

Module Manual

Bachelor of Science (B.Sc.)

General Engineering Science (German program, 7 semester)

Cohort: Winter Term 2021 Updated: 31st May 2023

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Program description

Content

The Bachelor-program General Engineering Science (GES) starts with a broad, for all students binding fundamental engineering curricula. With begin of the 3rd Semester students have to choose one of the 9 fields of study (civil engineering, biotechnology, electrical engineering, energy- and environmental engineering, computer science, mechanical engineering, medical engineering, naval engineering, process engineering), some of them with further specialisations. GES has with 210 credit points a higher workload compared to other Bachelor study courses. Therefore General Engineering Science is designed for 7 semesters.

Career prospects

The graduates of the Bachelor program General Engineering Science are directly able to enter a career in the field of mechanical engineering, civil engineering, electrical engineering, process engineering or computer science engineering and work responsibly as engineer. They are entitled to use the professional title Ingenieurin or Ingenieur (Engineer) pursuant to the Engineers Acts (Ingenieurgesetzen) of the states in Germany.

Possible employers include companies in mechanical, civil, process, electrical and computer science engineering as well as engineering firms.

The Bachelor degree in one of the fields of study enables a consecutive study of one of the corresponding Master studies, of another technical or of an economic oriented Master study. Most of the modules in the 1st and the 2nd semester of GES are offered in English.

Learning target

Knowledge

Students can:

- Name and describe the mathematical and scientific principles and methods of the engineering sciences;
- Ellucidate the principles and methods of the engineering sciences and present an overview of their subject;
- Explain in detail the foundations, methods and areas of application of their specialization, and, as necessary, their particular focus;

• Recite the foundations and methods of the engineering sciences and provide an overview of the relevant social, ethical, ecological and economic marginal conditions of their subject.

Skills

Graduates are able to

- · Identify and abstract subject-related problems fundamentally and solve them holistically
- · Identify, combine and apply in an interdisciplinary manner the methods appropriate for the desired analysis, modeling, simulation and optimization
- · Penetrate, analyze and evaluate products and methods from different branches of engineering on a systems technology basis
- Applofdesign methods from different branches of engineering
- Plan and carry out experiments and interpret the results
- Assess the limits of techniques and methods
- Use their knowledge in an interdisciplinary manner and responsible way, taking economic requirements into consideration
- Evaluate problems in a wider societal context and assess the non-technical repercussions of engineering.

Social Competence

Graduates are able to

- · Present the methods and results of their work comprehensively both orally and in writing
- Communicate with experts and laypersons about the contents and problems of engineering
- · Respond appropriately to inquiries, additions and comments
- · Work in groups, define, allocate and integrate subtasks, reach agreement on schedules and to interact socially.

Autonomy

Graduates are able to

• Familiarize themselves with the relevant literature and effectively use databases and other digital sources of information as well as present the results of their work comprehensively both orally and in writing

- Assess their existing competences realistically and develop and carry out strategies for compensating any deficits they identify
- Learn a range of subjects and work independently
- Expand and deepen their understanding through a process of lifelong learning

Program structure

The program is split into the core qualifications, the specialisation qualification and the Bachelor thesis.

The internship and the interdisciplinary final thesis is scheduled for the seventh semester.

Core Qualification

Module Responsible	Dagmar Richter
•	None
Recommended Previous	None
Knowledge	1
-	After taking part successfully, students have reached the following learning results
Professional Competence	
Knowledge	The Non-technical Academic Programms (NTA)
	imparts skills that, in view of the TUHH's training profile, professional engineering studies require but are not able to cover fu Self-reliance, self-management, collaboration and professional and personnel management competences. The departm implements these training objectives in its teaching architecture , in its teaching and learning arrangements , in teach areas and by means of teaching offerings in which students can qualify by opting for specific competences and a compete level at the Bachelor's or Master's level. The teaching offerings are pooled in two different catalogues for nontechn complementary courses.
	The Learning Architecture
	consists of a cross-disciplinarily study offering. The centrally designed teaching offering ensures that courses in the nontechn academic programms follow the specific profiling of TUHH degree courses.
	The learning architecture demands and trains independent educational planning as regards the individual development competences. It also provides orientation knowledge in the form of "profiles"
	The subjects that can be studied in parallel throughout the student's entire study program - if need be, it can be studied in one two semesters. In view of the adaptation problems that individuals commonly face in their first semesters after making transition from school to university and in order to encourage individually planned semesters abroad, there is no obligation study these subjects in one or two specific semesters during the course of studies.
	Teaching and Learning Arrangements
	provide for students, separated into B.Sc. and M.Sc., to learn with and from each other across semesters. The challenge of dea with interdisciplinarity and a variety of stages of learning in courses are part of the learning architecture and are deliberat encouraged in specific courses.
	Fields of Teaching
	are based on research findings from the academic disciplines cultural studies, social studies, arts, historical studies, migral studies, communication studies and sustainability research, and from engineering didactics. In addition, from the winter semes 2014/15 students on all Bachelor's courses will have the opportunity to learn about business management and start-ups in a go oriented way.
	The fields of teaching are augmented by soft skills offers and a foreign language offer. Here, the focus is on encouraging go oriented communication skills, e.g. the skills required by outgoing engineers in international and intercultural situations.
	The Competence Level
	of the courses offered in this area is different as regards the basic training objective in the Bachelor's and Master's fields. Th differences are reflected in the practical examples used, in content topics that refer to different professional application conte and in the higher scientific and theoretical level of abstraction in the B.Sc.
	This is also reflected in the different quality of soft skills, which relate to the different team positions and different group leaders functions of Bachelor's and Master's graduates in their future working life.
	Specialized Competence (Knowledge)
	Students can
	 locate selected specialized areas with the relevant non-technical mother discipline, outline basic theories, categories, terminology, models, concepts or artistic techniques in the disciplines represented in learning area, different specialist disciplines relate to their own discipline and differentiate it as well as make connections, sketch the basic outlines of how scientific disciplines, paradigms, models, instruments, methods and forms of represental in the specialized sciences are subject to individual and socio-cultural interpretation and historicity, Can communicate in a foreign language in a manner appropriate to the subject.
Skills	Professional Competence (Skills)
JKIII3	
	In selected sub-areas students can
	 apply basic methods of the said scientific disciplines, auestion a specific technical phenomena, models, theories from the viewpoint of another, aforementioned special discipline,
	 to handle simple questions in aforementioned scientific disciplines in a sucsessful manner, justify their decisions on forms of organization and application in practical questions in contexts that go beyond technical relationship to the subject.

Social Competence	Personal Competences (Social Skills)
	Students will be able
	 to learn to collaborate in different manner, to present and analyze problems in the abovementioned fields in a partner or group situation in a manner appropriate to the addressees, to express themselves competently, in a culturally appropriate and gender-sensitive manner in the language of the country (as far as this study-focus would be chosen), to explain nontechnical items to auditorium with technical background knowledge.
Autonomy	Personal Competences (Self-reliance) Students are able in selected areas
	 to reflect on their own profession and professionalism in the context of real-life fields of application to organize themselves and their own learning processes to reflect and decide questions in front of a broad education background to communicate a nontechnical item in a competent way in writen form or verbaly to organize themselves as an entrepreneurial subject country (as far as this study-focus would be chosen)
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 M0743: Electrical Engineering I: Direct Current Networks and Electromagnetic Fields						
Courses						
Title				Тур	Hrs/wk	СР
Electrical Engineering I: Direct Curr				Lecture	3	5
Electrical Engineering I: Direct Curr	rent Networks and Elect	romagnetic Fields (L	0676)	Recitation Section (small)	2	1
Module Responsible	Prof. Matthias Kuhl					
Admission Requirements	None					
Recommended Previous						
Knowledge						
Educational Objectives	After taking part suc	cessfully, students	have reached the follow	ing learning results		
Professional Competence						
Knowledge						
Skills						
Personal Competence						
Social Competence						
Autonomy						
Workload in Hours	Independent Study T	ïme 110, Study Tir	me in Lecture 70			
Credit points	6					
Course achievement		Form	Description			
	No 10 %	Excercises				
Examination	Written exam					
Examination duration and	120 Minutes					
scale						
Assignment for the			-	ore Qualification: Compulsory		
Following Curricula			Engineering: Compulsory			
	Electrical Engineering: Core Qualification: Compulsory					
		5	g: Core Qualification: Cor	npulsory		
	Mechatronics: Core Qualification: Compulsory					
	Orientation Studies:	Core Qualification:	Elective Compulsory			

Course L0675: Electrical Engineering I: Direct Current Networks and Electromagnetic Fields			
Тур	Lecture		
Hrs/wk	3		
CP	5		
Workload in Hours	Independent Study Time 108, Study Time in Lecture 42		
Lecturer	of. Matthias Kuhl		
Language	E		
Cycle	WiSe		
Content			
Literature	 M. Kasper, Skript zur Vorlesung Elektrotechnik 1, 2013 M. Albach: Grundlagen der Elektrotechnik 1, Pearson Education, 2004 F. Moeller, H. Frohne, K.H. Löcherer, H. Müller: Grundlagen der Elektrotechnik, Teubner, 2005 A. R. Hambley: Electrical Engineering, Principles and Applications, Pearson Education, 2008 		

Course L0676: Electrical Engineering I: Direct Current Networks and Electromagnetic Fields		
Тур	Recitation Section (small)	
Hrs/wk	2	
CP	1	
Workload in Hours	Independent Study Time 2, Study Time in Lecture 28	
Lecturer	Prof. Matthias Kuhl	
Language	DE	
Cycle	WiSe	
Content		
Literature	 Übungsaufgaben zur Elektrotechnik 1, TUHH, 2013 Ch. Kautz: Tutorien zur Elektrotechnik, Pearson Studium, 2010 	

Courses					
Title		Тур	Hrs/wk	СР	
Mechanics I (Statics) (L1001)		Lecture	2	3	
Mechanics I (Statics) (L1002)		Recitation Section (small)	2	2	
Mechanics I (Statics) (L1003)		Recitation Section (large)	1	1	
Module Responsible					
Admission Requirements	None				
Recommended Previous Knowledge					
Educational Objectives	After taking part successfully, students have reached	the following learning results			
Professional Competence					
Knowledge	The students can				
	 describe the axiomatic procedure used in mec 	hanical contoxts:			
	 explain important steps in model design; 	nanca contexts,			
	 present technical knowledge in stereostatics. 				
	present commentation age in stereostation				
Skills	The students can				
	explain the important elements of mathematic	cal / mechanical analysis and model for	mation, and appl	v it to the context	
	their own problems;			,	
	 apply basic statical methods to engineering pr 	oblems;			
	 estimate the reach and boundaries of statical r 		ole to wider probl	lem sets.	
Personal Competence					
Social Competence	The students can work in groups and support each ot	her to overcome difficulties.			
Autonomy	Students are capable of determining their own strengths and weaknesses and to organize their time and learning based on those				
Workload in Hours	Independent Study Time 110, Study Time in Lecture	70			
Credit points	6				
Course achievement	None				
Examination	Written exam				
Examination duration and	90 min				
scale					
Assignment for the	General Engineering Science (German program, 7 se	mester): Core Qualification: Compulsory			
Following Curricula	Civil- and Environmental Engineering: Core Qualificat	ion: Compulsory			
	Bioprocess Engineering: Core Qualification: Compulse	bry			
	Data Science: Specialisation Mechanics: Compulsory				
	Digital Mechanical Engineering: Core Qualification: Co	ompulsory			
	Electrical Engineering: Core Qualification: Elective Co	mpulsory			
	Green Technologies: Energy, Water, Climate: Core Qu	ualification: Compulsory			
	Computational Science and Engineering: Specialisation	on II. Mathematics & Engineering Science	e: Elective Compu	ulsory	
	Logistics and Mobility: Core Qualification: Compulsory				
	Mechanical Engineering: Core Qualification: Compulse	ory			
	Mechatronics: Core Qualification: Compulsory				
	Orientation Studies: Core Qualification: Elective Comp	oulsory			
	Orientation Studies: Core Qualification: Elective Com Naval Architecture: Core Qualification: Compulsory	pulsory			
	Orientation Studies: Core Qualification: Elective Comp	oulsory			

Course L1001: Mechanics I (S	Statics)
Тур	Lecture
Hrs/wk	2
СР	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Prof. Robert Seifried
Language	DE
Cycle	WiSe
Content	 Tasks in Mechanics Modelling and model elements Vector calculus for forces and torques Forces and equilibrium in space Constraints and reactions, characterization of constraint systems Planar and spatial truss structures Internal forces and moments for beams and frames Center of mass, volumn, area and line Computation of center of mass by intergals, joint bodies Friction (sliding and sticking) Friction of ropes
Literature	K. Magnus, H.H. Müller-Slany: Grundlagen der Technischen Mechanik. 7. Auflage, Teubner (2009).
	D. Gross, W. Hauger, J. Schröder, W. Wall: Technische Mechanik 1. 11. Auflage, Springer (2011).

Course L1002: Mechanics I (Statics)
Тур	Recitation Section (small)
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Prof. Robert Seifried
Language	DE
Cycle	WiSe
Content	Forces and equilibrium
	Constraints and reactions
	Frames
	Center of mass
	Friction
	Internal forces and moments for beams
Literature	K. Magnus, H.H. Müller-Slany: Grundlagen der Technischen Mechanik. 7. Auflage, Teubner (2009).
	D. Gross, W. Hauger, J. Schröder, W. Wall: Technische Mechanik 1. 11. Auflage, Springer (2011).

Course L1003: Mechanics I (Statics)		
Тур	Recitation Section (large)	
Hrs/wk	1	
CP	1	
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14	
Lecturer	Prof. Robert Seifried	
Language	DE	
Cycle	WiSe	
Content	Forces and equilibrium	
	Constraints and reactions	
	Frames	
	Center of mass	
	Friction	
	Internal forces and moments for beams	
Literature	K. Magnus, H.H. Müller-Slany: Grundlagen der Technischen Mechanik. 7. Auflage, Teubner (2009).	
	D. Gross, W. Hauger, J. Schröder, W. Wall: Technische Mechanik 1. 11. Auflage, Springer (2011).	

Module M0850: Mathe	ematics I					
Courses						
Title		Тур	Hrs/wk	СР		
Analysis I (L1010)		Lecture	2	2		
		Recitation Section (small)	1	1		
Analysis I (L1012)			1	1		
Analysis I (L1013)		Recitation Section (large)	2			
Linear Algebra I (L0912)		Lecture		2		
Linear Algebra I (L0913)		Recitation Section (small)	1	1		
Linear Algebra I (L0914)		Recitation Section (large)	1	1		
Module Responsible	Prof. Anusch Taraz					
Admission Requirements	None					
Recommended Previous	School mathematics					
Knowledge						
Educational Objectives	After taking part successfully, students have	e reached the following learning results				
Professional Competence						
Knowledge						
Kilomeuge	 Students can name the basic conce 	pts in analysis and linear algebra. They are at	ole to explain the	em using appropria		
	examples.					
	 Students can discuss logical connect 	ions between these concepts. They are capable	of illustrating th	nese connections w		
	the help of examples.		J			
	 They know proof strategies and can r 	correduce them				
		epioduce mem.				
Skills	Ctudents can madel problems in ana	lycic and linear algebra with the help of the con-	onto studiod in t	his course Moreov		
		lysis and linear algebra with the help of the cond	epts studied in t	This course. Moreov		
	they are capable of solving them by a					
	 Students are able to discover and ver 	ify further logical connections between the conce	epts studied in the	e course.		
	 For a given problem, the students of 	an develop and execute a suitable approach, a	and are able to c	critically evaluate t		
	results.					
Barrowal Commetance						
Personal Competence						
Social Competence	 Students are able to work together in teams. They are capable to use mathematics as a common language. 					
	 In doing so, they can communicate new concepts according to the needs of their cooperating partners. Moreover, they ca 					
			peracing partners	s. Moreover, they c		
	design examples to check and deepe	n the understanding of their peers.				
Autonomy						
, laterierity	 Students are capable of checking the 	eir understanding of complex concepts on their	own. They can sp	pecify open question		
	precisely and know where to get help	in solving them.				
	• Students have developed sufficient	persistence to be able to work for longer period	ds in a goal-orier	nted manner on ha		
	problems.		5			
	problemor					
	Independent Study Time 128, Study Time in	Lecture 112				
Credit points	8					
Course achievement	None					
Examination	Written exam					
Examination duration and	60 min (Analysis I) + 60 min (Linear Algebra	a I)				
scale						
	Gonoral Engineering Science (German prog	ram 7 somestor): Caro Qualification: Compulson				
-		ram, 7 semester): Core Qualification: Compulsory				
Following Curricula	Civil- and Environmental Engineering: Core					
	Bioprocess Engineering: Core Qualification:					
	Digital Mechanical Engineering: Core Qualifi	cation: Compulsory				
	Electrical Engineering: Core Qualification: Co	ompulsory				
	Green Technologies: Energy, Water, Climate	e: Core Qualification: Compulsory				
	Computational Science and Engineering: Co					
	Logistics and Mobility: Core Qualification: Co					
	Mechanical Engineering: Core Qualification:					
	Mechatronics: Core Qualification: Compulsor	-				
	Orientation Studies: Core Qualification: Elec	tive Compulsory				
	Naval Architecture: Core Qualification: Com	pulsory				
	Process Engineering: Core Qualification: Cor	npulsory				
		jistics and Mobility: Core Qualification: Compulso	~			
	and handgement major in E0g	,	,			

Course L1010: Analysis I				
Тур	Lecture			
Hrs/wk	2			
СР				
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28			
Lecturer	Dozenten des Fachbereiches Mathematik der UHH			
Language	DE			
Cycle	WiSe			
Content	Foundations of differential and integrational calculus of one variable			
	 statements, sets and functions natural and real numbers convergence of sequences and series continuous and differentiable functions mean value theorems Taylor series calculus error analysis fixpoint iteration 			
Literature	 http://www.math.uni-hamburg.de/teaching/export/tuhh/index.html 			

Course L1012: Analysis I	Course L1012: Analysis I				
Тур	Recitation Section (small)				
Hrs/wk	1				
СР	1				
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14				
Lecturer	Dozenten des Fachbereiches Mathematik der UHH				
Language	DE				
Cycle	WiSe				
Content	See interlocking course				
Literature	See interlocking course				

Course L1013: Analysis I	ourse L1013: Analysis I				
Тур	Recitation Section (large)				
Hrs/wk					
CP	1				
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14				
Lecturer	Dozenten des Fachbereiches Mathematik der UHH, Dr. Simon Campese				
Language	DE				
Cycle	WiSe				
Content	See interlocking course				
Literature	See interlocking course				

Course L0912: Linear Algebra	al
Тур	Lecture
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Prof. Anusch Taraz, Dr. Dennis Clemens, Prof. Marko Lindner
Language	DE
Cycle	WiSe
Content	 vectors: intuition, rules, inner and cross product, lines and planes systems of linear equations: Gauß elimination, matrix product, inverse matrices, transformations, block matrices, determinants orthogonal projection in R^n, Gram-Schmidt-Orthonormalization
Literature	 T. Arens u.a. : Mathematik, Spektrum Akademischer Verlag, Heidelberg 2009 W. Mackens, H. Voß: Mathematik I für Studierende der Ingenieurwissenschaften, HECO-Verlag, Alsdorf 1994 W. Mackens, H. Voß: Aufgaben und Lösungen zur Mathematik I für Studierende der Ingenieurwissenschaften, HECO-Verlag, Alsdorf 1994 G. Strang: Lineare Algebra, Springer-Verlag, 2003 G. und S. Teschl: Mathematik für Informatiker, Band 1, Springer-Verlag, 2013

Course L0913: Linear Algebra	al			
Тур	ecitation Section (small)			
Hrs/wk	1			
CP	1			
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14			
Lecturer	Prof. Anusch Taraz, Dr. Dennis Clemens, Prof. Marko Lindner			
Language	DE			
Cycle	WiSe			
Content	 vectors: intuition, rules, inner and cross product, lines and planes general vector spaces: subspaces, Euclidean vector spaces systems of linear equations: Gauß-elimination, matrix product, inverse matrices, transformations, LR-decomposition, block matrices, determinants 			
Literature	 T. Arens u.a. : Mathematik, Spektrum Akademischer Verlag, Heidelberg 2009 W. Mackens, H. Voß: Mathematik I für Studierende der Ingenieurwissenschaften, HECO-Verlag, Alsdorf 1994 W. Mackens, H. Voß: Aufgaben und Lösungen zur Mathematik I für Studierende der Ingenieurwissenschaften, HECO-Verlag, Alsdorf 1994 			

Course L0914: Linear Algebra	irse L0914: Linear Algebra I				
Тур	citation Section (large)				
Hrs/wk	1				
CP	1				
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14				
Lecturer	Dr. Christian Seifert, Dr. Dennis Clemens				
Language	DE				
Cycle	WiSe				
Content	See interlocking course				
Literature	See interlocking course				

Module M0687: Chem	istry				
Houdie Houor. Chem	istry				
Courses					
Title		Тур	Hrs/wk	СР	
Chemistry I+II (L0460)		Lecture	4	4	
Chemistry I+II (L0475)		Recitation Section (large)	2	2	
Module Responsible	Dr. Dorothea Rechtenbach				
Admission Requirements	None				
Recommended Previous	none				
Knowledge					
Educational Objectives	After taking part successfully, students have reac	hed the following learning results			
Professional Competence					
Knowledge	The students are able to name and to describe ba table, chemical bonds), physical chemistry (a chemistry (acid/base, pH-value, salts, solubility, n carbonyl compounds, aromates, reaction mecha explain basic chemical terms.	ggregate states, separating processes, t redox, metals) and organic chemistry (aliph	hermodynamics, atic hydrocarbon	kinetics), inorga s, functional grou	
Skills	s After successful completion of this module students are able to describe substance groups and chemical compounds. On this bas they are capable of explaining, choosing and applying specific methods and various reaction mechanisms.				
Personal Competence					
Social Competence	Students are able to take part in discussions on c contribute to those discussion by their own stater	•	of an interdiscipli	nary team. They o	
Autonomy	After successful completion of this module students are able to solve chemical problems independently by defending propose approaches with arguments. They can also document their approaches.				
Workload in Hours	Independent Study Time 96, Study Time in Lectur	e 84			
Credit points	6				
Course achievement	None				
Examination	Written exam				
Examination duration and	120 min				
scale					
Assignment for the	General Engineering Science (German program, 7	semester): Core Qualification: Compulsory			
Following Curricula					
		g Science: Elective Compulsory			

Course L04	60: Chemistry I+II				
Тур	Lecture				
Hrs/wk	4				
СР	4				
Workload	Independent Study Time 64, Study Time in Lecture 56				
in Hours Lecturer	Dr. Christoph Wutz				
	DE				
Cycle					
	Chemistry I:				
	- Structure of matter				
	- Periodic table				
	- Electronegativity				
	- Chemical bonds				
	- Solid compounds and solutions				
	- Chemistry of water				
	- Chemical reactions and equilibria				
	- Acid-base reactions				
	- Redox reactions				
	Chemistry II:				
	- Simple compounds of carbon, aliphatic hydrocarbons, aromatic hydrocarbons,				
	- Alkohols, phenols, ether, aldehydes, ketones, carbonic acids, ester, amines, amino acids, fats, sugars				
	- Reaction mechanisms, radical reactions, nucleophilic substitution, elimination reactions, addition reaction				
	- Practical applications and examples				
Literature	- Blumenthal, Linke, Vieth: Chemie - Grundwissen für Ingenieure				
	- Kickelbick: Chemie für Ingenieure (Pearson)				
	- Mortimer: Chemie. Basiswissen der Chemie.				
	- Brown, LeMay, Bursten: Chemie. Studieren kompakt.				
	- Schmuck: Basisbuch Organische Chemie (Pearson)				

Course L0475: Chemistry I+I	ourse L0475: Chemistry I+II				
Тур	Recitation Section (large)				
Hrs/wk	2				
СР	2				
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28				
Lecturer	Dr. Dorothea Rechtenbach				
Language	DE				
Cycle	WiSe				
Content	See interlocking course				
Literature	See interlocking course				

Courses							
Title				Тур	Hrs/wk	СР	
Computer Science for Engineers - I					Lecture	3	3
Computer Science for Engineers - Introduction and Overview (L2686)				Recitation Section (small)	2	3	
Module Responsible		nwin Fey					
Admission Requirements	None						
Recommended Previous							
Knowledge			f. II		in a la suela sues des		
Educational Objectives	After taking	g part suc	cessfully, students n	ave reached the follow	ing learning results		
Professional Competence Knowledge							
Skills							
Personal Competence							
Social Competence							
Autonomy							
Workload in Hours	Independe	nt Study T	ime 110. Study Time	e in Lecture 70			
Credit points							
Course achievement	Compulsory	Bonus	Form	Description			
	No	10 %	Attestation	Testate finde	en semesterbegleitend statt.		
Examination	Written exa	am					
Examination duration and	90 min						
scale							
Assignment for the	General Engineering Science (German program, 7 semester): Core Qualification: Compulsory						
Following Curricula		-					
		Green Technologies: Energy, Water, Climate: Core Qualification: Compulsory					
	Logistics and Mobility: Core Qualification: Compulsory						
	Mechanical Engineering: Core Qualification: Compulsory						
	Mechatronics: Core Qualification: Compulsory Orientation Studies: Core Qualification: Elective Compulsory						
		Naval Architecture: Core Qualification: Compulsory Engineering and Management - Major in Logistics and Mobility: Core Qualification: Compulsory					

Course L2685: Computer Science for Engineers - Introduction and Overview				
Тур	Lecture			
Hrs/wk	3			
CP	3			
Workload in Hours	Independent Study Time 48, Study Time in Lecture 42			
Lecturer	Prof. Görschwin Fey			
Language	DE/EN			
Cycle	WiSe			
Content				
Literature	 Informatik Helmut Herold, Bruno Lurz, Jürgen Wohlrab, Matthias Hopf: Grundlagen der Informatik, 3. Auflage, 816 Seiten, Pearson Studium, 2017. C++ Bjarne Stroustrup, Einführung in die Programmierung mit C++, 479 Seiten, Pearson Studium, 2010. 			

ourse L2686: Computer Science for Engineers - Introduction and Overview		
Тур	Recitation Section (small)	
Hrs/wk	2	
CP	3	
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28	
Lecturer	Prof. Görschwin Fey	
Language	DE/EN	
Cycle	WiSe	
Content	See interlocking course	
Literature	See interlocking course	

