus in die Ölberhaudik Tauhana Verlag, 2006	
	Matthies, H.J. Renius, K.Th.: Einführung in die Ölhydraulik, Teubner Verlag, 2006      Reiter W. Crate K. H. Dubbel, Teebanhunb für den Maschingsbau, Springer Verlag, Berlin, ektyelle Auflage.	
	Beitz, W., Grote, KH.: Dubbel - Taschenbuch für den Maschinenbau, Springer-Verlag, Berlin, aktuelle Auflage	
	Skript zur Vorlesung	

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	

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

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

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

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

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

Module M1342: Polyn	ners				
Courses					
Γitle		Тур	Hrs/wk	СР	
Structure and Properties of Polyme	rs (L0389)	Lecture	2	3	
Processing and design with polyme	ers (L1892)	Lecture	2	3	
Module Responsible	Dr. Hans Wittich				
Admission Requirements	None				
Recommended Previous	Basics: chemistry / physics / material science	ce			
Knowledge					
<b>Educational Objectives</b>	After taking part successfully, students have	e reached the following learning results			
<b>Professional Competence</b>					
Knowledge	Students can use the knowledge of plastics	and define the necessary testing and analyst	sis.		
	They can explain the complex relationships	structure property relationship and			
	They can explain the complex relationships	structure-property relationship and			
	the interactions of chemical structure of the	polymers, including to explain neighboring	contexts (e.g. sustaina	bility, environmental	
	protection).				
Skills	Students are capable of				
S.i.i.s	ordadino di e capable ci				
		in a given context to mechanical proper	rties (modulus, strengt	th) to calculate and	
	evaluate the different materials.				
	- selecting appropriate solutions for mecha	nical recycling problems and sizing example	stiffness, corrosion res	sistance.	
	3 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1	5 - 1 - 1 - 1 - 1 - 1 - 1 - 1 - 1 - 1 -			
Personal Competence					
Social Competence	Students can				
	- arrive at funded work results in 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 weaknesse	25.			
	their company of least in a constitution of	C - k	alite hands		
	assess their own state of learning in specific terms and to define further work steps on this basis.				
	- assess possible consequences of their prof	fessional activity.			
Workload in Hours	Independent Study Time 124, Study Time ir	Lecture 56			
		i Lecture 30			
Credit points  Course achievement					
Examination					
Examination duration and scale	180 min				
Assignment for the	Materials Science and Engineering: Specialis	sation Engineering Materials: Flective Comp	ulsory		
Following Curricula		· ·	a1501 y		
. cc.mig carricula	Biomedical Engineering: Specialisation Impl				
	Biomedical Engineering: Specialisation Artif		ctive Compulsory		
	Biomedical Engineering: Specialisation Man				
	Biomedical Engineering: Specialisation Med	-			
	Product Development, Materials and Product	**			
	Product Development, Materials and Produc	tion: Specialisation Materials: Elective Comp	oulsory		
	Product Development, Materials and Produc	tion: Specialisation Product Development: E	lective Compulsory		
	Theoretical Mechanical Engineering: Specia	lisation Materials Science: Elective Compulse	ory		