Courses				
		-	Here foods	CD
Title Electrical Engineering II: Alternatin	g Current Networks and Basic Devices (L0178)	Typ Lecture	Hrs/wk 3	CP 5
	g Current Networks and Basic Devices (L0178) g Current Networks and Basic Devices (L0179)	Recitation Section (small)	2	1
Module Responsible				
Admission Requirements				
Recommended Previous				
Knowledge				
lineineuge	Mathematics I			
	Direct current networks, complex numbers			
Educational Objectives	After taking part successfully, students have reached t	the following learning results		
Professional Competence	After taking part successiony, students have reached t			
	Students are able to reproduce and explain fundame	ental theories principles and methods	related to the t	heory of alternat
Knowledge	currents. They can describe networks of linear elemen			
	an overview of applications for the theory of alternat			
	explaining the behavior of fundamental passive and ac			
Skills	Students are capable of calculating parameters within	n simple electrical networks at alternat	ting currents by	means of a comp
	notation for voltages and currents. They can apprai			
	alternating currents. Students are able to analyze simple circuits such as oscillating circuits, filter, and matching network			
	quantitatively and dimension elements by means of a design. They can motivate and justify the fundamental elements of a			
	electrical power supply (transformer, transmission line, compensation of reactive power, multiphase system) and are qualified t			
	dimension their main features.			
Personal Competence				
Social Competence	Students are able to work together on subject related t	tasks in small groups. They are able to	present their resu	ults effectively.
Autonomy	Students are capable to gather necessary information	n from the references provided and rela	ate that informat	ion to the context
	the lecture. They are able to continually reflect their knowledge by means of activities that accompany the lecture, such as online			
	tests and exercises that are related to the exam. Bas			
	learning process. They are able to draw connections		this lecture and	the content of ot
	lectures (e.g. Electrical Engineering I, Linear Algebra, a	and Analysis).		
		<u></u>		
	Independent Study Time 110, Study Time in Lecture 70	v		
Credit points		cription		
Course achievement	No 10 % Midterm			
Examination	Written exam			
Examination duration and	90 - 150 minutes			
scale				
Assignment for the	General Engineering Science (German program, 7 sem	nester): Core Qualification: Compulsory		
Following Curricula	Data Science: Specialisation Electrical Engineering: Co	mpulsory		
	Electrical Engineering: Core Qualification: Compulsory			
	Computational Science and Engineering: Core Qualifica	ation: Compulsory		
	Mechatronics: Core Qualification: Compulsory			
	Orientation Studies: Core Qualification: Elective Compu	ulsory		

Course L0178: Electrical Eng	ineering II: Alternating Current Networks and Basic Devices
Тур	Lecture
Hrs/wk	3
СР	5
Workload in Hours	Independent Study Time 108, Study Time in Lecture 42
Lecturer	Prof. Christian Becker
Language	DE
Cycle	SoSe
Content	- General time-dependency of electrical networks
	- Representation and properties of harmonic signals
	- RLC-elements at alternating currents/voltages
	- Complex notation for the representation of RLC-elements
	- Power in electrical networks at alternating currents, compensation of reactive power
	- Frequency response locus (Nyquist plot) and Bode-diagrams
	- Measurement instrumentation for assessing alternating currents
	- Oscillating circuits, filters, electrical transmission lines
	- Transformers, three-phase current, energy converters
	- Simple non-linear and active electrical devices
Literature	- M. Albach, "Elektrotechnik", Pearson Studium (2011)
	- T. Harriehausen, D. Schwarzenau, "Moeller Grundlagen der Elektrotechnik", Springer (2013)
	- R. Kories, H. Schmidt-Walter, "Taschenbuch der Elektrotechnik", Harri Deutsch (2010)
	- C. Kautz, "Tutorien zur Elektrotechnik", Pearson (2009)
	- A. Hambley, "Electrical Engineering: Principles and Applications", Pearson (2013)
	- R. Dorf, "The Electrical Engineering Handbook", CRC (2006)

Course L0179: Electrical Eng	ineering II: Alternating Current Networks and Basic Devices			
Тур	Recitation Section (small)			
Hrs/wk	2			
CP	1			
Workload in Hours	Independent Study Time 2, Study Time in Lecture 28			
Lecturer	Prof. Christian Becker			
Language	DE			
Cycle	Se			
Content	- General time-dependency of electrical networks			
	- Representation and properties of harmonic signals			
	- RLC-elements at alternating currents/voltages			
	- Complex notation for the representation of RLC-elements			
	- Power in electrical networks at alternating currents, compensation of reactive power			
	- Frequency response locus (Nyquist plot) and Bode-diagrams			
	- Measurement instrumentation for assessing alternating currents			
	- Oscillating circuits, filters, electrical transmission lines			
	- Transformers, three-phase current, energy converters			
	- Simple non-linear and active electrical devices			
Literature	- M. Albach, "Elektrotechnik", Pearson Studium (2011)			
	- T. Harriehausen, D. Schwarzenau, "Moeller Grundlagen der Elektrotechnik", Springer (2013)			
	- R. Kories, H. Schmidt-Walter, "Taschenbuch der Elektrotechnik", Harri Deutsch (2010)			
	- C. Kautz, "Tutorien zur Elektrotechnik", Pearson (2009)			
	- A. Hambley, "Electrical Engineering: Principles and Applications", Pearson (2013)			
	- R. Dorf, "The Electrical Engineering Handbook", CRC (2006)			

Typ Lecture Recitation Section (large) rring g learning results elements, arios and practical examples elements, tents and tasks (problem solv tasketches,		CP 3 3
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arios and practical examples elements, nents and tasks (problem solv		ne elements, indicato
nents and tasks (problem solv	lving skills),	
ecture supported by activatin	ng methods.	
knowledge in exercises. o recapitulate poorly unders	stood content e.c	g. by using the vide
e Qualification: Compulsory		
ју Technology: Elective Com	npulsory	
rg		ore Qualification: Compulsory rgy Technology: Elective Compulsory ctive Compulsory

_				
	ecture			
	2			
CP	3			
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28			
Lecturer	Prof. Dieter Krause, Prof. Josef Schlattmann, Prof. Otto von Estorff, Prof. Sören Ehlers			
Language	DE			
Cycle	SoSe			
Content	Lecture			
	Introduction to design			
	Introduction to the following machine elements			
	Screws			
	Shaft-hub joints			
	Rolling contact bearings			
	Welding / adhesive / solder joints			
	• Springs			
	• Axes & shafts			
	Presentation of technical objects (technical drawing)			
	Exercise			
	Calculation methods for dimensioning the following machine elements:			
	Screws			
	Shaft-hub joints			
	Rolling contact bearings			
	Welding / adhesive / solder joints			
	• Springs			
	• Axis & shafts			
Literature	Dubbel, Taschenbuch für den Maschinenbau; Grote, KH., Feldhusen, J.(Hrsg.); Springer-Verlag, aktuelle Auflage.			
	 Maschinenelemente, Band I-III; Niemann, G., Springer-Verlag, aktuelle Auflage. 			
	 Maschinen- und Konstruktionselemente; Steinhilper, W., Röper, R., Springer Verlag, aktuelle Auflage. 			
	Konstruktionslehre, Pahl, G.; Beitz, W., Springer-Verlag, aktuelle Auflage.			
	Maschinenelemente 1-2; Schlecht, B., Pearson Verlag, aktuelle Auflage.			
	 Maschinenelemente - Gestaltung, Berechnung, Anwendung; Haberhauer, H., Bodenstein, F., Springer-Verlag, aktuelle Auflage. 			
	 Roloff/Matek Maschinenelemente; Wittel, H., Muhs, D., Jannasch, D., Voßiek, J., Springer Vieweg, aktuelle Auflage. Sowie weitere Bücher zu speziellen Themen 			

Course L0259: Fundamentals of Mechanical Engineering Design		
Тур	Recitation Section (large)	
Hrs/wk	2	
СР	3	
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28	
Lecturer	Prof. Dieter Krause, Prof. Josef Schlattmann, Prof. Otto von Estorff, Prof. Sören Ehlers	
Language	DE	
Cycle	SoSe	
Content	See interlocking course	
Literature	See interlocking course	

Courses				
Title		Тур	Hrs/wk	СР
Mechanics II (L0493)		Lecture	2	2
Mechanics II (L0494)		Recitation Section (small)	2	2
Mechanics II (L1691)		Recitation Section (large)	2	2
Module Responsible	Prof. Christian Cyron			
Admission Requirements	None			
Recommended Previous	Mechanics I			
Knowledge				
Educational Objectives	After taking part successfully, students have	e reached the following learning results		
Professional Competence				
Knowledge	Having accomplished this module, the s	tudents know and understand the basic co	oncepts of continu	ium mechanics ai
	elastostatics, in particular stress, strain, o	onstitutive laws, stretching, bending, torsion	failure analysis, e	energy methods ar
	stability of structures. Skills Having accomplished this module, the students are able to - apply the fundamental concepts of mathematical and mechanical modeling and analysis to problems of their choice - apply the basic methods of elastostatics to problems of engineering, in particular in the design of mechanical structure			
Skills				
	- to educate themselves about more advance	ed aspects of elastostatics		
Personal Competence				
Social Competence	-			
Autonomy	-			
,	Independent Study Time 96, Study Time in	lecture 84		
Credit points				
Course achievement	None			
Examination	Written exam			
Examination duration and	90 min			
scale				
Assignment for the	General Engineering Science (German prog	am, 7 semester): Core Qualification: Compulso	ry	
Following Curricula	Civil- and Environmental Engineering: Core	Qualification: Compulsory		
	Bioprocess Engineering: Core Qualification:	Compulsory		
	Data Science: Specialisation Mechanics: Cor	npulsory		
	Digital Mechanical Engineering: Core Qualifi	cation: Compulsory		
	Electrical Engineering: Core Qualification: El	ective Compulsory		
	Green Technologies: Energy, Water, Climate	: Core Qualification: Compulsory		
	Logistics and Mobility: Core Qualification: Co	mpulsory		
	Mechanical Engineering: Core Qualification:	Compulsory		
	Mechatronics: Core Qualification: Compulso	У		
	Orientation Studies: Core Qualification: Elec	tive Compulsory		
	Naval Architecture: Core Qualification: Com	pulsory		
	Technomathematics: Specialisation III. Engin	neering Science: Elective Compulsory		
	Process Engineering: Core Qualification: Cor			

Course L0493: Mechanics II	
Тур	Lecture
Hrs/wk	2
СР	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Prof. Christian Cyron
Language	DE
Cycle	SoSe
Content	stresses and strains
	Hooke's law
	tension and compression
	torsion
	bending
	stability
	buckling
	energy methods
Literature	 Gross, D., Hauger, W., Schröder, J., Wall, W.A.: Technische Mechanik 1, Springer Gross, D., Hauger, W., Schröder, J., Wall, W.A.: Technische Mechanik 2 Elastostatik, Springer

Course L0494: Mechanics II	
Тур	Recitation Section (small)
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Prof. Christian Cyron
Language	DE
Cycle	SoSe
Content	See interlocking course
Literature	See interlocking course

Course L1691: Mechanics II	
Тур	Recitation Section (large)
Hrs/wk	2
СР	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Prof. Christian Cyron, Dr. Konrad Schneider
Language	DE
Cycle	SoSe
Content	See interlocking course
Literature	See interlocking course

Module M0671: Techr	ical Thermodynamics I			
Courses				
Title		Тур	Hrs/wk	СР
Technical Thermodynamics I (L043	7)	Lecture	2	4
Technical Thermodynamics I (L043	9)	Recitation Section (large)	1	1
Technical Thermodynamics I (L044	1)	Recitation Section (small)	1	1
Module Responsible	Prof. Arne Speerforck			
Admission Requirements	None			
Recommended Previous	Elementary knowledge in Mathematics and Mec	hanics		
Knowledge				
Educational Objectives	After taking part successfully, students have rea	ched the following learning results		
Professional Competence				
Knowledge	Students are familiar with the laws of Thermoo	lynamics. They know the relation of the kin	ds of energy acc	ording to 1 st law
	distinguish between state variables and process variables and know the meaning of different state variables like te enthalpy, entropy and also the meaning of exergy and anergy. They are able to draw the Carnot cycle in a Therm related diagram. They know the physical difference between an ideal and a real gas and are able to use the related e state. They know the meaning of a fundamental state of equation and know the basics of two phase Thermodynamics.			
Skills	Students are able to calculate the internal ener simple change of states and to use this calculati for a real gas from measured thermal state varia	ons for the Carnot cycle. They are able to ca		
Personal Competence				
Social Competence	The students are able to discuss in small groups	and develop an approach.		
Autonomy	Students are able to define independently tasks knowledge in practice.	, to get new knowledge from existing knowle	dge as well as to	find ways to use t
Workload in Hours	Independent Study Time 124, Study Time in Lec	ture 56		
Credit points	6			
Course achievement	None			
Examination	Written exam			
Examination duration and	90 min			
scale				
Assignment for the	General Engineering Science (German program,	7 semester): Core Qualification: Compulsory		
Following Curricula	Bioprocess Engineering: Core Qualification: Com			
	Digital Mechanical Engineering: Core Qualification	on: Compulsory		
	Green Technologies: Energy, Water, Climate: Co	re Qualification: Compulsory		
	Logistics and Mobility: Specialisation Traffic Plan	ning and Systems: Elective Compulsory		
	Mechanical Engineering: Core Qualification: Com	npulsory		
	Mechatronics: Core Qualification: Compulsory			
	Orientation Studies: Core Qualification: Elective	Compulsory		
	Naval Architecture: Core Qualification: Compulse	ory		
	Technomathematics: Specialisation III. Engineer	ing Science: Elective Compulsory		
	Process Engineering: Core Qualification: Comput	sory		
	Engineering and Management - Major in Logistic	s and Mobility: Specialisation Traffic Planning	and Systems: Fl	octivo Compulsory

Course L0437: Technical The	ourse L0437: Technical Thermodynamics I				
Тур	Lecture				
Hrs/wk					
СР					
Workload in Hours	ndependent Study Time 92, Study Time in Lecture 28				
Lecturer	Prof. Arne Speerforck				
Language	DE				
Cycle					
Content	1. Introduction				
	2. Fundamental terms				
	3. Thermal Equilibrium and temperature				
	3.1 Thermal equation of state				
	4. First law				
	4.1 Heat and work				
	4.2 First law for closed systems				
	4.3 First law for open systems				
	4.4 Examples				
	5. Equations of state and changes of state				
	5.1 Changes of state				
	5.2 Cycle processes				
	6. Second law				
	6.1 Carnot process				
	6.2 Entropy				
	6.3 Examples				
	6.4 Exergy				
	7. Thermodynamic properties of pure fluids				
	7.1 Fundamental equations of Thermodynamics				
	7.2 Thermodynamic potentials				
	7.3 Calorific state variables for arbritary fluids				
	7.4 state equations (van der Waals u.a.)				
Literature	Schmitz, G.: Technische Thermodynamik, TuTech Verlag, Hamburg, 2009				
	- Pachr H.D.; Kabalac S.; Thermodynamik 15 Auflage Springer Verlag Parlin 2012				
	Baehr, H.D.; Kabelac, S.: Thermodynamik, 15. Auflage, Springer Verlag, Berlin 2012				
	Potter, M.; Somerton, C.: Thermodynamics for Engineers, Mc GrawHill, 1993				

Course L0439: Technical The	ourse L0439: Technical Thermodynamics I		
Тур	Recitation Section (large)		
Hrs/wk	1		
CP	1		
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14		
Lecturer	Prof. Arne Speerforck		
Language	DE		
Cycle	SoSe		
Content	See interlocking course		
Literature	See interlocking course		

Course L0441: Technical The	ourse L0441: Technical Thermodynamics I		
Тур	Recitation Section (small)		
Hrs/wk	1		
CP	1		
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14		
Lecturer	Prof. Arne Speerforck		
Language	DE		
Cycle	SoSe		
Content	See interlocking course		
Literature	See interlocking course		

Module M0851: Mathe	ematics II			
Courses				
Title		Typ	Hrs/wk	СР
		Тур		
Analysis II (L1025)		Lecture	2	2
Analysis II (L1026)		Recitation Section (large)	1	1
Analysis II (L1027)		Recitation Section (small)	1	1
Linear Algebra II (L0915)		Lecture	2	2
Linear Algebra II (L0916)		Recitation Section (small)	1	1
Linear Algebra II (L0917)		Recitation Section (large)	1	1
Module Responsible	Prof. Anusch Taraz			
	None			
	Mathematics I			
Knowledge				
	After taking part successfully, students ha	ave reached the following learning results		
Professional Competence				
Knowledge	· Chudente con nonce further conce	ante in analysis and linear sleakers. They are shi	a ta avalain tha	
		epts in analysis and linear algebra. They are abl	e to explain the	em using appropria
	examples.			
	 Students can discuss logical conner 	ections between these concepts. They are capable	of illustrating th	ese connections w
	the help of examples.			
	 They know proof strategies and car 	n reproduce them.		
Skills				
54113	 Students can model problems in an 	nalysis and linear algebra with the help of the conc	epts studied in tl	his course. Moreov
	they are capable of solving them b	v applying established methods.		
		verify further logical connections between the conce	onte studiod in the	
		s can develop and execute a suitable approach, a	ind are able to c	fillcally evaluate i
	results.			
Personal Competence				
Social Competence				
Social Competence	 Students are able to work together 	in teams. They are capable to use mathematics as	a common langu	age.
	 In doing so, they can communicate 	e new concepts according to the needs of their coo	perating partners	. Moreover, they c
		pen the understanding of their peers.	51.	, . , . , .
	design examples to check and dee	per the understanding of their peers.		
Autonomy	· Students are capable of checking	their understanding of complex concents on their (we They can ce	ocify open questio
		their understanding of complex concepts on their of	own. They can sp	ecity open questic
	precisely and know where to get he	elp in solving them.		
	 Students have developed sufficient 	t persistence to be able to work for longer period	ls in a goal-orien	ted manner on ha
	problems.			
Workload in Hours	Independent Study Time 128, Study Time	in Lecture 112		
Credit points	8			
Course achievement	None			
Examination	Written exam			
Examination duration and	60 min (Analysis II) + 60 min (Linear Alge	bra II)		
scale				
Assignment for the	General Engineering Science (German pro	ogram, 7 semester): Core Qualification: Compulsory		
Following Curricula	Civil- and Environmental Engineering: Cor	e Qualification: Compulsory		
3 • • • • • • • •	Bioprocess Engineering: Core Qualification			
	, , , , , , , , , , , , , , , , , , , ,			
	Digital Mechanical Engineering: Core Qua			
	Electrical Engineering: Core Qualification:			
	Green Technologies: Energy, Water, Clima	ate: Core Qualification: Compulsory		
	Computational Science and Engineering:	Core Qualification: Compulsory		
	Logistics and Mobility: Core Qualification:	Compulsory		
	Mechanical Engineering: Core Qualificatio	n: Compulsory		
	Mechatronics: Core Qualification: Compute			
	Orientation Studies: Core Qualification: El			
	Naval Architecture: Core Qualification: Co	mpulsony		
	Process Engineering: Core Qualification: Co			

Course L1025: Analysis II	
Тур	Lecture
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Dozenten des Fachbereiches Mathematik der UHH
Language	DE
Cycle	SoSe
Content	 power series and elementary functions interpolation integration (proper integrals, fundamental theorem, integration rules, improper integrals, parameter dependent integrals applications of integration (volume and surface of bodies of revolution, lines and arc length, line integrals numerical quadrature periodic functions
Literature	 http://www.math.uni-hamburg.de/teaching/export/tuhh/index.html

Course L1026: Analysis II	rse L1026: Analysis II		
Тур	Recitation Section (large)		
Hrs/wk	1		
CP	1		
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14		
Lecturer	Dozenten des Fachbereiches Mathematik der UHH, Dr. Sebastian Götschel		
Language	DE		
Cycle	SoSe		
Content	See interlocking course		
Literature	See interlocking course		

Course L1027: Analysis II	urse L1027: Analysis II		
Тур	Recitation Section (small)		
Hrs/wk	1		
CP	1		
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14		
Lecturer	Dozenten des Fachbereiches Mathematik der UHH		
Language	DE		
Cycle	SoSe		
Content	See interlocking course		
Literature	See interlocking course		

se L0915: Linear Algebr	all
Тур	Lecture
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Prof. Anusch Taraz, Dr. Dennis Clemens, Prof. Marko Lindner
Language	DE
Cycle	SoSe
Content	 general vector spaces: subspaces, Euclidean vector spaces linear mappings: basis transformation, orthogonal projection, orthogonal matrices, householder matrices linear regression: normal equations, linear discrete approximation eigenvalues: diagonalising matrices, normal matrices, symmetric and Hermite matrices system of linear differential equations matrix factorizations: LR-decomposition, QR-decomposition, Schur decomposition, Jordan normal form, singular value decomposition
Literature	 T. Arens u.a. : Mathematik, Spektrum Akademischer Verlag, Heidelberg 2009 W. Mackens, H. Voß: Mathematik I für Studierende der Ingenieurwissenschaften, HECO-Verlag, Alsdorf 1994 W. Mackens, H. Voß: Aufgaben und Lösungen zur Mathematik I für Studierende der Ingenieurwissenschaften, HECO-Verlag, Alsdorf 1994 G. Strang: Lineare Algebra, Springer-Verlag, 2003 G. und S. Teschl: Mathematik für Informatiker, Band 1, Springer-Verlag, 2013

Course L0916: Linear Algebra	a II		
Тур	ecitation Section (small)		
Hrs/wk	1		
CP	1		
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14		
Lecturer	Prof. Anusch Taraz, Dr. Dennis Clemens, Prof. Marko Lindner		
Language	DE		
Cycle	SoSe		
Content	 linear mappings: basis transformation, orthogonal projection, orthogonal matrices, householder matrices linear regression: QR-decomposition, normal equations, linear discrete approximation eigenvalues: diagonalising matrices, normal matrices, symmetric and Hermite matrices, Jordan normal form, singular value decomposition system of linear differential equations 		
Literature	 W. Mackens, H. Voß: Mathematik I für Studierende der Ingenieurwissenschaften, HECO-Verlag, Alsdorf 1994 W. Mackens, H. Voß: Aufgaben und Lösungen zur Mathematik I für Studierende der Ingenieurwissenschaften, HECO-Verlag, Alsdorf 1994 		

Course L0917: Linear Algebra	ırse L0917: Linear Algebra II		
Тур	Recitation Section (large)		
Hrs/wk	1		
CP	1		
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14		
Lecturer	Prof. Anusch Taraz, Dr. Christian Seifert, Dr. Dennis Clemens, Prof. Marko Lindner		
Language	DE		
Cycle	SoSe		
Content	See interlocking course		
Literature	See interlocking course		

Module M0688: Techr	ical Thermodynamics II			
Courses				
Title		Тур	Hrs/wk	СР
Technical Thermodynamics II (L044		Lecture	2	4
Technical Thermodynamics II (L045		Recitation Section (large)	1	1
Technical Thermodynamics II (L045		Recitation Section (small)	1	1
Module Responsible	•			
Admission Requirements	None			
Recommended Previous Knowledge	Elementary knowledge in Mathematics, Mechanics and Technical Thermodynamics I			
Educational Objectives	After taking part successfully, students have reach	hed the following learning results		
Professional Competence	Arter taking part successivily, stadents have reach	the following learning results		
	Students are familiar with different cycle processe derive energetic and exergetic efficiencies and clockwise and clockwise cycles (heat-power cycle, draw the different cycles in Thermodynamics re processes and are able to perform simple combus know the definition of the speed of sound and kno Students are able to use thermodynamic laws for exergy- and entropy balances and by this to optin	know the influence different factors. The , cooling cycle). They have increased know elated diagrams. They know the laws of g stion calculations. They are provided with w about a Laval nozzle.	y know the diffe ledge of steam c jas mixtures, esp basic knowledge Ily they are able	erence between a ycles and are able becially of humid in gas dynamics a to formulate ener
Personal Competence Social Competence	regard to an outflowing gas from a tank. They procedure. The students are able to discuss in small groups		-	
	content that are provided in the lecture with the C Students can physically understand and explain	lickerOnline tool "TurningPoint" after discu	ssions with other	students.
	processes) set in tasks. They are able to select t apply them independently to different types of tas	the methods taught in the lecture and exe		
Workload in Hours	Independent Study Time 124, Study Time in Lectu	ire 56		
Credit points				
Course achievement				
Examination				
Examination duration and scale	90 min			
Assignment for the	General Engineering Science (German program, 7	semester): Core Qualification: Compulson		
Following Curricula	Bioprocess Engineering: Core Qualification: Comp			
ronowing curricula	Chemical and Bioprocess Engineering: Core Qualif	,		
	Energy Systems: Technical Complementary Course			
	Engineering Science: Specialisation Mechanical En	igineering: Elective Compulsory		
	General Engineering Science (English program, 7	semester): Specialisation Mechanical Engin	eering: Elective C	ompulsory
	Green Technologies: Energy, Water, Climate: Core	Qualification: Compulsory		
	Integrated Building Technology: Core Qualification			
	Mechanical Engineering: Core Qualification: Comp	ulsory		
	Mechatronics: Core Qualification: Compulsory			
	Technomathematics: Specialisation III. Engineering			
	Process Engineering: Core Qualification: Compulse	огу		

Course L0449: Technical Thermodynamics II		
Тур	Lecture	
Hrs/wk	2	
СР	4	
Workload in Hours	Independent Study Time 92, Study Time in Lecture 28	
Lecturer	Prof. Arne Speerforck	
Language	DE	
Cycle	WiSe	
Content	8. Cycle processes	
	7. Gas - vapor - mixtures	
	10. Open sytems with constant flow rates	
	11. Combustion processes	
	12. Special fields of Thermodynamics	
Literature	Schmitz, G.: Technische Thermodynamik, TuTech Verlag, Hamburg, 2009	
	Baehr, H.D.; Kabelac, S.: Thermodynamik, 15. Auflage, Springer Verlag, Berlin 2012	
	Potter, M.; Somerton, C.: Thermodynamics for Engineers, Mc GrawHill, 1993	

Course L0450: Technical The	urse L0450: Technical Thermodynamics II	
Тур	Recitation Section (large)	
Hrs/wk	1	
CP	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	

Course L0451: Technical Thermodynamics II	
Тур	Recitation Section (small)
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

Courses				
Title		Тур	Hrs/wk	СР
Engineering Mechanics III (Dynami	cs) (L1134)	Lecture	3	3
Engineering Mechanics III (Dynami	cs) (L1136)	Recitation Section (I	arge) 1	1
Engineering Mechanics III (Dynami	cs) (L1135)	Recitation Section (s	mall) 2	2
Module Responsible	Prof. Robert Seifried			
Admission Requirements	None			
Recommended Previous Knowledge		5 I (Statics). Parallel to Engineering Mecha	nik III the module Math	ematics III should
Educational Objectives	After taking part successfully, students ha	ave reached the following learning results		
Professional Competence				
Knowledge	The students can			
	describe the axiomatic procedure			
	explain important steps in model d	-		
	 present technical knowledge in kin 	ematics, kinetics and vibrations.		
Skills	The students can			
	their own problems;	mathematical / mechanical analysis and r		bly it to the context
		s of kinematic, kinetic and vibraton metho		be applicable to wi
Personal Competence				
Social Competence	The students can work in groups and sup	port each other to overcome difficulties.		
Autonomy	Students are capable of determining thei	r own strengths and weaknesses and to org	anize their time and lear	ning based on those
Workload in Hours	Independent Study Time 96, Study Time	in Lecture 84		
Credit points	6			
Course achievement	None			
Examination	Written exam			
Examination duration and	120 min			
scale				
Assignment for the	General Engineering Science (German pro	ogram, 7 semester): Core Qualification: Cor	npulsory	
Following Curricula	Data Science: Core Qualification: Elective	Compulsory		
5		ate: Specialisation Energy Technology: Elec	tive Compulsory	
	Integrated Building Technology: Core Qua			
	Mechanical Engineering: Core Qualification			
	Mechatronics: Core Qualification: Comput			
	Naval Architecture: Core Qualification: Co	•		
	Technomathematics: Specialisation III. Er			

Тур	Lecture
Hrs/wk	
CP	
	Independent Study Time 48, Study Time in Lecture 42
	Prof. Robert Seifried
Language	
Cycle	
-	Kinematics
	1.1 Motion of a particle
	1.2 Planar motion of a rigid body
	1.3 Spatial motion of a rigid body
	1.4 Spatial relative Kinematics
	2 Kinetics
	2.1 Linear momentum and change of linear momentum
	2.2 Angular momentum and change of angular momentum
	2.3 Kinetics of rigid bodies
	2.4 Energy and balance of energy
	3 Vibrations
	3.1 Classification of Vibrations
	3.2 Free undamped vibration
	3.3 Free damped vibration
	3.4 Forced vibration
	4 Kinetics of gyroscopes
	4.1 Free gyroscopic motion
	4.2 Forced gyroscopic motion
Literature	K. Magnus, H.H. Müller-Slany: Grundlagen der Technischen Mechanik. 7. Auflage, Teubner (2009).
Literature	D. Gross, W. Hauger, J. Schröder, W. Wall: Technische Mechanik 3 und 4. 11. Auflage, Springer (2011).