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

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

Module M1170: Pheno	omena and Methods in Materials Scien	ce		
Courses				
Title		Тур	Hrs/wk	СР
Experimental Methods for the Characterization 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. Werkstoffwiss	enschaft I/II		
Knowledge				
<b>Educational Objectives</b>	After taking part successfully, students have reached the	following learning results		
Professional Competence				
Knowledge	The students will be able to explain the properties of ad	vanced materials along with their ap	plications in tech	nnology, in particular
	metallic, ceramic, polymeric, semiconductor, modern co	mposite materials (biomaterials) and	nanomaterials.	
Sville	The students will be able to select material configura	ions according to the technical nee	ds and if neces	ssary to design new
Skilis	materials considering architectural principles from the	-		
	modern materials science, which enables them to		-	
	applications.			
Personal Competence				
Social Competence	The students are able to present solutions to specialists	and to develop ideas further.		
Autonomy	The students are able to			
	<ul> <li>assess their own strengths and weaknesses.</li> </ul>			
	gather new necessary expertise by their own.			
	J			
Workload in Hours	Independent Study Time 96, Study Time in Lecture 84			
Credit points	6			
Course achievement	None			
Examination	Written exam			
Examination duration and	90 min			
scale				
Assignment for the	Chemical and Bioprocess Engineering: Specialisation Ger	neral Process Engineering: Elective Co	ompulsory	
Following Curricula	Chemical and Bioprocess Engineering: Specialisation Che			
	International Management and Engineering: Specialisation	on II. Product Development and Produ	ction: Elective Co	ompulsory
	Materials Science: Core Qualification: Compulsory			
	Product Development, Materials and Production: Speciali			
	Product Development, Materials and Production: Speciali		ry	
	Product Development, Materials and Production: Speciali			
	Theoretical Mechanical Engineering: Specialisation Mater	rials 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	<ul> <li>Structural characterization by photons, neutrons and electrons (in particular X-ray and neutron scattering, electron microscopy, tomography)</li> <li>Mechanical and thermodynamical characterization methods (indenter measurements, mechanical compression and tension tests, specific heat measurements)</li> <li>Characterization of optical, electrical and magnetic properties (spectroscopy, electrical conductivity and magnetometry)</li> </ul>
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 asset	ts		
Courses				
Title		Тур	Hrs/wk	СР
Fundamentals of Maintenance, Repair and Overhaul (MRO) (L3160)		Lecture	3	4
Fundamentals of Maintenance, Rep	pair and Overhaul (MRO) (L3161)	Recitation Section (large)	1	2
Module Responsible	Prof. Gerko Wende			
Admission Requirements	None			
Recommended Previous	We recommend knowledge in the areas of genera		,	3
Knowledge	fields like mechanical engineering, mechatronics content.	and production engineering will be intr	oduced into the	relevant aeronautical
Educational Objectives	After taking part successfully, students have reach	ed the following learning results		
Professional Competence				
Knowledge	The students are able to describe fundamental cor approaches for complex optimization problems.	relations for the sustainable operation of	technical 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 environment of multiple stakeholders.	with a clear focus on the approached	solutions by resp	pecting the complex
Autonomy	The students are enabled to find solutions for determining factors independently.	optimization problems and to take rec	uired decision for	the assessment of
Workload in Hours	Independent Study Time 124, Study Time in Lectur	re 56		
Credit points	6			
Course achievement	None			
Examination	Oral exam			
Examination duration and	30 min			
scale				
Assignment for the	Aircraft Systems Engineering: Core Qualification: E	lective Compulsory		
Following Curricula	Aeronautics: Core Qualification: Elective Compulso	ry		
	Mechatronics: Specialisation Intelligent Systems ar	nd Robotics: Elective Compulsory		
	Mechatronics: Specialisation System Design: Electi			
	Mechatronics: Core Qualification: Elective Compuls			
	Product Development, Materials and Production: Sp			
	Product Development, Materials and Production: Sp	•	-	
	Product Development, Materials and Production: Sp		-	
	Theoretical Mechanical Engineering: Specialisation			
	Theoretical Mechanical Engineering: Specialisation	Anciait systems Engineering: Elective Co	лприізої ў	

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):
	<ul> <li>Life cycle analytics</li> <li>Material circularity and service products</li> <li>Rules and regulations</li> <li>Processes and production methods</li> <li>Tools and technologies</li> <li>Data handling and usage</li> <li>Design for maintenance</li> <li>Self-healing technical systems</li> </ul>
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	

## **Supplement Modules Core Studies**

Module M0599: Digita	al Product Development and Lightweigl	nt Design		
Courses				
Title		Тур	Hrs/wk	СР
CAE-Team Project (L0271)		Project-/problem-based Learning	2	2
Digital Product Development (L026		Lecture	2	2
Development of Lightweight Design		Lecture	2	2
Module Responsible	Prof. Dieter Krause			
Admission Requirements	None			
Recommended Previous	Advanced Knowledge about engineering design:			
Knowledge	Fundamentals of Mechanical Engineering Design			
	Mechanical Engineering: Design			
	Advanced Mechanical Engineering Design			
Educational Objectives	After taking part successfully, students have reached the	following learning results		
Professional Competence				
Knowledge	After completing the module, students are capable of:			
	- compaining the functional principle of 2D CAD Coets	and FEM Cyckens		
	<ul> <li>explaining the functional principle of 3D-CAD-Syste</li> <li>describing the interaction of the different CAE-Syst</li> </ul>		c	
	describing the interaction of the university CAL-Syst	ems in the product development proces	55	
Skills				
	After completing the module, students are able to:			
	Arter completing the module, students are able to.			
	ovaluate different CAD, and RDM Systems with r	ogards to the desired requirements su	ich as classifi	sation schomos and
	<ul> <li>evaluate different CAD- and PDM-Systems with r product structuring</li> </ul>	egards to the desired requirements so	icii as ciassiii	cation schemes and
	<ul> <li>design an exemplary product using CAD-,PDM- and</li> </ul>	Vor FEM-Systems with shared workload		
	design an exemplary product using CAD-,FDM- and	I/OF I EM-Systems with shared workload		
Personal Competence				
-	After completing the module, students are able to:			
30ciai Competence	Arter completing the module, students are able to.			
	<ul> <li>To develop a project plan and allocate work approp</li> </ul>	oriate work packages in the framework	of group discu	issions
	Present project results as a team for instance in a	presentation		
Autonomy	Students are capable of:			
riatoriomy	Stadents are capable of.			
	<ul> <li>independently adapt to a CAE-Tool and complete a</li> </ul>	given practical task with it		
Workload in Hours	Independent Study Time 96, Study Time in Lecture 84			
Credit points	6			
Course achievement	Compulsory Bonus Form Descri	otion		
course demevement		eamprojekt inkl. Vortrag und Ausarbeitu	ıng	
	practical work			
Examination	Written exam			
	90			
scale				
Assignment for the	General Engineering Science (German program, 7 ser	nester): Specialisation Mechanical Eng	ineering, Foc	us Aircraft Systems
Following Curricula	Engineering: Compulsory			
	General Engineering Science (German program, 7 seme	ster): Specialisation Mechanical Engine	ering, Focus P	roduct Development
	and Production: Compulsory			
	Engineering Science: Specialisation Mechanical Engineeri	ng: Elective Compulsory		
	General Engineering Science (English program, 7 semest	er): Specialisation Mechanical Engineeri	ng: Elective Co	ompulsory
	Mechanical Engineering: Specialisation Product Developn	nent and Production: Compulsory		
	Mechanical Engineering: Specialisation Aircraft Systems I	Engineering: Compulsory		
	Product Development, Materials and Production: Technical	al Complementary Course Core Studies:	Elective Comp	oulsory

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

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

Course L0270: Development	of Lightweight Design Products
Тур	Lecture
Hrs/wk	2
СР	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Prof. Dieter Krause, Prof. Benedikt Kriegesmann
Language	DE
Cycle	SoSe
Content	Lightweight design materials     Product development process for lightweight structures     Dimensioning of lightweight structures
Literature	<ul> <li>Schürmann, H., "Konstruieren mit Faser-Kunststoff-Verbunden", Springer, Berlin, 2005.</li> <li>Klein, B., "Leichtbau-Konstruktion", Vieweg &amp; Sohn, Braunschweig, 1989.</li> <li>Krause, D., "Leichtbau", In: Handbuch Konstruktion, Hrsg.: Rieg, F., Steinhilper, R., München, Carl Hanser Verlag, 2012.</li> <li>Schulte, K., Fiedler, B., "Structure and Properties of Composite Materials", Hamburg, TUHH - TuTech Innovation GmbH, 2005.</li> <li>Wiedemann, J., "Leichtbau Band 1: Elemente", Springer, Berlin, Heidelberg, 1986.</li> </ul>