Course L1136: Engineering N	ourse L1136: Engineering Mechanics III (Dynamics)	
Тур	Recitation Section (large)	
Hrs/wk	1	
CP	1	
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14	
Lecturer	Prof. Robert Seifried	
Language	DE	
Cycle	WiSe	
Content	See interlocking course	
Literature	See interlocking course	

Course L1135: Engineering N	Course L1135: Engineering Mechanics III (Dynamics)	
Тур	Recitation Section (small)	
Hrs/wk	2	
СР	2	
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28	
Lecturer	Prof. Robert Seifried	
Language	DE	
Cycle	WiSe	
Content	See interlocking course	
Literature	See interlocking course	

Module M0853: Mathematics III				
Courses				
Title Analysis III (L1028) Analysis III (L1029) Analysis III (L1030) Differential Equations 1 (Ordinary I Differential Equations 1 (Ordinary I		Typ Lecture Recitation Section (small) Recitation Section (large) Lecture Recitation Section (small)	Hrs/wk 2 1 1 2 1	CP 2 1 1 2 1
Differential Equations 1 (Ordinary E		Recitation Section (large)	1	1
	Prof. Anusch Taraz			
Admission Requirements Recommended Previous	None Mathematics I + II			
Knowledge				
Educational Objectives	After taking part successfully, students have reached the	e following learning results		
Professional Competence Knowledge				
Skills	 Students can name the basic concepts in the area appropriate examples. Students can discuss logical connections between the help of examples. They know proof strategies and can reproduce the strategies an	n these concepts. They are capable em.	of illustrating th	ese connections wit
	 Students can model problems in the area of analycourse. Moreover, they are capable of solving the Students are able to discover and verify further low For a given problem, the students can develop results. 	m by applying established methods. gical connections between the conce	pts studied in the	e course.
Personal Competence Social Competence	 Students are able to work together in teams. The In doing so, they can communicate new concepts design examples to check and deepen the unders 	according to the needs of their coop		
Autonomy	 Students are capable of checking their understar precisely and know where to get help in solving the Students have developed sufficient persistence problems. 	hem.		
Workload in Hours	Independent Study Time 128, Study Time in Lecture 112	2		
Credit points				
Course achievement				
Examination Examination duration and	Written exam 60 min (Analysis III) + 60 min (Differential Equations 1)			
scale Assignment for the Following Curricula	General Engineering Science (German program, 7 seme Civil- and Environmental Engineering: Core Qualification			
	Bioprocess Engineering: Core Qualification: Compulsory Chemical and Bioprocess Engineering: Core Qualification Digital Mechanical Engineering: Core Qualification: Comp Electrical Engineering: Core Qualification: Compulsory Green Technologies: Energy, Water, Climate: Core Quali Computer Science in Engineering: Core Qualification: Con Logistics and Mobility: Specialisation Traffic Planning and Logistics and Mobility: Specialisation Production Manage Logistics and Mobility: Specialisation Information Techno Mechanical Engineering: Core Qualification: Compulsory Mechatronics: Core Qualification: Compulsory Naval Architecture: Core Qualification: Compulsory Process Engineering: Core Qualification: Compulsory Engineering and Management - Major in Logistics and Me Engineering and Management - Major in Logistics and Me Engineering and Management - Major in Logistics and Me	n: Compulsory pulsory fication: Compulsory mpulsory pulsory d Systems: Elective Compulsory ement and Processes: Elective Compul ology: Compulsory obility: Specialisation Traffic Planning Mobility: Specialisation Production M	and Systems: El Janagement and	Processes: Elective

Course L1028: Analysis III	
Тур	Lecture
Hrs/wk	2
СР	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Dozenten des Fachbereiches Mathematik der UHH
Language	DE
Cycle	WiSe
Content	Main features of differential and integrational calculus of several variables
Literature	 Differential calculus for several variables Mean value theorems and Taylor's theorem Maximum and minimum values Implicit functions Minimization under equality constraints Newton's method for multiple variables Double integrals over general regions Line and surface integrals Theorems of Gauß and Stokes
Literature	 http://www.math.uni-hamburg.de/teaching/export/tuhh/index.html

Course L1029: Analysis III	ourse L1029: Analysis III	
Тур	Recitation Section (small)	
Hrs/wk	1	
СР	1	
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14	
Lecturer	Dozenten des Fachbereiches Mathematik der UHH	
Language	DE	
Cycle	WiSe	
Content	See interlocking course	
Literature	See interlocking course	

Course L1030: Analysis III	Course L1030: Analysis III	
Тур	Recitation Section (large)	
Hrs/wk	1	
СР	1	
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14	
Lecturer	Dozenten des Fachbereiches Mathematik der UHH	
Language	DE	
Cycle	WiSe	
Content	See interlocking course	
Literature	See interlocking course	

Course L1031: Differential Equations 1 (Ordinary Differential Equations)	
Тур	Lecture
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Dozenten des Fachbereiches Mathematik der UHH
Language	DE
Cycle	WiSe
Content	Main features of the theory and numerical treatment of ordinary differential equations
Literature	 Introduction and elementary methods Exsitence and uniqueness of initial value problems Linear differential equations Stability and qualitative behaviour of the solution Boundary value problems and basic concepts of calculus of variations Eigenvalue problems Numerical methods for the integration of initial and boundary value problems Classification of partial differential equations
Literature	 http://www.math.uni-hamburg.de/teaching/export/tuhh/index.html

purse L1032: Differential Equations 1 (Ordinary Differential Equations)	
	Recitation Section (small)
Hrs/wk	
CP	1
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14
Lecturer	Dozenten des Fachbereiches Mathematik der UHH
Language	DE
Cycle	WiSe
Content	See interlocking course
Literature	See interlocking course
Course L1033: Differential E	quations 1 (Ordinary Differential Equations)
Тур	Recitation Section (large)
Hrs/wk	1
CP	1
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14
Lecturer	Dozenten des Fachbereiches Mathematik der UHH
Language	DE
Cycle	WiSe

Content

Literature

See interlocking course

See interlocking course

Modulo M0672: Signa	le and Sustaine			
Module M0672: Signa	is and Systems			
Courses				
Title		Тур	Hrs/wk	СР
Signals and Systems (L0432)		Lecture	3	4
Signals and Systems (L0433)		Recitation Section (small)	2	2
Module Responsible	Prof. Gerhard Bauch			
Admission Requirements	None			
Recommended Previous	Mathematics 1-3			
Knowledge	The modul is an introduction to the theory of signals a	nd systems. Cood knowledge in metho	an neuronal but the	, madula Mathamat
	1-3 is expected. Further experience with spectral tra	, ,	3	
	but not required.	isionnations (Fourier series, Fourier ti		transformy is usefu
Educational Objectives	After taking part successfully, students have reached	the following learning results		
Professional Competence				
Knowledge	The students are able to classify and describe signals	and linear time-invariant (LTI) systems	s using methods o	of signal and systen
	theory. They are able to apply the fundamental trans	formations of continuous-time and dis	crete-time signals	and systems. The
	can describe and analyse deterministic signals and s	ystems mathematically in both time a	and image domain	n. In particular, the
	understand the effects in time domain and image d	omain which are caused by the trans	ition of a continu	ous-time signal to
	discrete-time signal.			
	The students are familiar with the contents of lecture	and tutorials. They can explain and app	oly them to new p	roblems.
Skills	Skills The students are able to describe and analyse deterministic signals and linear time-invariant systems using metho			ethods of signal an
	system theory. They can analyse and design basic systems regarding important properties such as magnitude			
	response, stability, linearity etc They can assess the			
Personal Competence				
Social Competence	The students can jointly solve specific problems.			
Autonomy	The students are able to acquire relevant informa	tion from appropriate literature sour	ces. They can c	ontrol their level o
	knowledge during the lecture period by solving tutoria	l problems, software tools, clicker syste	em.	
Workload in Hours	Independent Study Time 110, Study Time in Lecture 7	0		
Credit points	6			
Course achievement	None			
Examination	Written exam			
Examination duration and	90 min			
scale				
Assignment for the	General Engineering Science (German program, 7 sem	ester): Core Qualification: Compulsory		
Following Curricula	Computer Science: Core Qualification: Compulsory			
	Computer Science: Specialisation II. Mathematics and	Engineering Science: Elective Compuls	ory	
	Data Science: Core Qualification: Compulsory			
	Electrical Engineering: Core Qualification: Compulsory			
	Computer Science in Engineering: Core Qualification:	Compulsory		
	Integrated Building Technology: Core Qualification: Co	mpulsory		
	Mechatronics: Core Qualification: Compulsory			
	Technomathematics: Specialisation III. Engineering Sc	ence: Elective Compulsory		

ourse L0432: Signals and S	ystems		
Тур	Lecture		
Hrs/wk			
СР			
Workload in Hours	ndependent Study Time 78, Study Time in Lecture 42		
Lecturer	rof. Gerhard Bauch, Dr. Rainer Grünheid		
Language)E/EN		
Cycle	SoSe		
Content			
	Introduction to signal and system theory		
	• Signals		
	Classification of signals		
	 Continuous-time and discrete-time signals 		
	 Analog and digital signals 		
	 Deterministic and random signals 		
	 Description of LTI systems by differential equations or difference equations, respectively 		
	 Basic properties of signals and operations on signals 		
	Elementary signals		
	 Distributions (Generalized Functions) 		
	 Power and energy of signals 		
	 Correlation functions of deterministic signals 		
	Autocorrelation function		
	 Crosscorrelation function 		
	 Orthogonal signals 		
	 Applications of correlation 		
	Linear time-invariant (LTI) systems		

- Linearity
- Time-invariance
- Description of LTI systems by impulse response and frequency response
- Convolution
- Convolution and correlation
- Properties of LTI-systems
- Causal systems
- Stable systems
- Memoryless systems
- Fourier Series and Fourier Transform
 - Fourier transform of continuous-time signals, discrete-time signals, periodic signals, non-periodic signals
 - Properties of the Fourier transform
 - Fourier transform of some basic signals
 - Parseval's theorem
- Analysis of LTI-systems and signals in the frequency domain
 - Frequency response, magnitude response and phase response
 - Transmission factor, attenuation, gain
 - Frequency-flat and frequency-selective LTI-systems
 - Bandwidth definitions
 - Basic types of systems (filters), lowpass, highpass, bandpass, bandstop systems
 - Phase delay and group delay
 - Linear-phase systems
 - Distortion-free systems
 - Spectrum analysis with limited observation window: Leakage effect
- Laplace Transform
 - Relation of Fourier transform and Laplace transform
 - Properties of the Laplace transform
 - Laplace transform of some basic signals
- Analysis of LTI-systems in the s-domain
 - Transfer function of LTI-systems
 - Relation of Laplace transform, magnitude response and phase response
 - Analysis of LTI-systems using pole-zero plots
 - Allpass filters
 - Minimum-phase, maximum-phase and mixed phase filters
 - Stable systems
- Sampling
 - Sampling theorem
 - Reconstruction of continuous-time signals in frequency domain and time domain
 - Oversampling
 - Aliasing
 - Sampling with pulses of finite duration, sample and hold
 - Decimation and interpolation
- Discrete-Time Fourier Transform (DTFT)
 - Relation of Fourier transform and DTFT
 - Properties of the DTFT
- Discrete Fourier Transform (DFT)
 - Relation of DTFT and DFT
 - Cyclic properties of the DFT
 - DFT matrix
 - Zero padding
 - Cyclic convolution
 - Fast Fourier Transform (FFT)
 - Application of the DFT: Orthogonal Frequency Division Multiplex (OFDM)
- Z-Transform
 - Relation of Laplace transform, DTFT, and z-transform
 - Properties of the z-transform
 - Z-transform of some basic discrete-time signals
- Discrete-time systems, digital filters
 - FIR and IIR filters
 - Z-transform of digital filters
 - Analysis of discrete-time systems using pole-zero plots in the z-domain
 - Stability
 - Allpass filters
 - Minimum-phase, maximum-phase and mixed-phase filters
 - Minimum-phase, maximum-phase and mixed-pi
 Linear phase filters
 - Enlear phase me
- Literature T. Frey , M. Bossert , Signal- und Systemtheorie, B.G. Teubner Verlag 2004
 - K. Kammeyer, K. Kroschel, Digitale Signalverarbeitung, Teubner Verlag.
 - B. Girod ,R. Rabensteiner , A. Stenger , Einführung in die Systemtheorie, B.G. Teubner, Stuttgart, 1997
 - J.R. Ohm, H.D. Lüke , Signalübertragung, Springer-Verlag 8. Auflage, 2002
 - S. Haykin, B. van Veen: Signals and systems. Wiley.
 - Oppenheim, A.S. Willsky: Signals and Systems. Pearson.

• Oppenheim, R. W. Schafer: Discrete-time signal processing. Pearson.

Course L0433: Signals and Systems		
Тур	Recitation Section (small)	
Hrs/wk	2	
CP	2	
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28	
Lecturer	Prof. Gerhard Bauch	
Language	DE/EN	
Cycle	SoSe	
Content	See interlocking course	
Literature	See interlocking course	

Courses				
Title		Тур	Hrs/wk	СР
ntroduction to Control Systems (L0	654)	Lecture	2	4
ntroduction to Control Systems (L0	655)	Recitation Section (small)	2	2
Module Responsible	NN			
Admission Requirements	None			
Recommended Previous	Representation of signals and systems in time a	nd frequency domain, Laplace transform		
Knowledge				
Educational Objectives	After taking part successfully, students have rea	ched the following learning results		
Professional Competence				
Knowledge	 Students can represent dynamic system 	ehavior in time and frequency domain, and	can in narticular	explain propertie
	first and second order systems	chavior in time and nequency domain, and t	cuir în particului	explain propertie
		control loops and interpret dynamic propertie	s in terms of free	auency response
	root locus			queries response
	 They can explain the Nyquist stability crit 	erion and the stability margins derived from it	-	
	They can explain the role of the phase ma	rgin in analysis and synthesis of control loops	5	
	They can explain the way a PID controller	affects a control loop in terms of its frequenc	y response	
	They can explain issues arising when cont	rollers designed in continuous time domain a	re implemented	digitally
C1-11-				
Skills	Students can transform models of linear c	ynamic systems from time to frequency dom	ain and vice vers	a
	 They can simulate and assess the behavior 	r of systems and control loops		
	 They can design PID controllers with the h 	elp of heuristic (Ziegler-Nichols) tuning rules		
	 They can analyze and synthesize simple c 	ontrol loops with the help of root locus and fr	equency respons	e techniques
	 They can calculate discrete-time apprention 	eximations of controllers designed in controllers	tinuous-time an	d use it for dig
	implementation			
	 They can use standard software tools (Ma 	lab Control Toolbox, Simulink) for carrying ou	ut these tasks	
Personal Competence				
-	Students can work in small groups to jointly solv	e technical problems, and experimentally vali	date their contro	ller designs
	Students can obtain information from provided			
,	when solving given problems.			
	They can assess their knowledge in weekly on-lin	e tests and thereby control their learning pro	ogress.	
	Independent Study Time 124, Study Time in Lec	ure 56		
Credit points				
Course achievement	None			
	Written exam			
Examination duration and				
Examination duration and scale	120 min			
Examination duration and scale Assignment for the	120 min General Engineering Science (German program,			
Examination duration and scale	120 min General Engineering Science (German program, Bioprocess Engineering: Core Qualification: Com	bulsory		
Examination duration and scale Assignment for the	120 min General Engineering Science (German program, Bioprocess Engineering: Core Qualification: Com Chemical and Bioprocess Engineering: Core Qua	bulsory ification: Compulsory		
Examination duration and scale Assignment for the	120 min General Engineering Science (German program, Bioprocess Engineering: Core Qualification: Com Chemical and Bioprocess Engineering: Core Qua Data Science: Core Qualification: Elective Compu	bulsory ification: Compulsory Ilsory		
Examination duration and scale Assignment for the	120 min General Engineering Science (German program, Bioprocess Engineering: Core Qualification: Com Chemical and Bioprocess Engineering: Core Qua Data Science: Core Qualification: Elective Compu Data Science: Specialisation II. Application: Elect	oulsory ification: Compulsory Ilsory ive Compulsory		
Examination duration and scale Assignment for the	120 min General Engineering Science (German program, Bioprocess Engineering: Core Qualification: Com Chemical and Bioprocess Engineering: Core Qua Data Science: Core Qualification: Elective Compu Data Science: Specialisation II. Application: Elect Electrical Engineering: Core Qualification: Compu	oulsory ification: Compulsory Ilsory ive Compulsory Ilsory		
Examination duration and scale Assignment for the	120 min General Engineering Science (German program, Bioprocess Engineering: Core Qualification: Com Chemical and Bioprocess Engineering: Core Qua Data Science: Core Qualification: Elective Compu Data Science: Specialisation II. Application: Elect Electrical Engineering: Core Qualification: Compu Green Technologies: Energy, Water, Climate: Co	oulsory ification: Compulsory Ilsory ive Compulsory Ilsory re Qualification: Compulsory		
Examination duration and scale Assignment for the	120 min General Engineering Science (German program, Bioprocess Engineering: Core Qualification: Com Chemical and Bioprocess Engineering: Core Qua Data Science: Core Qualification: Elective Compu Data Science: Specialisation II. Application: Elect Electrical Engineering: Core Qualification: Compu Green Technologies: Energy, Water, Climate: Co Computer Science in Engineering: Core Qualification	oulsory ification: Compulsory Ilsory ive Compulsory Ilsory re Qualification: Compulsory tion: Compulsory		
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Examination duration and scale Assignment for the	120 min General Engineering Science (German program, Bioprocess Engineering: Core Qualification: Com Chemical and Bioprocess Engineering: Core Qua Data Science: Core Qualification: Elective Compu Data Science: Specialisation II. Application: Elect Electrical Engineering: Core Qualification: Compu Green Technologies: Energy, Water, Climate: Co Computer Science in Engineering: Core Qualificat Integrated Building Technology: Core Qualification Logistics and Mobility: Specialisation Information	oulsory ification: Compulsory Ilsory ve Compulsory Ilsory re Qualification: Compulsory tion: Compulsory on: Elective Compulsory Technology: Elective Compulsory		
Examination duration and scale Assignment for the	120 min General Engineering Science (German program, Bioprocess Engineering: Core Qualification: Com Chemical and Bioprocess Engineering: Core Qua Data Science: Core Qualification: Elective Compu Data Science: Specialisation II. Application: Elect Electrical Engineering: Core Qualification: Compu Green Technologies: Energy, Water, Climate: Co Computer Science in Engineering: Core Qualification Integrated Building Technology: Core Qualification Logistics and Mobility: Specialisation Information Logistics and Mobility: Specialisation Traffic Plan	oulsory ification: Compulsory Ilsory ive Compulsory Ilsory ee Qualification: Compulsory tion: Compulsory in: Elective Compulsory Technology: Elective Compulsory ning and Systems: Elective Compulsory	SOLA	
Examination duration and scale Assignment for the	120 min General Engineering Science (German program, Bioprocess Engineering: Core Qualification: Com Chemical and Bioprocess Engineering: Core Qua Data Science: Core Qualification: Elective Compu Data Science: Specialisation II. Application: Elect Electrical Engineering: Core Qualification: Compu Green Technologies: Energy, Water, Climate: Co Computer Science in Engineering: Core Qualification Integrated Building Technology: Core Qualification Logistics and Mobility: Specialisation Information Logistics and Mobility: Specialisation Traffic Plan Logistics and Mobility: Specialisation Production	oulsory ification: Compulsory ilsory ive Compulsory ilsory re Qualification: Compulsory tion: Compulsory in: Elective Compulsory Technology: Elective Compulsory ning and Systems: Elective Compulsory Management and Processes: Elective Compul	sory	
Examination duration and scale Assignment for the	120 min General Engineering Science (German program, Bioprocess Engineering: Core Qualification: Com Chemical and Bioprocess Engineering: Core Qua Data Science: Core Qualification: Elective Compu Data Science: Specialisation II. Application: Elect Electrical Engineering: Core Qualification: Compu Green Technologies: Energy, Water, Climate: Co Computer Science in Engineering: Core Qualification Integrated Building Technology: Core Qualification Logistics and Mobility: Specialisation Informatior Logistics and Mobility: Specialisation Traffic Plan Logistics and Mobility: Specialisation Production Mechanical Engineering: Core Qualification: Com	oulsory ification: Compulsory ilsory ive Compulsory ilsory re Qualification: Compulsory tion: Compulsory in: Elective Compulsory Technology: Elective Compulsory ning and Systems: Elective Compulsory Management and Processes: Elective Compul	sory	
Examination duration and scale Assignment for the	120 min General Engineering Science (German program, Bioprocess Engineering: Core Qualification: Com Chemical and Bioprocess Engineering: Core Qua Data Science: Core Qualification: Elective Compu Data Science: Specialisation II. Application: Elect Electrical Engineering: Core Qualification: Compu Green Technologies: Energy, Water, Climate: Co Computer Science in Engineering: Core Qualification Logistics and Mobility: Specialisation Informatior Logistics and Mobility: Specialisation Traffic Plan Logistics and Mobility: Specialisation Production Mechanical Engineering: Core Qualification: Com Mechatronics: Core Qualification: Compulsory	oulsory ification: Compulsory ilsory ive Compulsory ilsory re Qualification: Compulsory tion: Compulsory m: Elective Compulsory Technology: Elective Compulsory ning and Systems: Elective Compulsory Management and Processes: Elective Compul pulsory	sory	
Examination duration and scale Assignment for the	120 min General Engineering Science (German program, Bioprocess Engineering: Core Qualification: Com Chemical and Bioprocess Engineering: Core Qua Data Science: Core Qualification: Elective Compu Data Science: Specialisation II. Application: Elect Electrical Engineering: Core Qualification: Compu Green Technologies: Energy, Water, Climate: Co Computer Science in Engineering: Core Qualification Logistics and Mobility: Specialisation Informatior Logistics and Mobility: Specialisation Traffic Plan Logistics and Mobility: Specialisation Production Mechanical Engineering: Core Qualification: Comp Mechatronics: Core Qualification: Comp Technomathematics: Specialisation III. Engineeri	oulsory ification: Compulsory ilsory ive Compulsory ilsory re Qualification: Compulsory tion: Compulsory in: Elective Compulsory Technology: Elective Compulsory Management and Processes: Elective Compul pulsory ng Science: Elective Compulsory		
Examination duration and scale Assignment for the	120 min General Engineering Science (German program, Bioprocess Engineering: Core Qualification: Com Chemical and Bioprocess Engineering: Core Qua Data Science: Core Qualification: Elective Compu Data Science: Specialisation II. Application: Elect Electrical Engineering: Core Qualification: Compu Green Technologies: Energy, Water, Climate: Co Computer Science in Engineering: Core Qualification Logistics and Mobility: Specialisation Informatior Logistics and Mobility: Specialisation Traffic Plan Logistics and Mobility: Specialisation Production Mechanical Engineering: Core Qualification: Com Mechatronics: Core Qualification: Comp Technomathematics: Specialisation III. Engineering Theoretical Mechanical Engineering: Technical C	oulsory ification: Compulsory Ilsory ive Compulsory ilsory re Qualification: Compulsory tion: Compulsory in: Elective Compulsory Technology: Elective Compulsory ming and Systems: Elective Compulsory Management and Processes: Elective Compul pulsory mg Science: Elective Compulsory omplementary Course Core Studies: Elective		
Examination duration and scale Assignment for the	120 min General Engineering Science (German program, Bioprocess Engineering: Core Qualification: Com Chemical and Bioprocess Engineering: Core Qua Data Science: Core Qualification: Elective Compu Data Science: Specialisation II. Application: Elect Electrical Engineering: Core Qualification: Compu Green Technologies: Energy, Water, Climate: Co Computer Science in Engineering: Core Qualification Logistics and Mobility: Specialisation Informatior Logistics and Mobility: Specialisation Traffic Plan Logistics and Mobility: Specialisation Production Mechanical Engineering: Core Qualification: Comp Mechatronics: Core Qualification: Comp Technomathematics: Specialisation III. Engineering Theoretical Mechanical Engineering: Technical C Process Engineering: Core Qualification: Compul	oulsory ification: Compulsory lsory ive Compulsory ilsory te Qualification: Compulsory tion: Compulsory m: Elective Compulsory Technology: Elective Compulsory ming and Systems: Elective Compulsory Management and Processes: Elective Compul pulsory mg Science: Elective Compulsory pomplementary Course Core Studies: Elective sory	Compulsory	compulsorv
Examination duration and scale Assignment for the	120 min General Engineering Science (German program, Bioprocess Engineering: Core Qualification: Com Chemical and Bioprocess Engineering: Core Qua Data Science: Core Qualification: Elective Compu Data Science: Specialisation II. Application: Elect Electrical Engineering: Core Qualification: Compu Green Technologies: Energy, Water, Climate: Co Computer Science in Engineering: Core Qualification Logistics and Mobility: Specialisation Information Logistics and Mobility: Specialisation Traffic Plan Logistics and Mobility: Specialisation Production Mechanical Engineering: Core Qualification: Comp Mechatronics: Core Qualification: Comp Technomathematics: Specialisation III. Engineering Theoretical Mechanical Engineering: Technical C Process Engineering: Core Qualification: Compul Engineering and Management - Major in Logistic	oulsory ification: Compulsory lsory ive Compulsory ilsory e Qualification: Compulsory tion: Compulsory m: Elective Compulsory Technology: Elective Compulsory ming and Systems: Elective Compulsory Management and Processes: Elective Compul pulsory mg Science: Elective Compulsory pomplementary Course Core Studies: Elective sory and Mobility: Specialisation Information Tech	Compulsory hnology: Elective	
Examination duration and scale Assignment for the	120 min General Engineering Science (German program, Bioprocess Engineering: Core Qualification: Com Chemical and Bioprocess Engineering: Core Qua Data Science: Core Qualification: Elective Compu Data Science: Specialisation II. Application: Elect Electrical Engineering: Core Qualification: Compu Green Technologies: Energy, Water, Climate: Co Computer Science in Engineering: Core Qualification Logistics and Mobility: Specialisation Informatior Logistics and Mobility: Specialisation Traffic Plan Logistics and Mobility: Specialisation Production Mechanical Engineering: Core Qualification: Comp Mechatronics: Core Qualification: Comp Technomathematics: Specialisation III. Engineering Theoretical Mechanical Engineering: Technical C Process Engineering: Core Qualification: Compul	oulsory ification: Compulsory lsory ive Compulsory ilsory e Qualification: Compulsory tion: Compulsory m: Elective Compulsory Technology: Elective Compulsory ming and Systems: Elective Compulsory Management and Processes: Elective Compul pulsory mg Science: Elective Compulsory pomplementary Course Core Studies: Elective sory and Mobility: Specialisation Information Techs and Mobility: Specialisation Traffic Planning	Compulsory hnology: Elective and Systems: Ele	ective Compulsor

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Тур	
Hrs/wk	2
СР	
	Independent Study Time 92, Study Time in Lecture 28
Lecturer	
Language	
Cycle	
Content	Signals and systems
	Linear systems, differential equations and transfer functions
	 First and second order systems, poles and zeros, impulse and step response
	• Stability
	Feedback systems
	Principle of feedback, open-loop versus closed-loop control
	Reference tracking and disturbance rejection
	Types of feedback, PID control
	 System type and steady-state error, error constants
	Internal model principle
	Root locus techniques
	Root locus plots
	Root locus design of PID controllers
	Frequency response techniques
	Bode diagram
	Minimum and non-minimum phase systems
	Nyquist plot, Nyquist stability criterion, phase and gain margin
	Loop shaping, lead lag compensation
	Frequency response interpretation of PID control
	Time delay systems
	Root locus and frequency response of time delay systems
	Smith predictor
	Digital control
	Sampled-data systems, difference equations
	Tustin approximation, digital implementation of PID controllers
	Software tools
	Introduction to Matlab Simuliak Control toolbox
	 Introduction to Matlab, Simulink, Control toolbox Computer-based exercises throughout the course
1.14	
Literature	Werner, H., Lecture Notes "Introduction to Control Systems"
	G.F. Franklin, J.D. Powell and A. Emami-Naeini "Feedback Control of Dynamic Systems", Addison Wesley, Reading, MA, 20
	• K. Ogata "Modern Control Engineering", Fourth Edition, Prentice Hall, Upper Saddle River, NJ, 2010
	R.C. Dorf and R.H. Bishop, "Modern Control Systems", Addison Wesley, Reading, MA 2010

Course L0655: Introduction to Control Systems		
Тур	Recitation Section (small)	
Hrs/wk	2	
CP	2	
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28	
Lecturer	NN	
Language	DE	
Cycle	WiSe	
Content	See interlocking course	
Literature	See interlocking course	

Courses				
Title		Тур	Hrs/wk	СР
Management Tutorial (L0882)		Recitation Section (small)	2	3
Introduction to Management (L088)))	Lecture	3	3
Module Responsible	Prof. Christoph Ihl			
Admission Requirements	None			
Recommended Previous	Basic Knowledge of Mathematics and Business			
Knowledge				
Educational Objectives	After taking part successfully, students have reached the	following learning results		
Professional Competence				
Knowledge	After taking this module, students know the important ba and Organisation to Marketing and Innovation, and also t			
	explain the differences between Economics and	- ,	lines in Manage	ment and to na
	important definitions from the field of Managemen		t important anno	ate of options and
	 explain the most important aspects of and goals projects 	In Management and name the mos	t important aspe	cts of entreprireu
	 describe and explain basic business functions 	as production procurement and s	ourcing supply	chain manageme
	organization and human ressource management, i			
	 explain the relevance of planning and decision 			
	uncertainty, and explain some basic methods from			
	 state basics from accounting and costing and selection 	cted controlling methods.		
SKIIIS	Students are able to analyse business units with respect out an Entrepreneurship project in a team. In particular, t		ojectives, strategi	ies etc.) and to ca
	 analyse Management goals and structure them ap 			
	analyse organisational and staff structures of com			
	 apply methods for decision making under multiple 		nder risk	
	analyse production and procurement systems and analyse and apply basis methods of perducting	Business information systems		
	 analyse and apply basic methods of marketing coloct and apply basic methods from methomatics 	l financo to prodofinod problems		
	 select and apply basic methods from mathematica apply basic methods from accounting, costing and 			
	• apply basic methods from accounting, costing and	controlling to predenited problems		
Personal Competence				
Social Competence	Students are able to			
	 work successfully in a team of students 			
	 to apply their knowledge from the lecture to an en 	trepreneurship project and write a co	oherent report on	the project
	 to communicate appropriately and 			
	 to cooperate respectfully with their fellow students 	5.		
Autonomy	Students are able to			
	 work in a team and to organize the team themselv 	res		
	 to write a report on their project. 			
Workload in Hours	Independent Study Time 110, Study Time in Lecture 70			
Credit points				
Course achievement				
	Subject theoretical and practical work			
	several written exams during the semester			
scale				
	General Engineering Science (German program, 7 semes	ter): Core Qualification: Compulsory		
Following Curricula				
2	Civil- and Environmental Engineering: Specialisation Wat		lsory	
	Civil- and Environmental Engineering: Specialisation Traf		-	
	Bioprocess Engineering: Core Qualification: Compulsory			
	Chemical and Bioprocess Engineering: Specialisation Bio	Engineering: Elective Compulsory		
	Chemical and Bioprocess Engineering: Specialisation Che	mical Engineering: Elective Compuls	sory	
	Computer Science: Core Qualification: Compulsory			
	Computer Science: Core Qualification: Compulsory Data Science: Core Qualification: Compulsory			
	Data Science: Core Qualification: Compulsory	on Biotechnologies: Elective Compul	sory	
	Data Science: Core Qualification: Compulsory Electrical Engineering: Core Qualification: Compulsory	- ,	-	mpulsory
	Data Science: Core Qualification: Compulsory Electrical Engineering: Core Qualification: Compulsory Green Technologies: Energy, Water, Climate: Specialisati	on Energy Systems / Renewable Ene	rgies: Elective Co	mpulsory
	Data Science: Core Qualification: Compulsory Electrical Engineering: Core Qualification: Compulsory Green Technologies: Energy, Water, Climate: Specialisati Green Technologies: Energy, Water, Climate: Specialisati Green Technologies: Energy, Water, Climate: Specialisati Green Technologies: Energy, Water, Climate: Specialisati	on Energy Systems / Renewable Ene on Energy Technology: Elective Com on Maritime Technologies: Elective C	rgies: Elective Co pulsory Compulsory	mpulsory
	Data Science: Core Qualification: Compulsory Electrical Engineering: Core Qualification: Compulsory Green Technologies: Energy, Water, Climate: Specialisati Green Technologies: Energy, Water, Climate: Specialisati	on Energy Systems / Renewable Ene on Energy Technology: Elective Com on Maritime Technologies: Elective Co on Water Technologies: Elective Con	rgies: Elective Co pulsory Compulsory	mpulsory
	Data Science: Core Qualification: Compulsory Electrical Engineering: Core Qualification: Compulsory Green Technologies: Energy, Water, Climate: Specialisati Green Technologies: Energy, Water, Climate: Specialisati Computer Science in Engineering: Core Qualification: Cor	on Energy Systems / Renewable Ene on Energy Technology: Elective Com on Maritime Technologies: Elective C on Water Technologies: Elective Con mpulsory	rgies: Elective Co pulsory Compulsory	mpulsory
	Data Science: Core Qualification: Compulsory Electrical Engineering: Core Qualification: Compulsory Green Technologies: Energy, Water, Climate: Specialisati Green Technologies: Energy, Water, Climate: Specialisati Computer Science in Engineering: Core Qualification: Comp Integrated Building Technology: Core Qualification: Comp	on Energy Systems / Renewable Ene on Energy Technology: Elective Com on Maritime Technologies: Elective C on Water Technologies: Elective Con mpulsory	rgies: Elective Co pulsory Compulsory	mpulsory
	Data Science: Core Qualification: Compulsory Electrical Engineering: Core Qualification: Compulsory Green Technologies: Energy, Water, Climate: Specialisati Green Technologies: Energy, Water, Climate: Specialisati Computer Science in Engineering: Core Qualification: Comp Logistics and Mobility: Core Qualification: CompLogistics and Co	on Energy Systems / Renewable Ene on Energy Technology: Elective Com on Maritime Technologies: Elective C on Water Technologies: Elective Con mpulsory	rgies: Elective Co pulsory Compulsory	mpulsory
	Data Science: Core Qualification: Compulsory Electrical Engineering: Core Qualification: Compulsory Green Technologies: Energy, Water, Climate: Specialisati Green Technologies: Energy, Water, Climate: Specialisati Computer Science in Engineering: Core Qualification: Comp Integrated Building Technology: Core Qualification: Comp	on Energy Systems / Renewable Ene on Energy Technology: Elective Com on Maritime Technologies: Elective C on Water Technologies: Elective Con mpulsory pulsory	rgies: Elective Co pulsory Compulsory	mpulsory

Mechatronics: Specialisation Electrical Systems: Compulsory	
Mechatronics: Specialisation Dynamic Systems and AI: Compulsory	
Mechatronics: Core Qualification: Compulsory	
Mechatronics: Specialisation Robot- and Machine-Systems: Compulsory	
Mechatronics: Specialisation Medical Engineering: Compulsory	
Orientation Studies: Core Qualification: Elective Compulsory	
Orientation Studies: Core Qualification: Elective Compulsory	
Naval Architecture: Core Qualification: Compulsory	
Technomathematics: Core Qualification: Compulsory	
Process Engineering: Core Qualification: Compulsory	
Engineering and Management - Major in Logistics and Mobility: Core Qualification: Compulsory	

Course L08	382: Management Tutorial
Тур	Recitation Section (small)
Hrs/wk	2
СР	3
Workload	Independent Study Time 62, Study Time in Lecture 28
in Hours	
Lecturer	Prof. Christoph Ihl, Katharina Roedelius
Language	DE
Cycle	WiSe/SoSe
Content	In the management tutorial, the contents of the lecture will be deepened by practical examples and the application of the discussed tools.
	If there is adequate demand, a problem-oriented tutorial will be offered in parallel, which students can choose alternatively. Here, students work in groups on se selected projects that focus on the elaboration of an innovative business idea from the point of view of an established company or a startup. Again, the busine knowledge from the lecture should come to practical use. The group projects are guided by a mentor.
Literature	Relevante Literatur aus der korrespondierenden Vorlesung.

Тур	Lecture
Hrs/wk	3
CP	3
Workload in Hours	Independent Study Time 48, Study Time in Lecture 42
Lecturer	Prof. Christoph Ihl, Prof. Christian Lüthje, Prof. Christian Ringle, Prof. Cornelius Herstatt, Prof. Kathrin Fischer, Prof. Matthias Meyer,
	Prof. Thomas Wrona, Prof. Thorsten Blecker, Prof. Wolfgang Kersten
Language	DE
Cycle	WiSe/SoSe
Content	 Introduction to Business and Management, Business versus Economics, relevant areas in Business and Management. Important definitions from Management, Developing Objectives for Business, and their relation to important Business functions Business Functions: Functions of the Value Chain, e.g. Production and Procurement, Supply Chain Management, Innovatior Management, Marketing and Sales Cross-sectional Functions, e.g. Organisation, Human Ressource Management, Supply Chain Management, Information Management Definitions as information, information systems, aspects of data security and strategic information systems Definition and Relevance of innovations, e.g. innovation opporunities, risks etc. Relevance of marketing, B2B vs. B2C-Marketing different techniques from the field of marketing (e.g. scenario technique), pricing strategies important organizational structures basics of human ressource management Introduction to Business Planning and the steps of a planning process Decision Analysis: Elements of decision problems and methods for solving decision problems Selected Planning Tasks, e.g. Investment and Financial Decisions Introduction to Accounting, Balance-Sheets, Costing Relevance of Controlling and selected Controlling methods Important aspects of Entrepreneurship projects
Literature	Bamberg, G., Coenenberg, A.: Betriebswirtschaftliche Entscheidungslehre, 14. Aufl., München 2008 Eisenführ, F., Weber, M.: Rationales Entscheiden, 4. Aufl., Berlin et al. 2003 Heinhold, M.: Buchführung in Fallbeispielen, 10. Aufl., Stuttgart 2006. Kruschwitz, L.: Finanzmathematik. 3. Auflage, München 2001.
	Pellens, B., Fülbier, R. U., Gassen, J., Sellhorn, T.: Internationale Rechnungslegung, 7. Aufl., Stuttgart 2008. Schweitzer, M.: Planung und Steuerung, in: Bea/Friedl/Schweitzer: Allgemeine Betriebswirtschaftslehre, Bd. 2: Führung, 9. Auf Stuttgart 2005.
	Weber, J., Schäffer, U. : Einführung in das Controlling, 12. Auflage, Stuttgart 2008.
	Weber, J./Weißenberger, B.: Einführung in das Rechnungswesen, 7. Auflage, Stuttgart 2006.

Courses					
Title		Тур	Hrs/wk	СР	
Advanced Intenship AIW/ ES: Inter	nship-accompanying Seminar (L2687)	Seminar	1	0	
Advanced Internship AIW/ ES: Prep	aration (L2682)	Seminar	1	0	
Module Responsible	Prof. Robert Seifried				
Admission Requirements	None				
Recommended Previous	Recommended Previous 150 Creditpoints in General Engineering Science				
Knowledge					
Educational Objectives	After taking part successfully, students have r	eached the following learning results			
Professional Competence					
Knowledge	Students of the different specialisations get ex	operiences in typical scope of duties of	engineers, who are worki	ing in a developme	
	division, planning division or in the management of a company. In the framework of this environment the knowledge fro				
	university can used a first time for real engineering tasks.				
Chulante of the different englishing should be intervated in turing doub work. By this they are been in			ing typical tasks a		
JKIIIS	s Students of the different specialisations should be integrated in typical day's work. By this they are learning typical tasks ar functions of engineers. They are able to structure and organize their working day and to finish tasks in a certain time.				
Personal Competence					
Social Competence	Students are able to cooperate with co-worker	rs in a company and to understand the	language of engineers.		
Autonomy	Students can finish own tasks.				
Autonomy	Students can inisi own tasks.				
Workload in Hours	Independent Study Time 512, Study Time in L	ecture 28			
Credit points	18				
Course achievement	None				
Examination	Written elaboration (accord. to Internship Reg	ulations)			
Examination duration and	see Internship Regulations				
scale					
Assignment for the	General Engineering Science (German program	n, 7 semester): Core Qualification: Con	npulsory		

Course L2687: Advanced Intenship AIW/ ES: Internship-accompanying Seminar

Тур	Seminar
Hrs/wk	1
CP	0
Workload in Hours	Independent Study Time -14, Study Time in Lecture 14
Lecturer	Prof. Robert Seifried, Eilika Schwenke
Language	DE/EN
Cycle	WiSe/SoSe
Content	The aim of the internship-accompanying seminar is the acquisition and consolidation of competences relevant for successfully doing the advanced internship in the 7th semester. The target group is students who already have found an internship placement. The focus is on strengthening personal competences to support the successful development of professional competences. In the seminar, students reflect on current challenges in relation to the internship. They discuss current topics with fellow students and teachers with the method of collegial counselling (peer-to-peer approach); in this way they gain (additional) self-confidence and increase their chances of successfully contributing in the internship, recognising and expressing their own wishes and needs in order to optimally use the internship for their own theory-practice transfer. The selection of topics is process-oriented and controlled by the group; the teachers provide impulses for reflection on certain topics. Topics that are dealt with are, for example: Negotiating the employment contract, Successful start into the internship - how do I behave in the first few days, How do I get interesting tasks, How do I deal with difficult situations (e.g. conflicts, sexism, racism), How do I note my progress/write the internship report? Through the internship sof their ports the acquisition and consolidation of competences in career management skills that can be transferred to later career steps.
Literature	

Course L2682: Advanced Inte	rnship AIW/ ES: Preparation
Тур	Seminar
Hrs/wk	1
СР	0
Workload in Hours	Independent Study Time -14, Study Time in Lecture 14
Lecturer	Prof. Robert Seifried, Eilika Schwenke
Language	DE/EN
Cycle	WiSe/SoSe
	The aim of the internship preparation (recommended in the 5th semester) is to acquire competences that are relevant for successfully searching for and doing the advanced internship in the 7th semester. Participation increases the students' chances of finding an internship of at least three months length and, if applicable, in English language, at the specified time. It also serves as a networking opportunity for the AIW/ES students. Participation in the 5th semester is recommended for a timely internship application.
	The seminar focuses on the topics of internship search, application and transfer competence. The students reflect on their already existing competences, skills and interests and learn which different employers are available for the engineering profession and how to find them. They continue to reflect on which topics of their studies they would like to try out in practical transfer in activities (theory-practice transfer) and look for suitable employers (if necessary under guidance). Contact is made with companies and other employers in the Hamburg metropolitan region who are potential employers for TUHH graduates. The students are supported in creating an appealing CV and cover letter. They practise presenting themselves in a job interview and complete a mock interview. They receive feedback from their fellow students and the teachers, gain self-confidence and increase their chances of finding an internship that is a good fit for them.
	The seminar strengthens the students' independence. The concrete application example of the advanced internship promotes the acquisition and consolidation of competences of career management skills, which can be transferred to later career steps. It also contributes to the interaction of theory and practice. Transfer in this context is "the successful application of previously acquired knowledge or skills in the context of a new requirement not yet apparent in the situation of knowledge or skill acquisition." Hasselhorn/Gold 2017
Literature	

Specialization Advanced Materials

Module M0662: Nume	erical Mathematics I	
Courses		
Title	Typ Hrs/wk CP	
Numerical Mathematics I (L0417)	Lecture 2 3	
Numerical Mathematics I (L0418)	Recitation Section (small) 2 3	
Module Responsible	Prof. Sabine Le Borne	
Admission Requirements		
-		
Recommended Previous Knowledge	 Mathematik I + II for Engineering Students (german or english) or Analysis & Linear Algebra I + II for Technomather 	ematicians
Knowledge	basic MATLAB/Python knowledge	
Educational Objectives	s After taking part successfully, students have reached the following learning results	
Professional Competence	3	
Knowledge	e Students are able to	
	name numerical methods for interpolation, integration, least squares problems, eigenvalue problems, nonlinear re	oot finding
	problems and to explain their core ideas,	
	 repeat convergence statements for the numerical methods, 	
	explain aspects for the practical execution of numerical methods with respect to computational and storage comp	lexitx.
Skills	s Students are able to	
	 implement, apply and compare numerical methods using MATLAB/Python, 	
	 justify the convergence behaviour of numerical methods with respect to the problem and solution algorithm, 	
	 select and execute a suitable solution approach for a given problem. 	
Personal Competence		
Social Competence	e Students are able to	
	work together in heterogeneously composed teams (i.e., teams from different study programs and background kr	
	explain theoretical foundations and support each other with practical aspects regarding the implementation of alg	
	explain theoretical foundations and support each other with practical aspects regarding the implementation of alg	onunns.
Autonomy	y Students are capable	
	 to assess whether the supporting theoretical and practical excercises are better solved individually or in a team, 	
	 to assess their individual progess and, if necessary, to ask questions and seek help. 	
Workload in Hours	e Jadenandant Study Time 124. Study Time in Lasture E6	
	s Independent Study Time 124, Study Time in Lecture 56	
Course achievement	t None	
Examination	n Written exam	
Examination Examination duration and		
	d 90 minutes	
Examination duration and scale	d 90 minutes	
Examination duration and scale Assignment for the	 g 90 minutes g 90 minutes g 6 General Engineering Science (German program, 7 semester): Specialisation Computer Science: Compulsory 	
Examination duration and scale Assignment for the	d 90 minutes	nechanics:
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Course L0417: Numerical Ma	thematics I
Тур	Lecture
Hrs/wk	2
CP	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Prof. Sabine Le Borne
Language	EN
Cycle	WiSe
Content	 Finite precision arithmetic, error analysis, conditioning and stability Linear systems of equations: LU and Cholesky factorization, condition Interpolation: polynomial, spline and trigonometric interpolation Nonlinear equations: fixed point iteration, root finding algorithms, Newton's method Linear and nonlinear least squares problems: normal equations, Gram Schmidt and Householder orthogonalization, singular value decomposition, regularizatio, Gauss-Newton and Levenberg-Marquardt methods Eigenvalue problems: power iteration, inverse iteration, QR algorithm Numerical differentiation Numerical integration: Newton-Cotes rules, error estimates, Gauss quadrature, adaptive quadrature
Literature	 Gander/Gander/Kwok: Scientific Computing: An introduction using Maple and MATLAB, Springer (2014) Stoer/Bulirsch: Numerische Mathematik 1, Springer Dahmen, Reusken: Numerik f ür Ingenieure und Naturwissenschaftler, Springer

Course L0418: Numerical Mathematics I		
Тур	Recitation Section (small)	
Hrs/wk	2	
СР	3	
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28	
Lecturer	Prof. Sabine Le Borne, Dr. Jens-Peter Zemke	
Language	EN	
Cycle	WiSe	
Content	See interlocking course	
Literature	See interlocking course	

Courses				
litle		Тур	Hrs/wk	СР
undamentals of Materials Science	I (L1085)	Lecture	2	2
undamentals of Materials Science	II (Advanced Ceramic Materials, Polymers and Composites) (L0506)	Lecture	2	2
Physical and Chemical Basics of Ma	terials Science (L1095)	Lecture	2	2
Module Responsible	Prof. Jörg Weißmüller			
Admission Requirements	None			
Recommended Previous	Highschool-level physics, chemistry und mathematics			
Knowledge				
Educational Objectives	After taking part successfully, students have reached the follow	ving learning results		
Professional Competence				
Skills	phase transformations, corrosion and mechanical properties. Th for materials and can identify relevant approaches for cha phenomena back to the underlying physical and chemical laws The students are able to trace materials phenomena back t phenomena here refers to mechanical properties such as stree resistance, and to phase transformations such as solidificatio between processing conditions and the materials microstructu	of nature. of nature. o the underlying ph ngth, ductility, and s n, precipitation, or r	properties. They are able sysical and chemical laws tiffness, chemical propertie melting. The students can	to trace materi of nature. Materi as such as corrosi explain the relat
Personal Competence Social Competence Autonomy	-			
Workload in Hours	Independent Study Time 96, Study Time in Lecture 84			
Credit points	6			
Course achievement	None			
Examination	Written exam			
Examination duration and	180 min			
scale				
Assignment for the	General Engineering Science (German program, 7 semester): S	pecialisation Mechan	ical Engineering: Compulso	iry
Following Curricula	General Engineering Science (German program, 7 semester): S General Engineering Science (German program, 7 semester): S General Engineering Science (German program, 7 semester): S Data Science: Specialisation II. Application: Elective Compulsory Digital Mechanical Engineering: Core Qualification: Compulsory Green Technologies: Energy, Water, Climate: Specialisation Ener Logistics and Mobility: Specialisation Engineering Science: Elect Logistics and Mobility: Specialisation Production Management a Mechanical Engineering: Core Qualification: Compulsory Mechatronics: Core Qualification: Compulsory Naval Architecture: Core Qualification: Compulsory	pecialisation Naval A pecialisation Advance y ergy Technology: Elec tive Compulsory	rchitecture: Compulsory ed Materials: Compulsory	' y

Course L0506: Fundamentals	s of Materials Science II (Advanced Ceramic Materials, Polymers and Composites)
Тур	Lecture
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Prof. Bodo Fiedler, Prof. Gerold Schneider
Language	DE
Cycle	SoSe
Content	Chemische Bindungen und Aufbau von Festkörpern; Kristallaufbau; Werkstoffprüfung; Schweißbarkeit; Herstellung von Keramiken;
	Aufbau und Eigenschaften der Keramik; Herstellung, Aufbau und Eigenschaften von Gläsern; Polymerwerkstoffe,
	Makromolekularer Aufbau; Struktur und Eigenschaften der Polymere; Polymerverarbeitung; Verbundwerkstoffe
Literature	Vorlesungsskript
	W.D. Callister: Materials Science and Engineering -An Introduction-5th ed., John Wiley & Sons, Inc., New York, 2000, ISBN 0-471- 32013-7

Course L1095: Physical and O	Chemical Basics of Materials Science
Тур	Lecture
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Gregor Vonbun-Feldbauer
Language	DE
Cycle	WiSe
Content	 Motivation: "Atoms in Mechanical Engineering?" Basics: Force and Energy The electromagnetic Interaction "Detour": Mathematics (complex e-funktion etc.) The atom: Bohr's model of the atom Chemical bounds The multi part problem: Solutions and strategies Descriptions of using statistical thermodynamics Elastic theory of atoms Consequences of atomar properties on makroskopic Properties: Discussion of examples (metals, semiconductors, hybrid systems)
Literature	 Für den Elektromagnetismus: Bergmann-Schäfer: "Lehrbuch der Experimentalphysik", Band 2: "Elektromagnetismus", de Gruyter Für die Atomphysik: Haken, Wolf: "Atom- und Quantenphysik", Springer Für die Materialphysik und Elastizität: Hornbogen, Warlimont: "Metallkunde", Springer

Module M0934: Adva	nced Materials for Sustainabil	itv			
Courses					
Title			Тур	Hrs/wk	СР
Advanced Materials Characterizatio			Lecture	2	2
Advanced Materials for Sustainabili					
Advanced Materials for Sustainabili			Recitation Section (large)	2	2
Module Responsible					
Admission Requirements					
	Fundamentals of Materials Science (I and II))			
Knowledge					
Educational Objectives	After taking part successfully, students have	e reached the following	ng learning results		
Professional Competence					
Knowledge	The students will be able to explain the pro	operties of advanced	materials along with their a	pplications in tech	nology, in particula
	metallic, ceramic, polymeric, semiconducto	r, modern composite	materials (biomaterials) and	l nanomaterials.	
Chille	The students will be able to colort mater	ial configurations on	anding to the technical pa	ada and if masaa	oom, to design now
SKIIIS	The students will be able to select mater	-	-		
	materials considering architectural princip			-	
	modern materials science, which enables the	terri to select optimul		pending on the te	
Personal Competence					
Social Competence	The students are able to present solutions to specialists and to develop ideas further.				
Autonomy	The students are able to				
	assess their own strengths and weaknesses.				
	define tasks independently.				
Workload in Hours	Independent Study Time 96, Study Time in	Locturo 84			
Credit points		Lecture 64			
Course achievement					
	None				
	Written exam				
Examination duration and	90 min				
scale					
Assignment for the	General Engineering Science (German p	rogram, 7 semester): Specialisation Mechanica	al Engineering, F	ocus Biomechanics
Following Curricula	Compulsory	_			
	General Engineering Science (German prog				
	General Engineering Science (German p	program, 7 semeste	er): Specialisation Mechani	cal Engineering,	Focus Materials in
	Engineering Sciences: Compulsory				
	Engineering Science: Specialisation Mechan				
	Engineering Science: Specialisation Advanc		-		
	Mechanical Engineering: Core Qualification:	Elective Compulsory			

Course L1087: Advanced Materials Characterization		
Тур	Lecture	
Hrs/wk	2	
СР	2	
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28	
Lecturer	Prof. Patrick Huber	
Language	DE	
Cycle	SoSe	
Content		
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 L1091: Advanced Materials for Sustainability		
Тур	Lecture	
Hrs/wk	2	
CP	2	
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28	
Lecturer	Prof. Patrick Huber, Prof. Bodo Fiedler, Prof. Gerold Schneider, Prof. Jörg Weißmüller, Prof. Kaline Pagnan Furlan, Prof. Patrick	
	Huber, Prof. Robert Meißner, Prof. Stefan Fritz Müller	
Language	DE/EN	
Cycle	SoSe	
Content		
Literature	Vorlesungsunterlagen	

Course L1092: Advanced Materials for Sustainability		
Тур	Recitation Section (large)	
Hrs/wk	2	
CP	2	
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28	
Lecturer	Prof. Bodo Fiedler, Prof. Gerold Schneider, Prof. Jörg Weißmüller, Prof. Patrick Huber, Prof. Stefan Fritz Müller	
Language	DE/EN	
Cycle	SoSe	
Content	See interlocking course	
Literature	See interlocking course	

Courses				
Title		Тур	Hrs/wk	СР
Computational Mechanics (EN) (L23		Integrated Lecture	4	4
Computational Mechanics (EN) (L23	399)	Recitation Section (small)	2	2
Module Responsible	Dr. Alexander Held			
Admission Requirements	None			
Recommended Previous	Mathematics I-III and Engineering Mechanics	1-111		
Knowledge				
	After taking part successfully, students have	reached the following learning results		
Professional Competence				
Knowledge	The students can			
	describe the axiomatic procedure used	l in mechanical contexts;		
	 explain important steps in model designation 	ın;		
	 present technical knowledge. 			
Chille	The students can			
Skills The students can				
	 explain the important elements of ma 	thematical / mechanical analysis and model f	ormation, and app	y it to the context
	their own problems;			
	 apply basic methods from numerical n 	nechanics to engineering problems;		
	 estimate the reach and boundaries of 	the methods and extend them to be applicable	to wider problem	sets.
Personal Competence				
Social Competence	The students can work in groups and support	each other to overcome difficulties.		
Autonomy	Students are capable of determining their ow	n strengths and weaknesses and to organize t	heir time and learr	ing based on those
Workload in Hours	Independent Study Time 96, Study Time in L	ecture 84		
Credit points	6			
Course achievement	None			
Examination	Written exam			
Examination duration and	120 min			
scale				
		m, 7 semester): Specialisation Advanced Mate	rials: Compulsory	
Following Curricula	Engineering Science: Core Qualification: Corr	pulsory		
Course L2398: Computationa	Mochanics (EN)			
Тур	Integrated Lecture			
Hrs/wk				
CP	4			

CP	4	
Workload in Hours	Independent Study Time 64, Study Time in Lecture 56	
Lecturer	r. Alexander Held	
Language	EN	
Cycle	SoSe	
Content	Part 1: Numerical Multibody Dynamics	
	Linear versus nonlinear vibration Numerical methods for time integration Concepts from analytical mechanics Spatial multibody systems Linearization of multibody systems Vibrations with multiple degrees of freedom: free, damped, forced, modal transformation Impacts Introduction to Matlab Part 2: Numerical Structural Mechanics	
Literature	K. Magnus, H.H. Müller-Slany: Grundlagen der Technischen Mechanik. 7. Auflage, Teubner (2009).	
	D. Gross, W. Hauger, J. Schröder, W. Wall: Technische Mechanik 1-4. 11. Auflage, Springer (2011).	
	W. Schiehlen, P. Eberhard: Technische Dynamik, Springer (2012).	