Module M1901: Mater	rials Science Laboratory			
Courses				
Title		Тур	Hrs/wk	СР
Companion Lecture for Materials So	cience Laboratory (L1088)	Lecture	2	2
Material Science Laboratory (L1235	5)	Practical Course	4	4
Module Responsible	Prof. Kaline Pagnan Furlan			
Admission Requirements	None			
Recommended Previous	none			
Knowledge				
<b>Educational Objectives</b>	After taking part successfully, students have reach	ed the following learning results		
Professional Competence				
Knowledge	Students are able to give a summary of the tec	hnical details of experiments in the	area of materials sc	iences and illustrate
	respective relationships. They are capable of desc	cribing and communicating relevant	problems and questio	ns using appropriate
	technical language. They can explain the typical pr	ocess of solving practical problems ar	nd present related res	ults.
Chille	The short one has a few the distance of the state of the			tical continues. These
Skills	The students can transfer their fundamental know	-		
	identify and overcome typical problems during the	realization of experiments in the cont	ext of material scienc	es.
Personal Competence				
Social Competence	Students are able to cooperate in small groups in o	order to conduct experiments in the co	ntext of materials sci	ences. They are able
	to effectively present and explain their results alon	e or in groups in front of a qualified a	ıdience.	
Autonomy	Students are capable of solving problems in the co	ontext of materials sciences lising nr	wided literature. They	are able to fill gans
Autonomy	in as well as extent their knowledge using the litera	- ·	-	are able to fill gaps
Workload in Hours	Independent Study Time 96, Study Time in Lecture	84		
Credit points	6			
Course achievement	None			
Examination	Subject theoretical and practical work			
Examination duration and	Reports on each one of the experiments and online	e learning modules with integrated che	ecking	
scale				
Assignment for the	General Engineering Science (German program, 7	semester): Specialisation Mechanical	Engineering, Focus F	roduct Development
Following Curricula	and Production: Elective Compulsory			
	General Engineering Science (German program, 7	semester): Specialisation Advanced M	aterials: Compulsory	
	Engineering Science: Specialisation Advanced Mate	erials: Compulsory		
	Engineering Science: Specialisation Advanced Mate	erials: Compulsory		
	Engineering Science: Specialisation Mechanical Engineering	gineering: Elective Compulsory		
	Mechanical Engineering: Specialisation Product De	velopment and Production: Compulsor	у	
	Mechanical Engineering: Specialisation Materials in	Engineering Sciences: Compulsory		
	Product Development, Materials and Production: Te	echnical Complementary Course Core	Studies: Elective Com	pulsory

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

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

Module M0726: Produ	iction Technology			
Courses				
Title Fundamentals of Machine Tools (L0689) Fundamentals of Machine Tools (L1992) Forming and Cutting Technology (L0613)		<b>Typ</b> Lecture Recitation Section (large) Lecture	Hrs/wk 2 1 2	CP 2 1 2
Forming and Cutting Technology (L	0614)	Recitation Section (large)	1	1
Module Responsible	Prof. Jan Hendrik Dege			
Admission Requirements	None			
<b>Recommended Previous</b>	without major course assessment			
Knowledge	internship recommended			
	Previous knowledge in mathematics, mechanics and	electrical engineering		
Educational Objectives	After taking part successfully, students have reache	d the following learning results		
Professional Competence	5 p	5		
	Students are able to			
	<ul> <li>explain the basics of chip formation and mech</li> <li>explain methods and parameters for design a</li> <li>explain technical concepts of machine tool bu</li> <li>explain types, constructions and functions of</li> <li>explain equipment components.</li> </ul>	nd analysis of metal forming, machining illding and give an overview on trends in	the machine tool	industry.
Skills	Students are able to			
	<ul> <li>select tool geometry, cutting materials, process parameters and appropriate measuring technique in accordance with requirements.</li> <li>estimate occurring forces and temperatures during chip formation.</li> <li>select appropriate machine tools for machining and create NC programs for turning and milling.</li> <li>assess the quality of a machine tools and to detect weak points.</li> </ul>			decordance with the
Personal Competence Social Competence	Students are able to  • develop solutions in a production environmen	t with qualified personnel at technical lev	el and represent	decisions.
Autonomy	Students are able to			
	<ul> <li>interpret independently cutting processes.</li> <li>create independently NC programs.</li> <li>select independently machine tools by reference assess own strengths and weaknesses in general assess their learning progress and define gap assess possible consequences of their actions</li> </ul>	eral. s to be improved.		
Workload in Hours	Independent Study Time 96, Study Time in Lecture 8	34		
Credit points	6			
Course achievement	None			
Examination	Written exam			
Examination duration and	180 min			
scale				
Assignment for the Following Curricula	General Engineering Science (German program, 7 s and Production: Compulsory Mechanical Engineering: Specialisation Product Deve		ineering, Focus I	Product Developmen
	Mechatronics: Specialisation Robot- and Machine-Sy Product Development, Materials and Production: Tec	• •	ies: Elective Com	pulsory