Course L2399: Computationa	urse L2399: Computational Mechanics (EN)	
Тур	Recitation Section (small)	
Hrs/wk	2	
CP	2	
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28	
Lecturer	NN	
Language	EN	
Cycle	SoSe	
Content	See interlocking course	
Literature	See interlocking course	

Courses				
Title		Тур	Hrs/wk	СР
Stochastics (L0777) Stochastics (L0778)		Lecture Recitation Section (small)	2	4 2
	Duraf Matthias Cabulta	Recitation Section (smail)	Z	Z
Module Responsible				
Admission Requirements	None			
Recommended Previous	Calculus			
Knowledge	Discrete algebraic structures (combinatorics)			
	Propositional logic			
Educational Objectives	After taking part successfully, students have reached	the following learning results		
	After taking part successfully, students have reached	the following learning results		
Professional Competence				
Knowledge	Students can name the basic concepts in Stoch	nastics. They are able to explain them us	sing appropriate e	examples.
	Students can discuss logical connections between	een these concepts. They are capable	of illustrating th	ese connections w
	the help of examples.			
	 They know proof strategies and can reproduce 	them.		
Skills				
Skiis	 Students can model problems from stochastic 	cs with the help of the concepts studie	ed in this course	. Moreover, they a
	capable of solving them by applying establishe	d methods.		
	 Students are able to discover and verify further 	-		
	 For a given problem, the students can develop 	op and execute a suitable approach, a	nd are able to c	ritically evaluate t
	results.			
Personal Competence				
Social Competence				
	 Students are able to work together (e.g. on the 			
	different study programs and background know			-
	 In doing so, they can communicate new conception and design exemples to shack and design the und 		perating partners	. Moreover, they c
	design examples to check and deepen the unde	erstanding of their peers.		
Autonomy			-	·
	 Students are capable of checking their unders 		own. They can sp	ecity open questio
	precisely and know where to get help in solvingStudents can put their knowledge in relation to			
	 Students can put their knowledge in relation to Students have developed sufficient persistence 		s in a goal orion	tod mannor on ha
	problems.	te to be able to work for longer period	s in a goal-onen	
	problems.			
Workload in Hours	Independent Study Time 124, Study Time in Lecture 5	56		
Credit points	6			
Course achievement	None			
Examination	Written exam			
Examination duration and	120 min			
scale				
Assignment for the	General Engineering Science (German program, 7 sen	nester): Specialisation Computer Scienc	e: Compulsory	
Following Curricula	General Engineering Science (German program, 7 sen	nester): Specialisation Advanced Materi	als: Elective Com	pulsory
	Computer Science: Core Qualification: Compulsory			
	Data Science: Core Qualification: Compulsory			
	Engineering Science: Specialisation Advanced Materia			
	Engineering Science: Specialisation Electrical Enginee	5 1 5		
	Computer Science in Engineering: Core Qualification:			
	Logistics and Mobility: Specialisation Engineering Scie Logistics and Mobility: Specialisation Information Tech			
	Orientation Studies: Core Qualification: Elective Comp Theoretical Mechanical Engineering: Core Qualification	pulsory		

Course L0777: Stochastics	
<i>,</i>	Lecture
Hrs/wk	2
СР	4
Workload in Hours	Independent Study Time 92, Study Time in Lecture 28
Lecturer	Prof. Matthias Schulte
Language	DE/EN
Cycle	SoSe
Content	 Definitions of probability, conditional probability Random variables Independence Distributions and density functions Characteristics: expectation, variance, standard deviation, moments Multivariate distributions Law of large numbers and central limit theorem Basic notions of stochastic processes Basic concepts of statistics (point estimators, confidence intervals, hypothesis testing)
Literature	 L. Dümbgen (2003): Stochastik für Informatiker, Springer. HO. Georgii (2012): Stochastics: Introduction to Probability and Statistics, 2nd edition, De Gruyter. N. Henze (2018): Stochastik für Einsteiger, 12th edition, Springer. A. Klenke (2014): Probability Theory: A Comprehensive Course, 2nd edition, Springer. U. Krengel (2005): Einführung in die Wahrscheinlichkeitstheorie und Statistik, 8th edition, Vieweg. A.N. Shiryaev (2012): Problems in probability, Springer.

Course L0778: Stochastics	ourse L0778: Stochastics	
Тур	Recitation Section (small)	
Hrs/wk	2	
СР	2	
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28	
Lecturer	Prof. Matthias Schulte	
Language	DE/EN	
Cycle	SoSe	
Content	See interlocking course	
Literature	See interlocking course	

Module M1730: Mathe	ematics IV (EN)			
Courses				
Title		Тур	Hrs/wk	СР
Differential Equations 2 (Partial Differential Equations) (EN) (L2783)		Lecture	2	1
Differential Equations 2 (Partial Diff	erential Equations) (EN) (L2784)	Recitation Section (large)	1	1
Differential Equations 2 (Partial Diff	erential Equations) (EN) (L2785)	Recitation Section (small)	1	1
Complex Functions (EN) (L2786)		Lecture	2	1
Complex Functions (EN) (L2787)		Recitation Section (large)	1	1
Complex Functions (EN) (L2788)		Recitation Section (small)	1	1
Module Responsible	Prof. Anusch Taraz			
Admission Requirements	None			
Recommended Previous Knowledge	Mathematics I - III (EN or DE)			
Educational Objectives	After taking part successfully, students have rea	ached the following learning results		
Professional Competence				
Knowledge				
Skills	 Students can discuss logical connections between these concepts. They are capable of illustrating these connections with the help of examples. They know proof strategies and can reproduce them. Students can model problems in Mathematics IV with the help of the concepts studied in this course. Moreover, they a capable of solving them by applying established methods. Students are able to discover and verify further logical connections between the concepts studied in the course. For a given problem, the students can develop and execute a suitable approach, and are able to critically evaluate the students can develop and execute a suitable approach. 			
Personal Competence Social Competence				
Autonomy	 Students are capable of checking their understanding of complex concepts on their own. They can specify open question precisely and know where to get help in solving them. Students have developed sufficient persistence to be able to work for longer periods in a goal-oriented manner on har problems. 			
Workload in Hours	Independent Study Time 68, Study Time in Lect	ure 112		
Credit points	6			
Course achievement	None			
Examination	Written exam			
Examination duration and				
scale				
Assignment for the				
	Engineering Science: Core Qualification: Compu	Isory		
	Engineering Science: Core Qualification: Compu			
	Engineering Science: Specialisation Mechatronic			

Course L2783: Differential E	Course L2783: Differential Equations 2 (Partial Differential Equations) (EN)	
Тур	Lecture	
Hrs/wk	2	
CP	1	
Workload in Hours	Independent Study Time 2, Study Time in Lecture 28	
Lecturer	Dozenten des Fachbereiches Mathematik der UHH	
Language	EN	
Cycle	SoSe	
Content	 Main features of the theory and numerical treatment of partial differential equations Examples of partial differential equations First order quasilinear differential equations Normal forms of second order differential equations Harmonic functions and maximum principle Maximum principle for the heat equation Wave equation Liouville's formula Consider formation 	
Literature	Special functions Difference methods Finite elements http://www.math.uni-hamburg.de/teaching/export/tuhh/index.html	

Course L2784: Differential E	Course L2784: Differential Equations 2 (Partial Differential Equations) (EN)	
Тур	Recitation Section (large)	
Hrs/wk	1	
CP	1	
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14	
Lecturer	Dozenten des Fachbereiches Mathematik der UHH	
Language	EN	
Cycle	SoSe	
Content	See interlocking course	
Literature	See interlocking course	

Course L2785: Differential E	urse L2785: Differential Equations 2 (Partial Differential Equations) (EN)	
Тур	Recitation Section (small)	
Hrs/wk	1	
CP	1	
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14	
Lecturer	Dozenten des Fachbereiches Mathematik der UHH	
Language	EN	
Cycle	SoSe	
Content	See interlocking course	
Literature	See interlocking course	

Course L2786: Complex Fund	ourse L2786: Complex Functions (EN)	
-	Lecture	
Hrs/wk		
CP	1	
Workload in Hours	Independent Study Time 2, Study Time in Lecture 28	
Lecturer	Dozenten des Fachbereiches Mathematik der UHH	
Language	EN	
Cycle	SoSe	
Content	Main features of complex analysis	
	 Functions of one complex variable Complex differentiation Conformal mappings Complex integration Cauchy's integral theorem Cauchy's integral formula Taylor and Laurent series expansion Singularities and residuals Integral transformations: Fourier and Laplace transformation 	
Literature	http://www.math.uni-hamburg.de/teaching/export/tuhh/index.html	

Course L2787: Complex Fund	ourse L2787: Complex Functions (EN)	
Тур	Recitation Section (large)	
Hrs/wk	1	
CP	1	
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14	
Lecturer	Dozenten des Fachbereiches Mathematik der UHH	
Language	EN	
Cycle	SoSe	
Content	See interlocking course	
Literature	See interlocking course	

Course L2788: Complex Functions (EN)		
Тур	Recitation Section (small)	
Hrs/wk	1	
CP	1	
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14	
Lecturer	Dozenten des Fachbereiches Mathematik der UHH	
Language	EN	
Cycle	SoSe	
Content	See interlocking course	
Literature	See interlocking course	

Module M1808: Quan	tum Mechanics for Materials Sci	ence		
Courses				
Title		Тур	Hrs/wk	СР
Atomic-Scale Fundamentals of Mat	erials Science (L2989)	Lecture	2	3
Atomic-Scale Fundamentals of Mat	erials Science (L2990)	Recitation Section (large)	2	3
Module Responsible	Prof. Jörg Weißmüller			
Admission Requirements	None			
Recommended Previous				
Knowledge				
Educational Objectives	After taking part successfully, students have re	ached the following learning results		
Professional Competence				
Knowledge				
Skills				
Personal Competence				
Social Competence				
Autonomy				
Workload in Hours	Independent Study Time 124, Study Time in Le	cture 56		
Credit points	6			
Course achievement	None			
Examination				
Examination duration and				
scale				
Assignment for the	General Engineering Science (German program	, 7 semester): Specialisation Advanced Ma	erials: Compulsory	
Following Curricula	Engineering Science: Specialisation Advanced I	laterials: Compulsory		
	Engineering Science: Specialisation Advanced I	Aaterials: Elective Compulsory		

Course L2989: Atomic-Scale	Course L2989: Atomic-Scale Fundamentals of Materials Science	
Тур	Lecture	
Hrs/wk	2	
CP	3	
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28	
Lecturer	NN	
Language	EN	
Cycle	WiSe/SoSe	
Content		
Literature		

Course L2990: Atomic-Scale	ourse L2990: Atomic-Scale Fundamentals of Materials Science		
Тур	Recitation Section (large)		
Hrs/wk	2		
СР	3		
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28		
Lecturer	NN		
Language	EN		
Cycle	WiSe/SoSe		
Content			
Literature			

Module M1579: Fluid	Mochanics (EN)			
Module M1579: Fluid	Mechanics (EN)			
Courses				
Title		Тур	Hrs/wk	CP
Fluid Mechanics (EN) (L2383)		Lecture	3	4
Fluid Mechanics (EN) (L2384)		Recitation Section	(large) 2	2
Module Responsible	Prof. Thomas Rung			
Admission Requirements	None			
Recommended Previous	Sound knowledge of engineering mathe	ematics, engineering mechanics and thermo	odynamics.	
Knowledge				
Educational Objectives	After taking part successfully, students	have reached the following learning results	5	
Professional Competence				
Knowledge	Students will have the required sound	d knowledge to explain the general princ	iples of fluid engineerir	g and physics of fluid:
	Students can scientifically outline the r	ationale of flow physics using mathematic	al models and are famil	iar with methods for th
	performance analysis and the predicito	n of fluid engineering devices.		
Skills		ering principles and flow-physics models f		
	enables the student to carry out all necessary theoretical calculations for the fluid dynamic design of engineering devices on a			
	scientific level.			
Personal Competence				
Social Competence	The students are able to discuss proble	ms and jointly develop solution strategies.		
Autonomy	The students are able to develop solution	on strategies for complex problems self-cor	isistent and crtically ana	lyse results.
Workload in Hours	Independent Study Time 110, Study Tir	ne in Lecture 70		
Credit points	6			
Course achievement	None			
Examination	Written exam			
Examination duration and	180 min			
scale				
Assignment for the	General Engineering Science (German	program, 7 semester): Specialisation Advan	ced Materials: Compulso	bry
Following Curricula		a Science, Focus Physical Modelling: Electiv		
-	Engineering Science: Core Qualification			
	Engineering Science: Specialisation Adv			
	Engineering Science: Specialisation Med			
	Engineering Science: Specialisation Med			
	Engineering Science: Specialisation Bio	medical Engineering: Compulsory		
		ctrical Engineering: Elective Compulsory		

Course L2383: Fluid Mechani	cs (EN)
	Lecture
Hrs/wk	
CP	4
Workload in Hours	Independent Study Time 78, Study Time in Lecture 42
Lecturer	NN
Language	EN
Cycle	WiSe
Content	 continuum physics definition of fluids, difference to solids/structures and material properties of fluids dimensional analysis and similitude fluid forces and fluid statics transport and conservation of mass, momentum & energy fluid kinematics technically relevant flow models for incompressible fluids control volume & stream tube analysis vortical flow models potential flows boundary layer flows different types of conservation equations and their realm (Navier-Stokes/Euler/Bernoulli equations) analytical solutions for Navier-Stokes systems Analysis of internal flows (channels, pipes, open channels) and external flows, fundamentals of wing aerodynamics turbulent flows
Literature	fundamentals of gas dynamics (1D compressible flows)

Course L2384: Fluid Mechani	ourse L2384: Fluid Mechanics (EN)		
Тур	Recitation Section (large)		
Hrs/wk	2		
CP	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		

Courses					
Title		Тур	Hrs/wk	СР	
Practical Course: Measurement and Measurement Technology for Mech		Practical Course Lecture	2	2 2	
Measurement Technology for Mech		Practical Course	2	2	
		Tractical Course	2	2	
Module Responsible					
Admission Requirements					
Recommended Previous Knowledge	Basic knowledge of physics, chemistry and e	electrical engineering			
	After taking part successfully, students have	weeked the following learning yearst			
Educational Objectives	After taking part successfully, students have	reached the following learning results			
Professional Competence					
Knowledge	Students are able to name the most impor Calibration, Static and Dynamic Properties of		nology (Quantities ar	d Units, Uncertain	
		uring methods for different kinds of quantit	ies to be maesured	(Electrical Quantiti	
	Temperature, mechanical quantities, Flow,	lime, Frequency).			
	They can describe important methods of che	emical Analysis (Gas Sensors, Spectroscopy,	Gas Chromatography	·)	
Skills	Students can select suitable measuring met	hods to given problems and can use refering	measurement device	es in practice.	
	The students are able to orally explain issues in the subject area of measurement technology and solution approaches as well				
	place the issues into the right context and a		nology and solution c	ipprodenes as we	
Personal Competence					
Social Competence	Students can arrive at work results in group	s and document them in a common report.			
Autonomy	Students are able to familiarize themselves	with new measurement technologies.			
,					
Workload in Hours	Independent Study Time 96, Study Time in I	Lecture 84			
Credit points	6				
Course achievement	Compulsory Bonus Form	Description			
	Yes None Subject theoretica	i and			
	practical work				
	Subject theoretical and practical work				
Examination duration and		periments on measurements technology ar	nd sucessfull particip	ation in the practi	
scale		nd Control Systems"			
Assignment for the	General Engineering Science (German progr	am, 7 semester): Specialisation Mechanical I	Engineering: Compuls	sory	
Following Curricula		am, 7 semester): Specialisation Biomedical E			
		am, 7 semester): Specialisation Advanced M	aterials: Elective Com	ipulsory	
	Digital Mechanical Engineering: Core Qualifi	cation: Compulsory			
	Engineering Science: Specialisation Mechatr	onics: Compulsory			
	Engineering Science: Specialisation Mechani	ical Engineering: Compulsory			
	Engineering Science: Specialisation Biomedi	cal Engineering: Elective Compulsory			
	Engineering Science: Specialisation Advance	ed Materials: Elective Compulsory			
	General Engineering Science (English program, 7 semester): Specialisation Mechatronics: Compulsory				
		am, 7 semester): Specialisation Mechanical E			
	General Engineering Science (English program, 7 semester): Specialisation Biomedical Engineering: Elective Compulsory				
	Logistics and Mobility: Specialisation Production Management and Processes: Elective Compulsory				
	Mechanical Engineering: Core Qualification: Compulsory				
	Mechatronics: Specialisation Naval Engineering: Compulsory				
	Mechatronics: Specialisation Electrical Systems: Compulsory				
	Mechatronics: Specialisation Dynamic Syste				
	Mechatronics: Core Qualification: Compulsor				
	Mechatronics: Specialisation Robot- and Mac				
	Mechatronics: Specialisation Medical Engine				
		ering: Compulsory ogistics and Mobility: Specialisation Product	ion Management an	d Processes: Elect	

Course L1119: Practical Cour	rse: Measurement and Control Systems
Тур	Practical Course
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Prof. Thorsten Kern
Language	DE
Cycle	WiSe/SoSe
Content	The content of experiment 1:
	Accuracy testing of a delta robot: In the course of the experiment, the accuracy of a delta robot is tested through 3 tasks. The first task focuses on the online/offline programming of the robot. The second task deals with sensor calibration. In the third task, the radius of a sphere is determined using three different measurement methods (manual measurement, manual measurement with a sensor, automatic data acquisition and data processing).
	The content of experiment 3:
	The aim of the task is to enable the parallel kinematics to find objects, grasp them and place them on a static target position Fo this purpose, the end effector of the kinematics is equipped with an optical sensor (camera), whose characteristics are to be defined. The measuring range of the sensor is to be identified and, based on this, a movement strategy for finding the objects is to be developed and implemented. Once the objects have been found, they are to be picked up with a magnetic gripper and transported to their destination.
	The content of experiment 4:
	The aim of the task is to enable the parallel kinematics to find objects, grab them and deposit them on a moving platform. For this purpose, the end effector of the kinematics is equipped with an optical sensor (camera), the properties of which were worked out in experiment 3. Based on this, the parallel kinematics should now be able to follow the moving platform. For this purpose, a position control must be developed and implemented. Once the controller has been appropriately configured, the objects can be placed on the moving platform.
Literature	Versuch 1:
	 1)Weck, Manfred; Brecher, Christian. Maschinenarten und Anwendungsbereiche. Springer (Werkzeugmaschinen, 1, Ed. 6). 2005 2)Weck, Manfred; Brecher, Christian. Automatisierung von Maschinen und Anlagen. Springer (Werkzeugmaschinen, 4, Ed. 6). 2006 3)Siciliano, Bruno; Khatib, Oussama. Springer handbook of robotics. Springer. 2008 4)Schüppstuhl, Thorsten. VL Grundlagen der Handhabungs- und Montagetechnik. 2017
	 Versuch 3: 1)Hompel, Michael, Hubert Büchter, and Ulrich Franzke. Identifikationssysteme und Automatisierung. Springer-Verlag, 2007. ArUco Library Documentation, https://docs.google.com/document/d/1QU9KoBtjSM2kF6ITOjQ76xqL7H0TEtXrjJX5kwi9Kgc/edil Stand 10/21 Demant, Christian, Bernd Streicher-Abel, and Axel Springhoff. Industrielle Bildverarbeitung: wie optische Qualitätskontrolle wirklich funktioniert. Springer-Verlag, 2011.
	Versuch 4:
	 1)Will, Thorsten T. C++ Das umfassende Handbuch, Rheinwerk Computing, 2020 2)Hildebrand, Walter. Grundkurs Regelungstechnik : Grundlagen für Bachelorstudiengänge aller technischen Fachrichtungen und Wirtschaftsingenieure, Springer Vieweg, 2013. 3)Erlenkötter, Helmut. C++: Objektorientiertes Programmieren von Anfang an, rororo, 2016
	Bibliography:
	Experiment 1
	 1)Weck, Manfred; Brecher, Christian. Maschinenarten und Anwendungsbereiche. Springer (Werkzeugmaschinen, 1, Ed. 6) 2005 2)Weck, Manfred; Brecher, Christian. Automatisierung von Maschinen und Anlagen. Springer (Werkzeugmaschinen, 4, Ed
	 6). 2006 3)Siciliano, Bruno; Khatib, Oussama. Springer handbook of robotics. Springer. 2008 4)Schüppstuhl, Thorsten. VL Grundlagen der Handhabungs- und Montagetechnik. 2017
	Experiment 3:
	 1)Hompel, Michael, Hubert Büchter, and Ulrich Franzke. Identifikationssysteme und Automatisierung. Springer-Verlag, 2007 ArUco Library Documentation, https://docs.google.com/document/d/1QU9KoBtjSM2kF6ITOjQ76xqL7H0TEtXrJX5kwi9Kgc/edi Stand 10/21 Demant, Christian, Bernd Streicher-Abel, and Axel Springhoff. Industrielle Bildverarbeitung: wie optische Qualitätskontrolle wirklich funktioniert. Springer-Verlag, 2011.
	Experiment 4:
	 1)Will, Thorsten T. C++ Das umfassende Handbuch, Rheinwerk Computing, 2020 2)Hildebrand, Walter. Grundkurs Regelungstechnik : Grundlagen für Bachelorstudiengänge aller technischer Fachrichtungen und Wirtschaftsingenieure, Springer Vieweg, 2013. 3)Erlenkötter, Helmut. C++: Objektorientiertes Programmieren von Anfang an, rororo, 2016

Course L1116: Measurement	Technology for Mechanical Engineering
Тур	Lecture
Hrs/wk	2
СР	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Prof. Thorsten Kern, Dennis Kähler
Language	
Cycle	
Content	1 Fundamentals
	1.1 Quantities and Units
	1.2 Uncertainty
	1.3 Calibration
	1.4 Static and Dynamic Properties of Sensors and Systems
	2 Measurement of Electrical Quantities
	2.1 Current and Voltage
	2.2 Impedance
	2.3 Amplification
	2.4 Oscilloscope
	2.5 Analog-to-Digital Conversion
	2.6 Data Transmission
	3 Measurement of Nonelectric Quantities
	3.1 Temperature
	3.2 Length, Displacement, Angle
	3.3 Strain, Force, Pressure
	3.4 Flow
	3.5 Time, Frequency
Literature	Lerch, R.: "Elektrische Messtechnik; Analoge, digitale und computergestützte Verfahren", Springer, 2006, ISBN: 978-3-540-34055- 3.
	Profos, P. Pfeifer, T.: "Handbuch der industriellen Messtechnik", Oldenbourg, 2002, ISBN: 978-3486217940.

Course L1118: Measurement	Course L1118: Measurement Technology for Mechanical Engineering		
Тур	Practical Course		
Hrs/wk	2		
CP	2		
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28		
Lecturer	Prof. Thorsten Kern		
Language	EN		
Cycle	WiSe/SoSe		
Content	See interlocking course		
Literature	See interlocking course		

Module M1592: Statis	stics			
Courses				
Title		Тур	Hrs/wk	СР
Statistics (L2430)		Lecture	3	4
Statistics (L2431)		Recitation Section (small)	1	2
Module Responsible	Prof. Matthias Schulte			
Admission Requirements	None			
Recommended Previous	Stochastics (or a comparable class)			
Knowledge				
Educational Objectives	After taking part successfully, students have reache	ed the following learning results		
Professional Competence				
Knowledge				
	Students can name the basic concepts in Sta			
	Students can discuss logical connections be	tween these concepts. They are capable	of illustrating th	ese connections w
	the help of examples.			
Skills				
	 Students can model statistical problems with 	the help of the concepts studied in this o	ourse. Moreover	, they are capable
	solving them by applying established metho	ds. They are able to use the statistical soft	ware R.	
	 Students are able to discover and verify furth 	ner logical connections between the conce	pts studied in the	e course.
	 For a given problem, the students can dev 	elop and execute a suitable approach, a	nd are able to c	ritically evaluate t
	results.			
Personal Competence				
Social Competence				
Social competence	 Students are able to work together (e.g. on 	their regular home work) in heterogeneo	usly composed t	eams and to pres
	their results appropriately (e.g. during exerc	se class).		
	 In doing so, they can communicate new con 	cepts according to the needs of their coop	perating partners	. Moreover, they c
	design examples to check and deepen the u	nderstanding of their peers.		
Autonomy				
Autonomy	 Students are capable of checking their under 	rstanding of complex concepts on their o	wn. They can sp	ecify open questio
	precisely and know where to get help in solv	ng them.		
	 Students can put their knowledge in relation 	to the contents of other lectures.		
	 Students have developed sufficient persister 	nce to be able to work for longer period	s in a goal-orien	ted manner on ha
	problems.			
Workload in Hours	Independent Study Time 124, Study Time in Lectur	e 56		
Credit points	6			
Course achievement	None			
Examination	Written exam			
Examination duration and	90 min			
scale				
Assignment for the	General Engineering Science (German program, 7 s	emester): Specialisation Advanced Materia	als: Elective Com	pulsory
Following Curricula	General Engineering Science (German program, 7 s	emester): Specialisation Computer Science	e: Elective Comp	ulsory
	General Engineering Science (German program, 7 s	emester): Specialisation Data Science: Co	mpulsory	
	Computer Science: Specialisation II. Mathematics a	nd Engineering Science: Elective Compulse	ory	
	Data Science: Core Qualification: Compulsory			
	Engineering Science: Specialisation Advanced Mate			
	Engineering Science: Specialisation Data Science: 0			
	Logistics and Mobility: Specialisation Information Te			
	Technomathematics: Specialisation I. Mathematics:	Elective Compulsory		
	Theoretical Mechanical Engineering: Specialisation	Robotics and Computer Science: Elective (Compulsory	
	Theoretical Mechanical Engineering: Specialisation			
	Engineering and Management - Major in Logistics a	nd Mobility: Specialisation Information Tec	hnology: Elective	e Compulsory

Course L2430: Statistics	
Тур	Lecture
Hrs/wk	3
CP	4
Workload in Hours	Independent Study Time 78, Study Time in Lecture 42
Lecturer	Prof. Matthias Schulte
Language	DE/EN
Cycle	WiSe
Content	 Multivariate distributions and stochastic convergence Point estimators Confidence intervals Hypothesis testing Nonparametric statistics Linear Regression Time series analysis Statistical software (R)
Literature	 L. Dümbgen (2016): Einführung in die Statistik, Birkhäuser. L. Dümbgen (2003): Stochastik für Informatiker, Springer. HO. Georgii (2012): Stochastics: Introduction to Probability and Statistics, 2nd edition, De Gruyter. N. Henze (2018): Stochastik für Einsteiger, 12th edition, Springer. A. Klenke (2014): Probability Theory: A Comprehensive Course, 2nd edition, Springer. U. Krengel (2005): Einführung in die Wahrscheinlichkeitstheorie und Statistik, 8th edition, Vieweg.

Course L2431: Statistics	Course L2431: Statistics	
Тур	Recitation Section (small)	
Hrs/wk	1	
CP	2	
Workload in Hours	Independent Study Time 46, Study Time in Lecture 14	
Lecturer	Prof. Matthias Schulte	
Language	DE/EN	
Cycle	WiSe	
Content	See interlocking course	
Literature	See interlocking course	

Module M1901: Mate	rials Science Laboratory			
Courses				
Title		Тур	Hrs/wk	CP
Companion Lecture for Materials S	-	Lecture	2	2
Material Science Laboratory (L123)		Practical Course	4	4
	Prof. Kaline Pagnan Furlan			
Admission Requirements				
Recommended Previous	none			
Knowledge				
	After taking part successfully, students have	ve reached the following learning results		
Professional Competence				
Knowledge		the technical details of experiments in the		
	1 1 5 1	e of describing and communicating relevant p		5 11 1
	technical language. They can explain the ty	ypical process of solving practical problems ar	nd present related res	ults.
Skills	The students can transfer their fundamen	tal knowledge on material sciences to the pr	ocess of solving prac	tical problems. Th
		ring the realization of experiments in the cont		
	··· · · · · · · · · · · · · · · · · ·	5		
Personal Competence				
Social Competence	Students are able to cooperate in small groups in order to conduct experiments in the context of materials sciences. They are able			
	to effectively present and explain their resu	ults alone or in groups in front of a qualified au	udience.	
Autonomy	Students are capable of solving problems i	in the context of materials sciences using pro	wided literature. They	, are able to fill ga
, accriently		the literature and other sources provided by the	-	, are usic to ini ge
	···			
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 an	nd online learning modules with integrated che	ecking	
scale				
Assignment for the	General Engineering Science (German pro-	gram, 7 semester): Specialisation Mechanical	Engineering, Focus F	Product Developme
Following Curricula	and Production: Elective Compulsory			
	General Engineering Science (German prog	gram, 7 semester): Specialisation Advanced Ma	aterials: Compulsory	
	Engineering Science: Specialisation Advance	ced Materials: Compulsory		
	Engineering Science: Specialisation Advance	ced Materials: Compulsory		
	Engineering Science: Specialisation Mechan	nical Engineering: Elective Compulsory		
	Mechanical Engineering: Specialisation Pro-	duct Development and Production: Compulsor	У	
	Mechanical Engineering: Specialisation Mat	terials in Engineering Sciences: Compulsory		
		tenuis in Engineering Sciences. compuisory		

Course L1088: Companion Lecture for Materials Science Laboratory		
Тур	Lecture	
Hrs/wk	2	
CP	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 Scien	ice Laboratory	
Тур	Practical Course	
Hrs/wk	4	
CP	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 M1807: Mach	ine Learning for Physical Systems			
Courses				
Title		Тур	Hrs/wk	СР
Machine Learning for Physical System	ems (L2987)	Lecture	2	3
Machine Learning for Physical System	ems (L2988)	Project-/problem-based Learning	2	3
Module Responsible	Prof. Christian Cyron			
Admission Requirements	None			
Recommended Previous				
Knowledge				
Educational Objectives	After taking part successfully, students have reached the follo	owing learning results		
Professional Competence				
Knowledge				
Skills				
Personal Competence				
Social Competence				
Autonomy				
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56			
Credit points	6			
Course achievement	None			
Examination	Written exam			
Examination duration and	60 min			
scale				
Assignment for the	General Engineering Science (German program, 7 semester):	Specialisation Advanced Materials:	Compulsory	
Following Curricula	Data Science: Specialisation IV. Special Focus Area: Elective C	Compulsory		
	Data Science: Specialisation III. Applications: Elective Comput	sory		
	Engineering Science: Specialisation Advanced Materials: Com	pulsory		
	Engineering Science: Specialisation Advanced Materials: Elect	ive Compulsory		
	Mechatronics: Specialisation Dynamic Systems and AI: Elective	e Compulsory		
	Mechatronics: Specialisation Robot- and Machine-Systems: El	ective Compulsory		

Course L2987: Machine Learning for Physical Systems	
Тур	Lecture
Hrs/wk	2
CP	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	NN
Language	EN
Cycle	WiSe/SoSe
Content	
Literature	

Course L2988: Machine Learning for Physical Systems	
Тур	Project-/problem-based Learning
Hrs/wk	2
CP	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	NN
Language	EN
Cycle	WiSe/SoSe
Content	
Literature	

Courses				
Title		Тур	Hrs/wk	СР
Production Process Organization (L	1925)	Lecture	2	3
Quality Management (L0926)	,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,	Lecture	2	3
Module Responsible	Prof. Hermann Lödding			
Admission Requirements	None			
Recommended Previous	None			
Knowledge				
Educational Objectives	After taking part successfully, students h	ave reached the following learning results		
Professional Competence				
Knowledge	Students are able to explain the contents	of the lecture of the module.		
Skills	Students are able to apply the methods a	nd models in the module to industrial problem	ns.	
Personal Competence				
Social Competence	-			
Autonomy	-			
Workload in Hours	Independent Study Time 124, Study Time	e in Lecture 56		
Credit points	6			
Course achievement	None			
Examination	Written exam			
Examination duration and	180 Minuten			
scale				
Assignment for the	General Engineering Science (German	program, 7 semester): Specialisation Mecha	anical Engineering, Foo	cus Aircraft Syste
Following Curricula	Engineering: Compulsory			
		rogram, 7 semester): Specialisation Mechanic	al Engineering, Focus F	Product Developme
	and Production: Compulsory			
		ogram, 7 semester): Specialisation Advanced	Materials: Elective Com	pulsory
	Engineering Science: Specialisation Mech			
	Engineering Science: Specialisation Mech			
	Engineering Science: Specialisation Mech	5 5 1 5		
	Engineering Science: Specialisation Adva			
		luction Management and Processes: Compulso	ory	
	Mechanical Engineering: Core Qualification Engineering and Management - Major in 1	on: Elective Compulsory		

Course L0925: Production Pr	ocess Organization
Тур	Lecture
Hrs/wk	2
СР	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Prof. Hermann Lödding
Language	
Cycle	SoSe
Content	(A) Introduction
	(B) Product planning
	(C) Process planning
	(D) Procurement
	(E) Manufacturing
	(F) Production planning and control (PPC)
	(G) Distribution
	(H) Cooperation
Literature	Wiendahl, HP.: Betriebsorganisation für Ingenieure
	Vorlesungsskript

Course L0926: Quality Manag	jement
Тур	Lecture
Hrs/wk	2
CP	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Prof. Hermann Lödding
Language	EN
Cycle	SoSe
Content	 Definition and Relevance of Quality Continuous Quality Improvement Quality Management in Product Development Quality Management in Production Processes Design of Experiments
Literature	 Pfeifer, Tilo: Quality Management. Strategies, Methods, Techniques; Hanser-Verlag, München 2002 Pfeifer, Tilo: Qualitätsmanagement. Strategien, Methoden, Techniken; Hanser-Verlag, München, 3. Aufl. 2001 Mitra, Amitava: Fundamentals of Quality Control and Improvement; Wiley; Macmillan, 2008 Kleppmann, W.: Taschenbuch Versuchsplanung. Produkte und Prozesse optimieren; Hanser-Verlag, München, 6. Aufl. 2009

Courses				
Title		Тур	Hrs/wk	СР
Modeling, Simulation and Optimiza	tion (EN) (L2446)	Integrated Lecture	4	6
Module Responsible	Prof. Benedikt Kriegesmann			
Admission Requirements	None			
Recommended Previous	Sound knowledge of engineering mathema	atics, engineering mechanics and fluid mechanic	S	
Knowledge				
Educational Objectives	After taking part successfully, students have	ve reached the following learning results		
Professional Competence				
Knowledge	Students will have an overview of various	technical problems and the differential equati	ons, which describe	e them. Students w
	gave an overview of different solution appr	roaches and for which kind of problems they can	be used for.	
Skille	Students are able to solve different technic	cal problems with the introduced discretization n	nethods	
JAIIIS		a problems with the introduced discretization in	nethous.	
Personal Competence				
Social Competence	The students are able to discuss problems	and jointly develop solution strategies.		
Autonomy	The students are able to develop colution	trataging for complex problems colf consistent	and critically analyse	o roculto
Autonomy	The students are able to develop solution s	strategies for complex problems self-consistent a	and critically analysi	e results.
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	General Engineering Science (German pro	gram, 7 semester): Specialisation Mechanical Er	ngineering, Focus Th	neoretical Mechanio
Following Curricula	Engineering: Compulsory			
	General Engineering Science (German prog	gram, 7 semester): Specialisation Advanced Mat	erials: Compulsory	
	General Engineering Science (German p	rogram, 7 semester): Specialisation Mechanic	al Engineering, Foo	cus Aircraft Syster
	Engineering: Elective Compulsory			
		gram, 7 semester): Specialisation Mechanical E	ngineering, Focus M	lechatronics: Electi
	Compulsory			
	Engineering Science: Core Qualification: Co			
	Engineering Science: Specialisation Advance Engineering Science: Specialisation Mecha			
	Engineering Science: Specialisation Mecha Engineering Science: Specialisation Mecha			
	Engineering Science: Specialisation Biome			
		eoretical Mechanical Engineering: Compulsory		
	Mechanical Engineering: Specialisation Me			
	Mechanical Engineering: Specialisation Airo			
	Mechanical Engineering: Specialisation Aire	crait systems Engineering. Compulsory		
	Technomathematics: Specialisation III. Eng			

Course L2446: Modeling, Sim	ourse L2446: Modeling, Simulation and Optimization (EN)	
Тур	Integrated Lecture	
Hrs/wk	4	
CP	6	
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56	
Lecturer	Prof. Benedikt Kriegesmann, Prof. Alexander Düster, Prof. Robert Seifried, Prof. Thomas Rung	
Language	EN	
Cycle	SoSe	
Content	 Partial Differential Equations in technical problems Overview of modelling approaches Finite Approximation Methods - Finite Differences / Elements / Volumes Introduction to the Discrete Element Method Numerical methods for time dependent problems Gradient-based optimization 	
Literature	Michael Schäfer, Computational Engineering - Introduction to Numerical Methods, Springer.	

Courses				
Title		Тур	Hrs/wk	СР
Electromagnetics for Engineers I: Ti		Lecture	3	5
Electromagnetics for Engineers I: Ti	me-Independent Fields (L2282)	Recitation Section (small)	2	1
Module Responsible	Dr. Cheng Yang			
-	None			
	Basic principles of electrical engineering and	d advanced mathematics		
Knowledge				
-	After taking part successfully, students have	e reached the following learning results		
Professional Competence Knowledge	They can explicate the principal behavior sources. They can describe the properties	ulas, relations, and methods of the theory of of electrostatic, magnetostatic, and current of complex electromagnetic fields by mean ns for the theory of time-independent electro	density fields with s of superposition of	regard to respecti solutions for simp
Skills	Students can apply Maxwell's Equations in integral notation in order to solve highly symmetrical, time-independent electromagnetic field problems. Furthermore, they are capable of applying a variety of methods that require solving Maxwell' Equations for more general problems. The students can assess the principal effects of given time-independent sources of fields an analyze these quantitatively. They can deduce meaningful quantities for the characterization of electrostatic, magnetostatic, and electrical flow fields (capacitances, inductances, resistances, etc.) from given fields and dimension them for practical applications.			
Personal Competence Social Competence	Students are able to work together on subject related tasks in small groups. They are able to present their results effectively (e.g during exercise sessions).			
Autonomy	Students are capable to gather necessary information from provided references and relate this information to the lecture. They are able to continually reflect their knowledge by means of activities that accompany the lecture, such as short oral quizzes during the lectures and exercises that are related to the exam. Based on respective feedback, students are expected to adjust their individua learning process. They are able to draw connections between their knowledge obtained in this lecture and the content of othe lectures (e.g. Electrical Engineering I, Linear Algebra, and Analysis).			
Workload in Hours	Independent Study Time 110, Study Time in	Lecture 70		
Credit points				
Course achievement				
Examination	Written exam			
Examination duration and scale	120 min			
Assignment for the	General Engineering Science (German progr	am, 7 semester): Specialisation Advanced Ma	terials: Elective Com	pulsory
-	Engineering Science: Core Qualification: Cor			-
	Engineering Science: Specialisation Advance	ed Materials: Compulsory		
	Engineering Science: Specialisation Mechan			
	Engineering Science: Specialisation Mechatr			
	Engineering Science: Specialisation Data Sc Engineering Science: Specialisation Biomedi	ience, Focus Physical Modelling: Elective Com	pulsory	

Course L2281: Electromagne	tics for Engineers I: Time-Independent Fields
Тур	Lecture
Hrs/wk	3
СР	5
	Independent Study Time 108, Study Time in Lecture 42
	Dr. Cheng Yang, Prof. Christian Schuster
Language	
Cycle	- Maxwell's Equations in integral and differential notation
Content	
	- Boundary conditions
	- Laws of conservation for energy and charge
	- Classification of electromagnetic field properties
	- Integral characteristics of time-independent fields (R, L, C)
	- Generic approaches to solving Poisson's Equation
	- Electrostatic fields and specific methods of solving
	- Magnetostatic fields and specific methods of solving
	- Fields of electrical current density and specific methods of solving
	- Action of force within time-independent fields
	- Numerical methods for solving time-independent problems
	The practical application of numerical methods will be trained within specifically prepared lectures in an interactive manner using small MATLAB programs.
Literature	- G. Lehner, "Elektromagnetische Feldtheorie: Für Ingenieure und Physiker", Springer (2010)
	- H. Henke, "Elektromagnetische Felder: Theorie und Anwendung", Springer (2011)
	- W. Nolting, "Grundkurs Theoretische Physik 3: Elektrodynamik", Springer (2011)
	- D. Griffiths, "Introduction to Electrodynamics", Pearson (2012)
	- J. Edminister, " Schaum's Outline of Electromagnetics", Mcgraw-Hill (2013)
	- Richard Feynman, "Feynman Lectures on Physics: Volume 2", Basic Books (2011)

Course L2282: Electromagnetics for Engineers I: Time-Independent Fields	
Тур	Recitation Section (small)
Hrs/wk	2
СР	1
Workload in Hours	Independent Study Time 2, Study Time in Lecture 28
Lecturer	Dr. Cheng Yang, Prof. Christian Schuster
Language	EN
Cycle	SoSe
Content	See interlocking course
Literature	See interlocking course

Courses				
		T	User fools	CD
Title Materials and Process Modeling (L2	862)	Typ Lecture	Hrs/wk 3	СР 3
Materials Selection and Processing		Lecture	3	3
Module Responsible			-	
Admission Requirements				
Recommended Previous		ntial equations, integration), materials science	(classes of materials	tructure propertie
Knowledge		cs (stress, strain, elasticity, deformation).		cructure, properti
Educational Objectives		s have reached the following learning results		
Professional Competence	After taking part succession, statene	nave rederied the following learning results		
Knowledge	material processing, the associated mi are decisive for the applicability and er covered in the sense of a broad range In parallel to the material-technologica laws for plasticity under monotonic and also plays a major role in manufactu	al consideration, the modeling of material behaves of cyclic loading is worked out. In addition to the ring processes and thus provides the basis for	operties. In conjunction foreground. Ceramics ar vior by means of phenor evaluation of componen or process simulation.	with the costs, the nd polymers are al menological mater t behavior, plastic Process models a
Skills	 simulation methods for selected manufacturing processes, such as rolling or forming, are presented for this topic area. Students are able to analyze the material behavior of metallic materials for general load histories with respect to elasticity and plasticity as w as the associated velocity-dependent material behavior and describe it with corresponding material laws to relate the deformation behavior to the underlying microstructural mechanisms to assess how processing procedures affect the chain microstructure - process - properties understand how the mechanical properties of metallic materials can be tailored by the processing due to microstructure 			
Personal Competence Social Competence		ourse by contributing to the discussion. ems and explain them in English in the plenum a	and discuss them with th	neir fellow studen
Autonomy	 develop solutions to given problems and explain them in English in the plenum and discuss them with their fellow students Students are able to, assess their own strengths and weaknesses concretely assess their respective learning status and define further work steps on this basis abstract given tasks and then apply them to new problems by transferring the taught material. 			
Workload in Hours	Independent Study Time 96, Study Tim	ne in Lecture 84		
Credit points				
Course achievement	Compulsory Bonus Form No 20 % Excercises	Description Wir stellen Übungsaufgaben (ÜA), o den wöchentlichen Übungen vorge: bis zu 20% bei der Prüfung berücks	stellt werden. Diese kör	
Examination	Written exam			
Examination duration and	120 min			
scale				
Assignment for the Following Curricula	Engineering Science: Specialisation Me Engineering Science: Specialisation Ad		Materials: Compulsory	
	Engineering Science: Specialisation Ad Mechanical Engineering: Specialisation	vanced Materials: Compulsory Materials in Engineering Sciences: Compulsory		

Course L2862: Materials and	Process Modeling
Тур	Lecture
Hrs/wk	3
CP	3
Workload in Hours	Independent Study Time 48, Study Time in Lecture 42
Lecturer	Prof. Norbert Huber
Language	EN
Cycle	SoSe
Content	 Relevance of plasticity in materials processing and operation Fundamentals of plasticity in metals and alloys Modellierung von Materialverhalten Plasticity in cyclic loading Rate dependency, recristallization Rolling, forming, and solid state joining processes Residual stress design
Literature	 Hull and Bacon: Introduction to Dislocations (1984) G. Gottstein: Physik. Grundlagen der Materialk. (2001) P. Haupt: Cont. Mechanics and Theory of Materials (2002) N. Huber: Vorlesungsskript "Grundlagen der mechanischen Eigenschaften von Werkstoffen", TUHH

Course L2861: Materials Sele	ection and Processing
Тур	Lecture
Hrs/wk	3
СР	3
Workload in Hours	Independent Study Time 48, Study Time in Lecture 42
Lecturer	Prof. Kaline Pagnan Furlan
Language	EN
Cycle	SoSe
Content	 Introduction Overview of fabrication processes Shape considerations: macrostructural aspects Material properties: microstructural aspects Materials engineering: microstructure, shape and processing relation Materials engineering: function and costs relation Materials engineering: function and costs relation K.P. Furlan, Lecture slides "Materials Selection and Processing (Iv2861)", StudIP E-learning system, TUHH W.D. Callister, Materials science and engineering: an introduction, 5 th edition, Wiley (2000) https://katalog.tub.tuhh.de/Record/270018409 or https://katalog.tub.tuhh.de/Record/1696922097 (online link at 'Exemplare') M.F.Ashby, Materials selection in mechanical design, 3 rd edition, Butterworth-Heinemann (2005) https://katalog.tub.tuhh.de/Record/39697838X

Specialization Civil Engineering

In the specialization "civil engineering" the graduates attain the basic competences to plan, build and repair structures like bridges and tunnels, structures in hydraulic engineering, as well as industrial and housing construction. The specialization allows the transition to the master program civil engineering.

Module M0580: Princi	ples of Building Materials a	nd Building Physics		
Courses				
Title		Тур	Hrs/wk	СР
Building Physics (L0217)		Lecture	2	2
Building Physics (L0219)		Recitation Section (large)	1	1
Building Physics (L0247)		Recitation Section (small)	1	1
Principles of Building Materials (L02		Lecture	2	2
Module Responsible	Prof. Frank Schmidt-Döhl			
Admission Requirements	None			
Recommended Previous	Knowledge of physics, chemistry and ma	thematics from school		
Knowledge				
Educational Objectives	After taking part successfully, students h	ave reached the following learning results		
Professional Competence				
Knowledge	The students are able to identify fundam	ental effects of action to materials and structures, to	o explain different	types of mechanica
	behaviour, to describe the structure o	f building materials and the correlations betwee	n structure and	other properties, to
	show methods of joining and of corrosion processes and to describe the most important regularities and properties of			roperties of building
	materials and structures and their measu	urement in the field of protection against moisture, o	oldness, fire and	noise.
Skille	The students are able to work with the r	most important standardized methods and regularit	ies in the field of	moisture protection
54///3		, fire protection and noise protection in the case of a		moisture protection
	the definition regulation for energy saving		sinan banang.	
Personal Competence				
Social Competence	The students are able to support each ot	her to learn the very extensive specialist knowledge		
Autonomy	The students are able to make the timing	g and the operation steps to learn the specialist know	wladge of a very	extensive field
Autonomy		g and the operation steps to learn the specialist know	vieuge of a very e	extensive neid.
Workload in Hours	Independent Study Time 96, Study Time	in Lecture 84		
Credit points				
Course achievement				
Examination	Written exam			
Examination duration and	2 h written exam			
scale				
Assignment for the	General Engineering Science (German pr	ogram, 7 semester): Specialisation Civil Engineering	: Compulsory	
-	Civil- and Environmental Engineering: Co			
	Integrated Building Technology: Core Qu			
	Orientation Studies: Core Qualification: E			
	Technomathematics: Specialisation III. Er			

Course L0217: Building Phys	ics
Тур	Lecture
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Prof. Frank Schmidt-Döhl
Language	DE
Cycle	WiSe
Content	Heat transport, thermal bridges, balances of energy consumption, German regulation for energy saving, heat protection in
	summer, moisture transport, condensation moisture, protection against mold, fire protection,
	noise protection
Literature	Fischer, HM. ; Freymuth, H.; Häupl, P.; Homann, M.; Jenisch, R.; Richter, E.; Stohrer, M.: Lehrbuch der Bauphysik. Vieweg und
	Teubner Verlag, Wiesbaden, ISBN 978-3-519-55014-3

Course L0219: Building Phys	Course L0219: Building Physics	
Тур	Recitation Section (large)	
Hrs/wk	1	
CP	1	
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14	
Lecturer	Prof. Frank Schmidt-Döhl	
Language	DE	
Cycle	WiSe	
Content	See interlocking course	
Literature	See interlocking course	

Course L0247: Building Physics	
Тур	Recitation Section (small)
Hrs/wk	1
СР	1
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14
Lecturer	Prof. Frank Schmidt-Döhl
Language	DE
Cycle	WiSe
Content	See interlocking course
Literature	See interlocking course

Course L0215: Principles of E	Building Materials
	Lecture
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Prof. Frank Schmidt-Döhl
Language	DE
Cycle	WiSe
Content	Structure of building materials
	Effects of action
	Fundamentals of mechanical behaviour
	Material testing
	Principles of metals
	Joining methods
Literature	Wendehorst, R.: Baustoffkunde. ISBN 3-8351-0132-3
	Scholz, W.:Baustoffkenntnis. ISBN 3-8041-4197-8

Courses					
Title			Тур	Hrs/wk	СР
Structural Analysis I (L0666)			Lecture	2	3
Structural Analysis I (L0667)			Recitation Section (large)	2	3
Module Responsible	Prof. Bastian Oester	le			
Admission Requirements	None				
Recommended Previous	Mechanics I, Mathen	natics I			
Knowledge					
Educational Objectives	After taking part suc	cessfully, students have re	ached the following learning results		
Professional Competence					
Knowledge	After successfully co	mpleting this module, stud	lents can express the basic aspects of linear	frame analysis of s	tatically determina
	systems.				
Skills			e students are able to distinguish between s	-	
	-		riables and to construct influence lines of s	statically determina	ite plane and spat
	frame and truss stru	ictures.			
Personal Competence					
Social Competence	Students can				
	 participate in 	subject-specific and interd	isciplinary discussions,		
	 defend their own work results in front of others 				
	 promote the s 	scientific development of c	olleagues		
	 Furthermore, 	they can give and accept p	professional constructive criticism		
Autonomy			k assignments. Due to the in-term feedback	k, they are enabled	d to self-assess the
	learning progress du	iring the lecture period, alr	eady.		
Workload in Hours	Independent Study	Time 124, Study Time in Le	cture 56		
Credit points	6				
Course achievement	Compulsory Bonus	Form	Description		
	No 10 %	Written elaboration	Hausübungen mit Testat, betreut durch	Studentische Tutor	en (Tutorium)
Examination	Written exam				
Examination duration and	90 minutes				
scale					
Assignment for the	General Engineering	Science (German program	n, 7 semester): Specialisation Civil Engineerir	ng: Compulsory	
Following Curricula	Civil- and Environme	ental Engineering: Core Qua	alification: Compulsory		
	Logistics and Mobilit	y: Specialisation Traffic Pla	nning and Systems: Elective Compulsory		
	Technomathematics: Specialisation III. Engineering Science: Elective Compulsory				
	Engineering and Ma	nagement - Major in Logist	ics and Mobility: Specialisation Traffic Planni	ng and Systems: Ele	ective Compulsory

Course L0666: Structural An	alysis I
Тур	Lecture
Hrs/wk	2
CP	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Prof. Bastian Oesterle
Language	DE
Cycle	WiSe
Content	Statically determinate structural systems
	 modelling of structures theory of plane and spacial structures assessment of structural behaviour, degree of static indeterminacy and kinematics analysis of forces and moments, as well as diplscements and rotations principle of virtual work influence lines
Literature	 Vorlesungsmanuskript Bletzinger et al.: Aufgabensammlung zur Baustatik: Übungsaufgaben zur Berechnung ebener Stabtragwerke. Hanser. Dinkler: Grundlagen der Baustatik. Springer. Marti: Baustatik. Ernst und Sohn.