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

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

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

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

### **Thesis**

Module M1801: Maste	er thesis (dual study program)
Courses	
Title	Typ Hrs/wk CP
Module Responsible	Professoren der TUHH
Admission Requirements	None
Recommended Previous	
Knowledge	
Educational Objectives	After taking part successfully, students have reached the following learning results
Professional Competence	
Knowledge	Dual students
Skills	<ul> <li> use the specialised knowledge (facts, theories and methods) from their field of study and the acquired professional knowledge confidently to deal with technical and practical professional issues.</li> <li> can explain the relevant approaches and terminologies in depth in one or more of their subject's specialist areas, describe current developments and take a critical stance.</li> <li> formulate their own research assignment to tackle a professional problem and contextualise it within their subject area. They ascertain the current state of research and critically assess it.</li> <li>Dual students</li> </ul>
	<ul> <li> can select suitable methods for the respective subject-related professional problem, apply them and develop them further as required.</li> <li> assess knowledge and methods acquired during their studies (including practical phases) and apply their expertise to complex and/or incompletely defined problems in a solution- and application-oriented manner.</li> <li> acquire new academic knowledge in their subject area and critically evaluate it.</li> </ul>
Personal Competence Social Competence	
	<ul> <li> can present a professional problem in the form of an academic question in a structured, comprehensible and factually correct manner, both in writing and orally, for a specialist audience and for professional stakeholders.</li> <li> answer questions as part of a professional discussion in an expert, appropriate manner. They represent their own points of view and assessments convincingly.</li> </ul> Dual students
	<ul> <li> can structure their own project into work packages, work through them at an academic level and reflect on them with regard to feasible courses of action for professional practice.</li> <li> work in-depth in a partially unknown area within the discipline and acquire the information required to do so.</li> <li> apply the techniques of academic work comprehensively in their own research work when dealing with an operational problem and question.</li> </ul>
Workload in Hours	Independent Study Time 900, Study Time in Lecture 0
Credit points	30
Course achievement	None
Examination	Thesis
Examination duration and	According to General Regulations
scale	
Assignment for the	Civil Engineering: Thesis: Compulsory
Following Curricula	Bioprocess Engineering: Thesis: Compulsory
	Chemical and Bioprocess Engineering: Thesis: Compulsory Computer Science: Thesis: Compulsory
	Data Science: Thesis: Compulsory
	Electrical Engineering: Thesis: Compulsory
	Energy Systems: Thesis: Compulsory
	Environmental Engineering: Thesis: Compulsory
	Aircraft Systems Engineering: Thesis: Compulsory
	Computer Science in Engineering: Thesis: Compulsory
	Information and Communication Systems: Thesis: Compulsory
	International Management and Engineering: Thesis: Compulsory
	Logistics, Infrastructure and Mobility: Thesis: Compulsory Aeronautics: Thesis: Compulsory
	Materials Science and Engineering: Thesis: Compulsory
	Materials Science: Thesis: Compulsory
	Mechanical Engineering and Management: Thesis: Compulsory
	Mechatronics: Thesis: Compulsory
	Biomedical Engineering: Thesis: Compulsory
	Microelectronics and Microsystems: Thesis: Compulsory
	Product Development, Materials and Production: Thesis: Compulsory  Renewable Energies: Thesis: Compulsory
	Renewable Energies: Thesis: Compulsory  Naval Architecture and Ocean Engineering: Thesis: Compulsory
	Theoretical Mechanical Engineering: Thesis: Compulsory

Process Engineering: Thesis: Compulsory

Water and Environmental Engineering: Thesis: Compulsory