Course L0667: Structural Ana	se L0667: Structural Analysis I			
Тур	Recitation Section (large)			
Hrs/wk	2			
CP	3			
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28			
Lecturer	Prof. Bastian Oesterle			
Language	DE			
Cycle	WiSe			
Content	See interlocking course			
Literature	See interlocking course			

Module M0590: Buildi	ng Materials a	nd Building	Chemistry			
Fiodule Fiossor Build	ing Materials a	na banang	chennistry			
Courses						
Title				Тур	Hrs/wk	СР
Building Materials and Building Che	mistry (L0248)			Lecture	4	4
Building Materials and Building Che	mistry (L0249)			Recitation Section (small)	1	2
Module Responsible	Prof. Frank Schmidt-D	öhl				
Admission Requirements	None					
Recommended Previous	Module Principles of E	Building Materials	and Building Phys	ics		
Knowledge						
Educational Objectives	After taking part succ	essfully, students	have reached the	following learning results		
Professional Competence						
Knowledge	The students are a	ble to explain t	he most importa	nt components, the manufact	ure, the structure,	the most importan
	characteristics of the	mechanical beh	aviour and the co	rrosion behaviour, the material	testing and the fiel	ds of utilization of al
	relevant building mat	erials.				
Skills	The students are able to assess the usability of building materials for different applications and to select building materials					
	according to their spe	ecific advantages	and disadvantage	s. The students are able to prep	are the mixture of a	normal type concret
	and to consider the r	mixture in respec	t to the actual ru	es and the connections betwee	n the characteristic	concrete parameters
	They are able to selec	ct suitable materi	als and mixtures t	o avoid damage processes.		
Personal Competence						
	The students are able	e to support each	other to learn th	e very extensive specialist know	/ledge in learning gr	oups and to carry ou
,	exercises in small gro				55	
	,					
Autonomv	The students are able	e to make the timi	ing and the operat	ion steps to learn the specialist	knowledge of a verv	extensive field.
			5			
Workload in Hours	Independent Study Ti	me 110, Study Ti	me in Lecture 70			
Credit points						
Course achievement	Compulsory Bonus	Form	Descri	ption		
Free and the	No 10 %	Presentation				
Examination						
	2 h written exam					
scale	Conorol Engineering			ter), Creciclization Civil Francis	wing, Compulsor:	
-				ter): Specialisation Civil Enginee	ening: Compulsory	
Following Curricula	Civil- and Environmer					
	Integrated Building Te			-		
	Orientation Studies: C	ore Qualification:	Elective Compuls	огу		

Course L0248: Building Mate	rials and Building Chemistry
Тур	Lecture
Hrs/wk	4
CP	4
Workload in Hours	Independent Study Time 64, Study Time in Lecture 56
Lecturer	Prof. Frank Schmidt-Döhl
Language	DE
Cycle	SoSe
Content	Cementing materials, aggregates, admixtures and other components in mortar and concrete, concrete, durability of cement
	bonded materials, repair of concrete structures, steel, cast iron, non-ferrous metals,
	metal corrosion, timber, plastics, natural stone, synthetic stones, mortar, masonry, glass, bitumen
Literature	Wendehorst, R.: Baustoffkunde. ISBN 3-8351-0132-3
	Scholz, W.:Baustoffkenntnis. ISBN 3-8041-4197-8
	Henning, O.; Knöfel, D.: Baustoffchemie. ISBN 3-345-00799-1
	Knoblauch, H.; Schneider, U.: Bauchemie. ISBN 3-8041-5174-4

Course L0249: Building Mate	rials and Building Chemistry
Тур	Recitation Section (small)
Hrs/wk	1
CP	2
Workload in Hours	Independent Study Time 46, Study Time in Lecture 14
Lecturer	Prof. Frank Schmidt-Döhl, Andre Rössler
Language	DE
Cycle	SoSe
Content	See interlocking course
Literature	See interlocking course

Courses							
Title				Тур	Hrs/wk	СР	
Project Seminar Concrete I (L0896)				Seminar	1	1	
Reinforced Concrete Design I (L030	3)			Lecture	2	3	
Reinforced Concrete Design I (L030	5)			Recitation Section (large)	2	2	
Module Responsible	Prof. Günter Romba	ch					
Admission Requirements	None						
Recommended Previous	Basic knowledge in	structural analysis and	d building materials.				
Knowledge	Madulaa, Chruchura	Analysia I. Mashaniaa	1.11				
	Modules: Structura	l Analysis I, Mechanics	1+11				
Educational Objectives	After taking part suc	ccessfully, students ha	we reached the following	ng learning results			
Professional Competence							
Knowledge	The students can ou	utline the history of co	ncrete construction an	d explain the basics of struc	tural engineering,	including usual lo	
	combinations and s	afety concepts. They a	are able to draft and d	mension simple structures,	as well as to eval	uate and discuss t	
	behaviour of the materials and of structural members.						
Skills	The students are able to apply basic procedures of the conception and dimensioning to practical cases. They are capable to draft						
	simple concrete structures and to design them for bending and bending with axial force, and to plan their detailing an						
	execution. Moreover, they can make design and construction sketches and draw up technical descriptions.						
		r, they can make desig	gir and construction ske	teries and araw up teerinica	r desemptions.		
Personal Competence							
-							
Social Competence	The standards are sh	la ha sa mu and storala.	to also in the componenties	and dimensioning of should		U	
Autonomy	The students are ab	le to carry out simple	tasks in the conceptior	and dimensioning of struct	ures and to critica	lly reflect the resu	
Workload in Hours	Independent Study	Time 110, Study Time	in Lecture 70				
Credit points	6						
Course achievement	Compulsory Bonus	Form	Description				
	No None	Excercises					
Examination	Written exam						
Examination duration and	120 minutes						
scale							
Assignment for the	General Engineering	g Science (German pro	gram, 7 semester): Sp	ecialisation Civil Engineering	J: Compulsory		
Following Curricula	Civil- and Environme	ental Engineering: Cor	e Qualification: Compu	lsory			
-			•				
Course L0896: Project Semin	ar Concrete I						
Тур	Seminar						
Hrs/wk	1						
	-						

HIS/WK	I
СР	1
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14
Lecturer	Prof. Günter Rombach
Language	DE
Cycle	SoSe
Content	In the course of the project seminar, a simple structure is drafted and dimensioned.
Literature	Download der Unterlagen zur Vorlesung über Stud.IP!

Course L0303: Reinforced Co	ncrete Design I
Тур	Lecture
Hrs/wk	2
СР	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Prof. Günter Rombach
Language	DE
Cycle	SoSe
Content	The following subjects/contents are treated:
Literature	 history of concrete construction building materials: mechanical and physical-chemical properties of concrete, steel, GFRP, CFRP Introduction in safety concepts, ultimate limit states and safety coefficients actions on structures design of linear concrete members with arbitrary cross section for tension and bending with/without axial force design of slender columns Download der Unterlagen zur Vorlesung über Stud.IP! Zilch K., Zehetmaier G.: Bemessung im konstruktiven Betonbau. Springer Verlag, 2010 König G., Tue N.: Grundlagen des Stahlbetonbaus, 3. Auflage, Teubner-Verlag, 2008 Deutscher Beton- und Bautechnikverein E.V.: Beispiele zur Bemessung von Betontragwerken nach Eurocode 2. Band 1:
	 Hochbau, Bauverlag GmbH, Wiesbaden 2011 Fingerlos F., Hegger J., Zilch K.: Eurocode 2 für Deutschland. Berlin 2016 Dahms KH.: Rohbauzeichnungen, Bewehrungszeichnungen. Bauverlag, Wiesbaden 1997 Grasser E., Thielen G.: Hilfsmittel zur Berechnung der Schnittgrößen und Formänderungen von Stahlbetontragwerken. Deutscher Ausschuss für Stahlbeton, Heft 240, Verlag Ernst & Sohn, Berlin 1978

Course L0305: Reinforced Co	ncrete Design I
Тур	Recitation Section (large)
Hrs/wk	2
СР	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Prof. Günter Rombach
Language	DE
Cycle	SoSe
Content	See interlocking course
Literature	See interlocking course

Courses Type Mrs/wk CP Statutard Andyris IL0073) Kature 2 3 Module Responsible Port Batisto Octorele 3 Admission Requirements Knowneedse Knowneedse Xnowneedse Xnowneedse </th <th>Module M0744: Struc</th> <th>tural Analysis II</th> <th></th> <th></th> <th></th> <th></th> <th></th>	Module M0744: Struc	tural Analysis II					
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Module Regeneration Into Essibility Close (III) Admission Requirements Recommended Previous Knowledge • Machanics (II • Machanics (III • Machanics (III) • Machanics (III) • Structural Analysis I Educational Objectives After taking part successfully, students have reached the following learning results Professional Competence Knowledge After taking part successfully, students have reached the following learning results Professional Competence Knowledge After successful completion of this module, students can express the basic aspects of linear frame analysis of static indeterminate systems. Skills After successful completion of this module, the students are able to analyze state variables and to construct influence lines statically inderminate plane and spatial frame and truss structures. Skills After successful completion of this module, the students are able to analyze state variables and to construct influence lines statically inderminate plane and spatial frame and truss structures. Skills After successful completion of this module, the students are able to analyze state variables and to construct influence lines statically inderminate plane and spatial frame and truss structures. Versional Competence Students can • surficients in subject-specific and interdisciplinary discussions, • pretomber work results in foot of chars • pretomber more, they can give and accept professional constructive criticism Automation • surficients in subject-specific and interdisciplinary discussions, • pretomber more, they							
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Recommended Previous Mechanics VII Mechanics VII Mechanics VII Mechanics VII Mechanics VII Structural Analysis I Struct		Prof. Bastian Oesterle					
Knowledge • Mechanics (II • Differential Equations I • Differential Equations I • Structural Analysis I • Structural Analysis I • Professional Competence Knewkdel After successful completion of this module, students can express the basic aspects of linear frame analysis of static inderminate systems. After successful completion of this module, the students are able to analyze state variables and to construct influence linear frame analysis of static inderminate plane and spatial frame and truss structures. Social Competence Social Competecon Social Competeence		None					
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Skills After successful completion of this module, the students are able to analyze state variables and to construct influence lines statically inderminate plane and spatial frame and truss structures. Personal Competence Skills Social Competence students can • participate in subject-specific and interdisciplinary discussions, - defend their own work results in front of others - promote the scientific development of colleagues - Furthermore, they can give and accept professional constructive criticism Autonomy The students are able to work in-term homework assignments. Due to the in-term feedback, they are enabled to self-assess the in-term interdisciplinary discussions, - interming progress during the lecture period, aiready. Workload in Houre Independent Study Time 124, Study Time in Lecture 56 Course achievement Semination duration and 30 minutes No 10 % Written elaboration Hausibungen mit Testat, betreut durch Studentische Tutoren (Tutorium) Examination duration and 30 minutes Statistical Virien exam Seciet General Engineering Science (German program, 7 semester): Specialisation Civil Engineering: Compulsory Following Curricuts Evaluation Leguneering: Core Qualification: Compulsory Following Curricuts Evaluation Seciet German program, 7 semester): Specialisation Civil Engineering: Compulsory Following Curicuts Evalumental Engineering Science (German progra	niiomeage			stadents can exp			alysis of static
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Workload in Hours Independent Study Time 62, Study Time in Lecture 28 Lecturer Prof. Bastian Oesterle Language DE							
Lecturer Prof. Bastian Oesterle Language DE							
Language DE			e 62, Study Time in Lec	ture 28			

Cycle	Sose
Content	 Analysis of statically indeterminant structures Force method, displacement method coputational methods, direct stiffness method elastically supported structures
Literature	 Vorlesungsmanuskript Bletzinger et al.: Aufgabensammlung zur Baustatik: Übungsaufgaben zur Berechnung ebener Stabtragwerke. Hanser. Dinkler: Grundlagen der Baustatik. Springer. Marti: Baustatik. Ernst und Sohn.

Course L0674: Structural Ana	urse L0674: Structural Analysis II			
Тур	Recitation Section (large)			
Hrs/wk	2			
CP	3			
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28			
Lecturer	Prof. Bastian Oesterle			
Language	DE			
Cycle	SoSe			
Content	See interlocking course			
Literature	See interlocking course			

Courses				
Title		Тур	Hrs/wk	СР
Steel Structures I (L0299)		Lecture	2	3
Steel Structures I (L0300)		Recitation Section (large)	2	3
Module Responsible	Prof. Marcus Rutner			
Admission Requirements	None			
Recommended Previous	Structural analysis I, Structural analysis II			
Knowledge	Mechanics I, Mechanics II			
	Building Materials and Building Chemistry			
	Principles of Building Materials and Building Ph	vsics		
Educational Objectives	After taking part successfully, students have reached	the following learning results		
Professional Competence				
Knowledge	After passing this module students are able to			
	 give a summary of the security concept 			
	explain the priciples of the design process			
	describe and illustrate the bhaviour of memers	in tension, compression and bending		
Skills	Students can rate and apply the material steel approp	iately with respect to its properties and	usage.	
	They can use the security concept with respect to loa	ds, forces and resistances.		
	They can check the ultimate limit state and the service	eability of simple members in tension, o	compression and	bending.
Personal Competence				
Social Competence	After participation of an optional course (building of	a simple truss) they are able to organiz	themselves in	groups. They will b
	successful in guided building a truss with bolted conn	ections according to design drawings.		
Autonomy				
Workload in Hours	Independent Study Time 124, Study Time in Lecture 5	6		
Credit points	6			
Course achievement	None			
Examination	Written exam			
Examination duration and	120 minutes			
scale				
Assignment for the	General Engineering Science (German program, 7 ser	nester): Specialisation Civil Engineering	Compulsory	
Following Curricula	Civil- and Environmental Engineering: Core Qualificati	on: Compulsory		
Course L0299: Steel Structu	res I			
Тур	Lecture			
Hrs/wk	2			

71	
Hrs/wk	2
CP	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Prof. Marcus Rutner
Language	DE
Cycle	WiSe
Content	 Introduction to steel constructions Materials Design and security model Tension rods Beams (elsatic and plastic design Column design Bolted connections
	Petersen, C.: Stahlbau, 4. Auflage 2013, Springer-Vieweg Verlag Wagenknecht, G.: Stahlbau-Praxis nach Eurocode 3, Bauwerk-Verlag 2011 • Band 1 Tragwerksplanung, Grundlagen • Band 2 Verbindungen und Konstruktionen

Course L0300: Steel Structur	Course L0300: Steel Structures I			
Тур	Recitation Section (large)			
Hrs/wk	2			
СР	3			
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28			
Lecturer	Prof. Marcus Rutner			
Language	DE			
Cycle	WiSe			
Content	See interlocking course			
Literature	See interlocking course			

Module M0706: Geote	chnics I					
Courses						
Title				Тур	Hrs/wk	СР
Soil Mechanics (L0550)				Lecture	2	2
Soil Mechanics (L0551)				Recitation Section (large)	2	2 2
Soil Mechanics (L1493) Module Responsible	Brof Jürgon Grabo			Recitation Section (small)	Z	2
Admission Requirements						
Recommended Previous						
Knowledge	Mechanics I-II					
Educational Objectives	After taking part sur	cessfully students	have reached the follow	ing learning results		
Professional Competence	Arter taking part suc	cessiuny, students	nave reached the follow	ing learning results		
•	The students know t	bo basics of soil m	ochanics as the structure	e and characteristics of soil, s	trocc distribution	due to weight wat
Knowledge						-
Skille	or structures, consolidation and settlement calculations, as well as failure of the soil due to ground- or slope failure. After the successful completion of the module the students should be able to describe the mechanical properties and to evalual					
SKIIIS	them with the help of geotechnical standard tests. They can calculate stresses and deformation in the soils due to weigh influence of structures. They are are able to prove the usability (settlements) for shallow foundations.					
						his due to weight
	initiactice of scructur	cs. mey are are us	ie to prove the usublicy	(Settlements) for shallow rou	laations.	
Personal Competence						
Social Competence						
Autonomy						
Workload in Hours	Independent Study 7	Fime 96, Study Time	e in Lecture 84			
Credit points	6					
Course achievement	Compulsory Bonus	Form	Description			
	No 20 %	Attestation				
Examination	Written exam					
Examination duration and	90 minutes					
scale						
Assignment for the	General Engineering	Science (German p	program, 7 semester): Sp	pecialisation Civil Engineering	: Compulsory	
Following Curricula	Civil- and Environme	ental Engineering: C	Core Qualification: Compu	ulsory		
	Logistics and Mobilit	y: Specialisation Tr	affic Planning and Syster	ns: Elective Compulsory		
	Technomathematics	Specialisation III.	Engineering Science: Ele	ctive Compulsory		
	Engineering and Mar	nagement - Major ir	n Logistics and Mobility: S	Specialisation Traffic Planning	and Systems: El	ective Compulsory

Course L0550: Soil Mechanic	S
Тур	Lecture
Hrs/wk	
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Prof. Jürgen Grabe
Language	DE
Cycle	WiSe
Content	 Structure of the soil Ground surveying Compstition and properties of the soil Groundwater One-dimensional compression Spreading of stresses Settlement calculation Consolidation Shear strength Earth pressure Slope failure Ground failure Suspension based earth tenches
Literature	 Vorlesungsumdruck, s. ww.tu-harburg.de/gbt Grabe, J. (2004): Bodenmechanik und Grundbau Gudehus, G. (1981): Bodenmechanik Kolymbas, D. (1998): Geotechnik - Bodenmechanik und Grundbau Grundbau-Taschenbuch, Teil 1, aktuelle Auflage

Course L0551: Soil Mechanic	S
Тур	Recitation Section (large)
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Prof. Jürgen Grabe
Language	DE
Cycle	WiSe
Content	See interlocking course
Literature	See interlocking course

Course L1493: Soil Mechanic	:S
Тур	Recitation Section (small)
Hrs/wk	2
СР	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Prof. Jürgen Grabe
Language	DE
Cycle	WiSe
Content	See interlocking course
Literature	See interlocking course

Courses							
Title					Тур	Hrs/wk	СР
Hydrology (L0909)				I	Lecture	1	1
Hydrology (L0956)				I	Project-/problem-based Learning	1	2
Hydromechanics (L0615)				I	Lecture	2	2
Hydromechanics (L0616)					Project-/problem-based Learning	1	1
Module Responsible	Prof. Peter	Fröhle					
Admission Requirements	None						
Recommended Previous	Mathemati	cs I, II and	111				
Knowledge	Mechanics	l und ll					
Educational Objectives	After taking	g part suc	cessfully, students have r	eached the following	g learning results		
Professional Competence							
Knowledge	The students are able to define the basic terms of hydromechanics, hydrology groundwater hydrology and water management They are able to derive the basic formulations of i) hydrostatics, ii) kinematics of flows and iii) conservation laws and to describ and quantify the relevant processes of the hydrological water cycle. Besides, the students can describe the main aspects rainfall-run-off-modelling and of established reservoir / storage models as well as the concepts of the determination of a un hydrograph.						
Skills	The students are able to apply the fundamental formulations of hydromechanics to basic practical problems. Furthermore, they able to run, explain and document basic hydraulic experiments. Besides, they are able to apply basic hydrological approaches and methods to simple hydrological problems. The students here applied to expendently apply simple reservoir/storage models and a unit-hydrograph to given problems.						
	In addition, the basic concepts of field-measurements of hydrological and hydrodynamic values can be described and the studer are able to perform, analyze and assess respective measurements.						
Personal Competence							
Social Competence		ssions by	use of peer learning appr		tructured manner. They can e re, they are able to prepare ar		
Autonomy	specific kn	Students are capable of organising their individual work flow to contribute to the conduct of experiments and to present discipline specific knowledge. They can provide each other with feedback and suggestions on their results. They are capable of reflecting their study techniques and learning strategy on an individual basis.					
Workload in Hours	Independe	nt Study 1	Time 110, Study Time in Le	ecture 70			
Credit points							
Course achievement	Compulsory	Bonus	Form	Description			
	Yes Yes Yes	None None None	Excercises Subject theoretical practical work Group discussion	Hydromechani Erstellung ein	en Hydrologie Dokumentation und Präs k oder Hydraulik in Gruppen ne Posters zu einer Themat Gruppen und Präsentation		
Examination							
Examination duration and							
scale							
Assignment for the			Science (German prograr ental Engineering: Core Qu		cialisation Civil Engineering: Co	mpulsory	

Course L0909: Hydrology	
Тур	Lecture
Hrs/wk	1
CP	1
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14
Lecturer	Prof. Peter Fröhle
Language	DE
Cycle	WiSe
Content	Introduction to basics of hydrology and groundwater hydrology:
	 Hydrological cycle Data acquisition in hydrology Data analyses and statistical assessment Statistics of extremes Regionalization methods for hydrological values rainfall-run-off modelling on the basis of a unit hydrograph concept
Literature	Maniak, U. (2017). Hydrologie und Wasserwirtschaft: Eine Einführung für Ingenieure. Springer Vieweg. Skript "Hydrologie und Gewässerkunde"

Course L0956: Hydrology	
Тур	Project-/problem-based Learning
Hrs/wk	1
CP	2
Workload in Hours	Independent Study Time 46, Study Time in Lecture 14
Lecturer	Prof. Peter Fröhle
Language	DE
Cycle	WiSe
Content	Introduction to basics of Hydrology: • Hydrological cycle • Data acquisition • Data analyses and statistical assessment • Statistics of extremes • Regionalization methods for hydrological values Rainfall-run-off modelling on the basis of a unit hydrograph conceps
Literature	Maniak, Hydrologie und Wasserwirtschaft, Eine Einführung für Ingenieure, Springer Skript Hydrologie und Gewässerkunde

Course L0615: Hydromechanics		
Тур	Lecture	
Hrs/wk	2	
CP	2	
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28	
Lecturer	Prof. Peter Fröhle	
Language	DE	
Cycle	WiSe	
Content	Fundamentals of Hydromechanics	
Literature	 Characteristics of fluids Hydrostatics Kinematics of flows, laminar and turbulent flows Conservation laws Conservation of mass Conservation of Energy Momentum Equation Application of conservation laws to flow conditions 	
Literature	Skript zur Vorlesung Hydromechanik/Hydraulik, Kapitel 1-2 Truckenbrodt, E.: Lehrbuch der angewandten Fluidmechanik, Springer Verlag, Berlin, 1998. Truckenbrodt, E.: Grundlagen und elementare Strömungsvorgänge dichtebeständiger Fluide / Fluidmechanik, Springer Verlag, Berlin, 1996.	

ourse L0616: Hydromechanics		
Тур	Project-/problem-based Learning	
Hrs/wk	1	
СР	1	
Workload in Hours	dependent Study Time 16, Study Time in Lecture 14	
Lecturer	Prof. Peter Fröhle	
Language	E	
Cycle	le WiSe	
Content	See interlocking course	
Literature	e interlocking course	

Courses				
Fitle	Тур		Hrs/wk	СР
Basics in Structural Design (L0209)		ect-/problem-based Learning	2	4
Basics of Structural Design (L0205)	Lectu		2	1
Basics in Structural Design (L0208)		tation Section (large)	1	1
Module Responsible				
Admission Requirements	None			
	Contents of module "Principles of Building Materials and Building Phys	SICS"		
Knowledge				
	After taking part successfully, students have reached the following lea	arning results		
Professional Competence	After alter die alle "Duildie Construction" au duit als de la ser al la			
Knowleage	After attending the "Building Construction" module students are able			
	 to define the basics of building regulations law 			
	 to explain load effects and associated concepts 			
	 to describe overriding conventions of the construction industry 			
	 to specify typical building components 			
	 to distinguish between different possibilities of load bearing between 	haviour and risks due to lac	< of stability	
	 to explain the main objective of fire control. 			
Skills	After the successful completion of the "Building Construction" module	, students will be able		
	 to apply industry-specific drawing conventions 			
	 carry out preliminary dimensioning of basic building componen 	ts		
	 develop stability and foundation concepts 			
	use BIM software			
	 and to design and construct standard cross-sections due to struct 	uctural aspects.		
Personal Competence				
-	After attending the course students are able			
	• to work in a team and to persent the results of the team work			
	 to use the feedback from other students to improve the own re to give a feedback to other students in a constructive manner. 	SUITS		
	• to give a feedback to other students in a constructive manner			
Autonomy	After attending the course students are able			
	 to control and improve their knowledge with the help of weeekl 	ly presentations (lecture rec	m) and tests	(פו חו דו)
	 to control and improve their knowledge with the help of weekly to divide the main task in different parts, to deduce the needed 			
	• to divide the main task in different parts, to deduce the needed	a knowledge and to schedal	the unreren	t work steps
Workload in Hours	Independent Study Time 110, Study Time in Lecture 70			
Credit points				
Course achievement				
Examination	Subject theoretical and practical work			
Examination duration and	Desing, Construction and prelimnary design in a written form			
scale	besing, construction and preminary design in a written form			
Assignment for the	General Engineering Science (German program, 7 semester): Speciali	sation Civil Engineering: Co	npulsorv	
Following Curricula	Civil- and Environmental Engineering: Core Qualification: Compulsory		, ,	
	Integrated Building Technology: Core Qualification: Compulsory			

ourse L0209: Basics in Stru	ctural Design
Тур	Project-/problem-based Learning
Hrs/wk	
CP	
Workload in Hours	Independent Study Time 92, Study Time in Lecture 28
Lecturer	Sebastian Rybczynski
Language	DE
Cycle	WiSe
Content	Constructing a small individuell buidling in groups of 4 persons
	 Analysing the informations and the contents of development plans and building regulation laws
	 Design of building components and approving of the functionality (sealing, facades, roofs)
	 Design and approve of the functionality of the component interconnections
	 Proofing and assessing of moisture behaviour, energy comsumption, acoustic protection and fire control
	Assessing the building stability
	Basics of building services Each work the results of different work stone are presented in and written form
	 Each week the results of different work steps are presented in oral and written form
Literature	Vortragsfolien der Lehrveranstaltung stehen über STUD.IP zum download zur Verfügung
	Neumann, Dietrich (Hestermann, Ulf.; Rongen, Ludwig.; Weinbrenner, Ulrich)
	Frick/Knöll Baukonstructionslehre 1 / [Internet-Ressource]
	ISBN: 978-3-8351-9121-1
	Wiesbaden : B.G. Teubner Verlag / GWV Fachverlage GmbH, Wiesbaden, 2006
	Frick[Begr.], Otto (Knöll[Begr.], Karl.; Neumann, Dietrich.; Hestermann, Ulf.; Rongen, Ludwig.)
	Baukonstruktionslehre 2 / [Internet-Ressource]
	ISBN: 978-3-8348-9486-1
	Wiesbaden : Vieweg+Teubner Verlag / GWV Fachverlage GmbH, Wiesbaden, 2008
	Dierks, Klaus (Wormuth, Rüdiger.)
	Baukonstruktion : [Einführung, Grundlagen, Gründungen, technische Ausrüstung, Wände, Geschossdecken, Treppen, Däche
	Fenster, Türen, Konstruktionsatlas]
	ISBN: 3804150454 (Gb.) ISBN: 978-3-8041-5045-4
	Neuwied : Werner, 2007
	Schneider, Klaus-Jürgen (Goris, Alfons.; Berner, Klaus)
	Bautabellen für Ingenieure : mit Berechnungshinweisen und Beispielen ; [auf CD-ROM: Stabwerksprogramm IQ 100 B, Tools f
	den konstr. Ingenieurbau, Fachinformationen, Normentexte]
	ISBN: 3804152287
	Neuwied : Werner, 2006
	Wendehorst, Reinhard (Wetzell, Otto W.,; Baumgartner, Herwig,; Deutsches Institut für Normung)
	Wendehorst Bautechnische Zahlentafeln
	ISBN: 978-3-8351-0055-8 ISBN: 3835100556
	Stuttgart [u.a.] : Teubner Berlin [u.a.] : Beuth, 2007
	Neufert, Ernst (Kister, Johannes)
	Bauentwurfslehre : Grundlagen, Normen, Vorschriften über Anlage, Bau, Gestaltung, Raumbedarf, Raumbeziehungen, Maße
	Gebäude, Räume, Einrichtungen, Geräte mit dem Menschen als Maß und Ziel ; Handbuch für den Baufachmann, Bauher
	Lehrenden und Lernenden
	ISBN: 978-3-8348-0732-8 (GB.)
	Wiesbaden : Vieweg + Teubner, 2009

Course L0205: Basics of Stru	ictural Design		
Тур			
Hrs/wk			
CP			
	Independent Study Time 2, Study Time in Lecture 28		
	Sebastian Rybczynski		
Language			
Cycle	WiSe		
Content	Basics of building regulation laws		
	Foundation of buildings		
	Sealing of basements		
	• facades		
	Ceilings		
	Roofs		
	Windows, doors and post-and-beam constructions		
	Staircases		
	Basics of strucural engineering design		
	Structural fire prevention		
	Optional tests on STUD.IP		
Literature	Vortragsfolien der Lehrveranstaltung stehen über STUD. IP zum download zur Verfügung		
	Schneider Bautabellen (Hrsg. A. Albert)		
	23., überarbeitete Aufl.		
	ISBN 978-3-8462-0880-9		
	Reguvis Fachmedien GmbH, 2018		
	Neumann, Dietrich (Hestermann, U.; Rongen, L.; Weinbrenner, U.) Frick/Knöll Baukonstructionslehre 1 / [Internet-Ressource]		
	ISBN: 978-3-8351-9121-1		
	Wiesbaden: Vieweg+Teubner Verlag, 2006		
	Wiesbauen. Vieweg+Teubliel Verlag, 2000		
	Frick, Otto (Knöll, K.; Neumann, D.; Hestermann, U.; Rongen, L.)		
	Baukonstruktionslehre 2 / [Internet-Ressource]		
	ISBN: 978-3-8348-9486-1		
	Wiesbaden: Vieweg+Teubner Verlag, 2008		
	Dierks, Klaus (Wormuth, R.)		
	Baukonstruktion		
	ISBN: 978-3-8041-5045-4		
	Neuwied : Werner, 2007		
	Neufert, Ernst (Kister, J.)		
	Bauentwurfslehre (42. Aufl.)		
	ISBN: 978-3-8348-0732-8		
	Wiesbaden : Vieweg + Teubner, 2018		
	Wendehorst, Reinhard (Wetzell, O. W.,; Baumgartner, H.,)		
	Wendehorst Bautechnische Zahlentafeln		
	ISBN: 978-3-8351-0055-8		
	Stuttgart/Berlin: Teubner/Beuth, 2018		

Course L0208: Basics in Stru	ctural Design
	Recitation Section (large)
Тур	
Hrs/wk	
CP	
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14
Lecturer	Sebastian Rybczynski
Language	DE
Cycle	WiSe
Content	
	Constructing a small individuell building in groups of 4 persons
	 Analysing the informations and the contents of development plans and building regulation laws
	 Design of building components and approving of the functionality (sealing, facades, roofs)
	 Design and approve of the funcionality of the component interconnections
	 Proofing and assessing of moisture behaviour, energy comsumption, acoustic protection and fire control
	Assessing the building stabilty
	Basics of building services
	Each week the results of different work steps are presented in oral and written form
Literature	Vortragsfolien der Lehrveranstaltung stehen über STUD. IP zum download zur Verfügung
	Neumann, Dietrich (Hestermann, Ulf.; Rongen, Ludwig.; Weinbrenner, Ulrich)
	Frick/Knöll Baukonstructionslehre 1 / [Internet-Ressource]
	ISBN: 978-3-8351-9121-1
	Wiesbaden : B.G. Teubner Verlag / GWV Fachverlage GmbH, Wiesbaden, 2006
	Frick[Begr.], Otto (Knöll[Begr.], Karl.; Neumann, Dietrich.; Hestermann, Ulf.; Rongen, Ludwig.)
	Baukonstruktionslehre 2 / [Internet-Ressource]
	ISBN: 978-3-8348-9486-1
	Wiesbaden : Vieweg+Teubner Verlag / GWV Fachverlage GmbH, Wiesbaden, 2008
	Dierks, Klaus (Wormuth, Rüdiger.)
	Baukonstruktion : [Einführung, Grundlagen, Gründungen, technische Ausrüstung, Wände, Geschossdecken, Treppen, Dächer,
	Fenster, Türen, Konstruktionsatlas]
	ISBN: 3804150454 (Gb.) ISBN: 978-3-8041-5045-4
	Neuwied : Werner, 2007
	Schneider, Klaus-Jürgen (Goris, Alfons.; Berner, Klaus)
	Bautabellen für Ingenieure : mit Berechnungshinweisen und Beispielen ; [auf CD-ROM: Stabwerksprogramm IQ 100 B, Tools für
	den konstr. Ingenieurbau, Fachinformationen, Normentexte]
	ISBN: 3804152287
	Neuwied : Werner, 2006
	Wendehorst, Reinhard (Wetzell, Otto W.,; Baumgartner, Herwig,; Deutsches Institut für Normung)
	Wendehorst Bautechnische Zahlentafeln
	ISBN: 978-3-8351-0055-8 ISBN: 3835100556
	Stuttgart [u.a.] : Teubner Berlin [u.a.] : Beuth, 2007
	Neufert, Ernst (Kister, Johannes)
	Bauentwurfslehre : Grundlagen, Normen, Vorschriften über Anlage, Bau, Gestaltung, Raumbedarf, Raumbeziehungen, Maße fü
	Gebäude, Räume, Einrichtungen, Geräte mit dem Menschen als Maß und Ziel ; Handbuch für den Baufachmann, Bauherrr
	Lehrenden und Lernenden
	ISBN: 978-3-8348-0732-8 (GB.) Wiechaden : Vieweg + Teubner 2009
	Wiesbaden : Vieweg + Teubner, 2009

Module M0631: Reinforced Concrete Structures II					
Courses					
Title			Тур	Hrs/wk	СР
Project Concrete Structures II (L08	94)		Project Seminar	1	1
Concrete Structures II (L0348)			Lecture	2	3
Concrete Structures II (L0349)	1		Recitation Section (large)	2	2
Module Responsible					
Admission Requirements	None				
Recommended Previous	 Knowledge of loads on s 	tructures and combinati	ion of actions		
Knowledge	 Basics of safety format 				
	Knowledge in design of		ultimate limit state		
	Modules: Reinforced Cor	ncrete Structures I, Struc	ctural Analysis I+II, Mechanics I+II		
Educational Objectives	After taking part successfully,	students have reached t	he following learning results		
Professional Competence					
Knowledge	The students know the basic principles which are required for design of reinforced concrete structures. They know the various				
	methods to estimate the member forces in simple one and two-way slabs.				
Skills					
	 The students can design reinforced concrete structure in the ultimate limit state (shear, bending, torsion) and in the students limit state (shear). 			torsion) and in the	
	serviceability limit state (crack and deflection control) including detailing (anchorage and links etc.).The students can estimate the member forces of simple slabs.				
	The students know the o				
Personal Competence					
Social Competence	Cooperation in a project work,	where they design in a t	eam a real concrete building and prese	ent the results at	the end.
Autonomy	Students are able to design si	mple reinforced concrete	e structures and evaluate the results.		
Workload in Hours	Independent Study Time 110,	Study Time in Lecture 7	0		
Credit points	6		-		
Course achievement		Des	cription		
	No None Excerci	ses			
Examination	Written exam				
Examination duration and	120 minutes				
scale					
Assignment for the	General Engineering Science (German program, 7 sem	ester): Specialisation Civil Engineering	: Elective Compu	lsory
Following Curricula	Civil- and Environmental Engin	eering: Specialisation Ci	vil Engineering: Compulsory		
	Civil- and Environmental Engin	eering: Specialisation Tr	affic and Mobility: Elective Compulsory	,	
	Civil- and Environmental Engin	eering: Specialisation W	ater and Environment: Elective Compu	lsory	

Course L0894: Project Concrete Structures II		
Тур	Project Seminar	
Hrs/wk	1	
CP	1	
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14	
Lecturer	Prof. Günter Rombach	
Language	DE	
Cycle	WiSe	
Content	Design of a truss structure	
Literature	Skript zur Lehrveranstaltung "Stahlbetonbau II"	

Course L0348: Concrete Structures II		
Тур	ecture	
Hrs/wk	2	
СР	3	
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28	
Lecturer	Prof. Günter Rombach	
Language	DE	
Cycle	WiSe	
Content	 Design of concrete members for shear, punching and torsion Design for serviceability limit state (durability): crack- and deflection control Detailing Design of discontinuity regions (e.g. corbels, frame corner) design of footings Introduction in the design of slabs Layout and content of a structural design 	
Literature	 Vorlesungsumdrucke zum downloaden im STUDiP Zilch K., Zehetmaier G.: Bemessung im konstruktiven Betonbau. Springer Verlag, 2010 König G., Tue N.: Grundlagen des Stahlbetonbaus. Teubner Verlag, Stuttgart 1998 Deutscher Beton- und Bautechnikverein E.V.: Beispiele zur Bemessung von Betontragwerken nach Eurocode 2. Band 1: Hochbau, Bauverlag GmbH, Wiesbaden 2011 Dahms KH.: Rohbauzeichnungen, Bewehrungszeichnungen. Bauverlag, Wiesbaden 1997 Grasser E. ,Thielen G.: Hilfsmittel zur Berechnung der Schnittgrößen und Formänderungen von Stahlbetontragwerken. Deutscher Ausschuss für Stahlbeton, Heft 240, Verlag Ernst & Sohn, Berlin 1978 DIN EN 1992-1-1:2011: Bemessung und Konstruktion von Stahlbeton- und Spannbetontragwerken - Teil 1: Allgemeine Bemessungsregeln für den Hochbau. 	

ourse L0349: Concrete Structures II		
Тур	Recitation Section (large)	
Hrs/wk	2	
СР		
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28	
Lecturer	Prof. Günter Rombach	
Language	E	
Cycle	Cycle WiSe	
Content	See interlocking course	
Literature	See interlocking course	

Courses				
Title Computational Stuctural Mechanics Computational Structural Mechanic		Typ Integrated Lecture Recitation Section (small)	Hrs/wk 2 1	CP 2 1
Module Responsible	Prof. Christian Cyron			
Admission Requirements	None			
Recommended Previous Knowledge	Engineering Mechanics I, Engineering N	echanics II, Mathematics I, Mathematics II		
Educational Objectives	After taking part successfully, students	have reached the following learning results		
-	 Students now commonly used models for linear and planar structures in structural mechanics. Moreover, they understand importance of computational methods in modern solid mechanics and in particular also the theoretical foundations of the fir element method. Students are able to develop simple computational methods and programs to solve problems in solid mechanics. Moreover, student have sufficient basic knowledge about the finite element method to use commercial software in this area for successful solution of at least simple problems (after a short introduction into the handling of a specific software package). 			
Personal Competence				
Social Competence	Students are capable to communicate	nd work out complex problems and their solutions v	vith professional st	aff.
Autonomy	The students are able to assess their own strengths and weaknesses. They can independently and on their own identify and sol problems in the area of Computational Structural Mechanic and acquire the knowledge required to this end.			
Workload in Hours	Independent Study Time 48, Study Time in Lecture 42			
Credit points	3			
Course achievement	None			
Examination	Written exam			
Examination duration and scale	90 min			
Assignment for the	General Engineering Science (German	rogram, 7 semester): Specialisation Civil Engineerin	g: Compulsory	

Course L2475: Computational Stuctural Mechanics			
Тур	tegrated Lecture		
Hrs/wk	2		
CP	2		
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28		
Lecturer	Prof. Christian Cyron		
Language	DE		
Cycle	SoSe		
Content	The lecture Computational Structural Mechanics extends the content of the lecture Engineering Mechanic II. It bridges the gap between the manual calculation of mechanical stress and deformation in systems with a particularly simple geometry and the efficent computer-based computation of general mechanical systems: • Basics of linear continuum mechanics • Planar structures: plate, membrane, slab • Linientragwerke: beam, cable, truss • Weak form and Galerkin's method • Finite element method: theory and application • Principles of mechanics: principle of virtual work, virtual displacements, virtual forces		
Literature	Gross, Hauger, Wriggers, "Technische Mechanik 4", Springer		

Course L2873: Computationa	al Structural Mechanics (Exercise)
Тур	Recitation Section (small)
Hrs/wk	1
CP	1
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14
Lecturer	Prof. Christian Cyron
Language	DE
Cycle	SoSe
Content	The exercise on Computational Structural Mechanics demonstrates how the theoretical content of the lecture on Computational
	Structural Mechanics can be applied to solve specific mechanical problems.
Literature	

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Courses					
Title		Тур	Hrs/wk	СР	
Introduction to Geoinformation Sci		Project-/problem-based Learning	3	3	
Module Responsible					
Admission Requirements					
	Principles of analysis and linear algebra				
Knowledge					
Educational Objectives	After taking part successfully, students have	ve reached the following learning results			
Professional Competence					
Knowledge		and terms from the field of application of geo informa	-		
	basics, the basic approaches and methods of geo information systems and are able to transfer these to practical questions.				
Skills	Students are able to apply the basic methods used in geo-information systems to practical problems. They are able to apply ther				
	to simple applications of geographic information systems and to transfer them to other problems. The students can process				
	simple GIS project and present their results.				
Personal Competence					
Social Competence	The students can work together groups co	operatively and productively.			
Autonomy	Students are able to organize their work	< flow to prepare themselves before presentations a	and discussion	1. They can acqui	
	appropriate knowledge by making enquirie	es independently.			
Workload in Hours	Independent Study Time 48, Study Time in	lecture 42			
Credit points					
Course achievement					
Examination	Subject theoretical and practical work				
	Computer aided GIS-Application and writte	n-theoretical part			
scale	· · · · · · · · · · · · · · · · · · ·	р			
Assignment for the	General Engineering Science (German pro	gram, 7 semester): Specialisation Civil Engineering: Co	mpulsory		
-	Civil- and Environmental Engineering: Spec		. ,		
-	,	cialisation Water and Environment: Compulsory			

Course L2465: Introduction t	o Geoinformation Science
Тур	Project-/problem-based Learning
Hrs/wk	3
CP	3
Workload in Hours	Independent Study Time 48, Study Time in Lecture 42
Lecturer	Yohannis Tadesse
Language	DE
Cycle	SoSe
Content	 Theoretical basics of Geo-Information-Systems Data models, geographical coordinates, geo-referencing, map-views Data mining and -analyses of geo-data Analysis techniques
Literature	

Module M0612: Steel	Structures in				
Courses					
Title		Тур	Hrs/wk	СР	
Steel Structures II (L0301)		Lecture	2	3	
Steel Structures II (L0302)	Γ	Recitation Section (large)	2	3	
Module Responsible	Prof. Marcus Rutner				
Admission Requirements	None				
Recommended Previous	Steel Structures I				
Knowledge					
Educational Objectives	After taking part successfully, students I	nave reached the following learning results			
Professional Competence					
Knowledge	After successful completition students c	an			
	describe and explain the behaviour of bolted and welded connections				
	 design and check simple halls and buildings calculate forces and stresses of simple structures (trusses, beams, frames) illustrate and dimension he main details (framework, column base, load application points) 				
			points)		
Skills	Students are able to design simple structures and connections, describe the load distribution and recognize the possible modes (
	failure. They can apply structural imperf	ections, calculate according to 2nd order theory a	nd verify their result	ts.	
Personal Competence					
Social Competence					
Autonomy					
Workload in Hours	Independent Study Time 124, Study Tim	e in Lecture 56			
Credit points	6				
Course achievement	None				
Examination	Written exam				
Examination duration and	120 minutes				
scale					
Assignment for the	General Engineering Science (German p	rogram, 7 semester): Specialisation Civil Engineer	ing: Elective Compu	lsory	
Following Curricula	Civil- and Environmental Engineering: S	pecialisation Civil Engineering: Compulsory			
	Civil- and Environmental Engineering: S	pecialisation Traffic and Mobility: Elective Compuls	ory		
	Civil- and Environmental Engineering: Si	pecialisation Water and Environment: Elective Com	nulsory		

Course L0301: Steel Structur	7es
	Lecture
Hrs/wk	2
CP	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Prof. Marcus Rutner
Language	DE
Cycle	SoSe
Content	 Welded connections Simple constructions Trusses Plate girders Frames Columns Buildings with several storeys Halls
Literature	Petersen, C.: Stahlbau, 4. Auflage 2013, Springer-Vieweg Verlag Wagenknecht, G.: Stahlbau-Praxis nach Eurocode 3, Bauwerk-Verlag 2011 • Band 1 Tragwerksplanung, Grundlagen • Band 2 Verbindungen und Konstruktionen

Course L0302: Steel Structur	res II
Тур	Recitation Section (large)
Hrs/wk	2
CP	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Prof. Marcus Rutner
Language	DE
Cycle	SoSe
Content	See interlocking course
Literature	See interlocking course

	shartes II					
Module M0755: Geote						
Courses						
Title		Тур	Hrs/wk	СР		
oundation Engineering (L0552)		Lecture	2	2		
Foundation Engineering (L0553)		Recitation Section (large)	2	2		
oundation Engineering (L1494)		Recitation Section (small)	2	2		
Module Responsible	Prof. Jürgen Grabe					
Admission Requirements	None					
Recommended Previous	Modules:					
Knowledge						
	 Mechanics I-II 					
	Geotechnics I					
Educational Objectives	After taking part successfully, students h	have reached the following learning results				
Professional Competence						
Knowledge	The students know the basic principles and methods which are required to verificate the stability of geotechnical structures.					
Skills	After successful completion of the module the students are able to:					
	 verificate the stability and usability of foundations, 					
	 know individual methods of ground improvement and apply them in their range of application, 					
	 design retaining walls. 					
Personal Competence						
Social Competence						
Autonomy						
Workload in Hours	Independent Study Time 96, Study Time	e in Lecture 84				
Credit points	6					
Course achievement	Compulsory Bonus Form	Description				
	No 20 % Attestation					
Examination	Written exam					
Examination duration and	90 minutes					
scale						
Assignment for the	General Engineering Science (German p	rogram, 7 semester): Specialisation Civil Engineering	: Elective Compu	lsory		
Following Curricula		pecialisation Civil Engineering: Compulsory		-		
-	Civil- and Environmental Engineering: Specialisation Traffic and Mobility: Elective Compulsory					
		pecialisation Water and Environment: Elective Compu				
	Technomathematics: Specialisation III. E		,			

Course L0552: Foundation E	ngineering
Тур	Lecture
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Prof. Jürgen Grabe
Language	DE
Cycle	SoSe
Content	 Shallow foundations Pile foundations Ground improvement Retaining walls Underpinning Groundwater Conservation Cut-off Walls
Literature	 Vorlesung/Übung s. www.tu-harburg.de/gbt Grabe, J. (2004): Bodenmechanik und Grundbau Kolymbas, D. (1998): Geotechnik - Bodenmechanik und Grundbau Grundbau-Taschenbuch, neueste Auflage

Course L0553: Foundation E	ourse L0553: Foundation Engineering			
Тур	Recitation Section (large)			
Hrs/wk	2			
СР	2			
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28			
Lecturer	Prof. Jürgen Grabe			
Language	DE			
Cycle	SoSe			
Content	See interlocking course			
Literature	See interlocking course			

Course L1494: Foundation En	urse L1494: Foundation Engineering			
Тур	Recitation Section (small)			
Hrs/wk	2			
CP	2			
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28			
Lecturer	Prof. Jürgen Grabe			
Language	DE			
Cycle	SoSe			
Content	See interlocking course			
Literature	See interlocking course			

Specialization Chemical and Bioengineering

Module M1760: Introd	duction to Chemical and Bio	engineering						
Courses								
Title		Тур	Hrs/wk	СР				
Introduction to Chemical and Bioen	gineering (L2892)	Lecture	2	3				
Module Responsible	Prof. Johannes Gescher							
Admission Requirements	None							
Recommended Previous	No previous experience is required.							
Knowledge								
Educational Objectives	After taking part successfully, students h	nave reached the following learning results						
Professional Competence								
Knowledge	After successfully completing this module	e, students will be able to:						
	- give an overview of the most important	t topics in chemical and bioengineering.						
	- to explain some working methods for di	ifferent subfields of chemical engineering.						
	- to conduct scientific literature research	independently						
	- to formulate simple scientific texts and	to cite them correctly						
Skills	After successfully completing this module	e, students will be able to:						
	- use publication databases independently							
	- to cite correctly							
	- to describe typical process engineering and biotechnological processes independently and roughly with the help of references.							
Personal Competence								
Social Competence	Students will be able to:							
	- compile work results in groups and doc	ument them						
	- give appropriate feedback and deal con	nstructively with feedback on their own performan	ice					
Autonomy	Students will be able to independently a	ssess their learning and reflect on their weakness	ses and strengths in t	he field of chemica				
	engineering and biochemical engineering	g.						
Workload in Hours	Independent Study Time 62, Study Time	in Lecture 28						
Credit points	3							
Course achievement	None							
Examination	Written elaboration							
Examination duration and	max. 5 pages							
scale								
		rogram, 7 semester): Specialisation Chemical and	Bioengineering: Com	pulsory				
Following Curricula	Chemical and Bioprocess Engineering: Co	ore Quannearion: Compuisory						
Course L2892: Introduction t	o Chemical and Bioengineering							
Тур	5 5							
Hrs/wk								
СР								
Workload in Hours	Independent Study Time 62, Study Time	in Lecture 28						
Lecturer	Dozenten des SD V							

Language

Content

Literature

Cycle WiSe

DE

Literatur und zusätzliche Informationsquellen werden während der Veranstaltung über StudIP zur Verfügung gestellt.

their own short scientific texts and learn how to cite correctly and safely.

The course pursues three important goals for the education of chemical and bioengineers. Using examples such as the production of penicillin or the Haber-Bosch process, the lecturers of process engineering present how green engineering processes can be developed with the help of process engineering approaches and methods and which development stages are passed through in the process. The lecturers also show how such processes can be made increasingly sustainable with the help of new research directions and results. In addition, students learn the basis of scientific literature research and how this can be used to open up a new subject area. They also learn how to distinguish between scientific and non-scientific sources. Finally, the students create

Courses					
Title			Тур	Hrs/wk	СР
Practical Course Measurement Technology (L2270)			Practical Course	2	2
Measurement Technology (L2268)			Lecture	2	2
Physical Fundamentals of Measure	ment Technology (L22	269)	Lecture	2	2
Module Responsible	Prof. Alexander Per	nn			
Admission Requirements	None				
Recommended Previous	Technical interest, logical skills, integral- and differential calculus, basic physical concepts such as temperature, mass, velocity				
Knowledge	etc				
Educational Objectives	After taking part si	uccessfully students ha	ave reached the following learning results		
Professional Competence	, and the second second second	accessiany, seadents no			
-	-		ics (theory of motion), rotation of rigid bo nperature and heat, ideal gas.	dies, energy and mo	omentum, electric
	Metrology: SI units, measurement and measurement uncertainty, basics of sensor technology, physical principles, temperatu measurement, pressure measurement, level measurement, flow measurement. Usage of Matlab scripts.				
			calorimetry, image data acquisition, flow mea of solid concentrations, spectroscopy, error ca		
Skills	Literature research, categorisation of thematical topics, analysis of an experimental test stand, preparation of test protocol, f programming with Matlab, use of relevant laboratory measurement technology, preparation of a test protocol, execution calculations.				
Personal Competence					
Social Competence	-	nd in groups, consulta	ctical training and learning groups, assessme tion with persons responsible for teaching		
Autonomy	protective equipm		pendent development of the thematic basics, g, practice of presentation in front of a g s by using clicker.		
Workload in Hours	Independent Study	/ Time 96, Study Time i	n Lecture 84		
Credit points	6	*			
Course achievement	Compulsory Bonus	Form	Description		
	No 20 %	Excercises	Popup-Quizzes währen der Vorlesun	g	
Examination	Written exam				
Examination duration and	120 min				
scale					
Assignment for the	General Engineerir	ng Science (German pro	gram, 7 semester): Specialisation Process Eng	gineering: Compulsory	
Following Curricula	General Engineering Science (German program, 7 semester): Specialisation Green Technologies: Compulsory				
	General Engineering Science (German program, 7 semester): Specialisation Chemical and Bioengineering: Compulsory				
	Bioprocess Engineering: Core Qualification: Compulsory				
	Chemical and Bioprocess Engineering: Core Qualification: Compulsory				
	Green Technologie	s: Energy, Water, Clima	ate: Core Qualification: Compulsory		
	Orientation Studies	s: Core Qualification: Ele	ective Compulsory		
		ig: Core Qualification: C			

Course L2270: Practical Course Measurement Technology	
Тур	Practical Course
Hrs/wk	2
СР	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Prof. Alexander Penn
Language	DE
Cycle	WiSe
	In the Practical Course in Measurement Technology the theory from the lectures "Physical Fundamentals of Measurement Technology" and "Measurement Technology" will be applied in practice. In small groups students learn how to handle different measurement techniques from industry and research. During the practical course, a wide range of different measurement methods will be taught, including the use of HLPC columns for qualitative mass analysis, the determination of mass transfer coefficients using optical oxygen sensors or the evaluation of image data to obtain process parameters. The practical course also teaches how measurement data are statistically evaluated and experiments are correctly documented.
Literature	Hug, H.: Instrumentelle Analytik. Theorie und Praxis. Verlag Europa-Lehrmittel, Haan-Gruiten, 2015. Kamke, W.: Der Umgang mit experimentellen Daten, insbesondere Fehleranalyse, im physikalischen Anfänger-Praktikum. Eine elementare Einführung. W. Kamke, Kirchzarten [Keltenring 197], 2010. Strohrmann, G.: Messtechnik im Chemiebetrieb. Einführung in das Messen verfahrenstechnischer Größen. Oldenbourg, München, 2004.

Course L2268: Measurement	Technology
Тур	Lecture
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Prof. Alexander Penn
Language	DE
Cycle	WiSe
Content	Basic introduction to measurement technology for process engineers. Includes error calculation, measurement units, calibration, measurement data analysis, measurement techniques and sensors. Particular attention is paid to the measurement of temperature, pressure, flow and level. The lecture provides insights into the latest developments in sensor technology in measurement technology and process engineering.
Literature	 Fraden, Jacob (2016): Handbook of Modern Sensors. Physics, Designs, and Applications. 5th ed. 2016. Cham, New York: Springer. Online verfügbar unter http://search.ebscohost.com/login.aspx?direct=true&scope=site&db=nlebk&AN=1081958. Hering, Ekbert; Schönfelder, Gert (2018): Sensoren in Wissenschaft und Technik. Funktionsweise und Einsatzgebiete. 2. Aufl. 2018. Online verfügbar unter http://dx.doi.org/10.1007/978-3-658-12562-2. Strohrmann, Günther (2004): Messtechnik im Chemiebetrieb. Einführung in das Messen verfahrenstechnischer Größen. 10., durchges. Aufl. München: Oldenbourg. Tränkler, Hans-Rolf; Reindl, Leonhard M. (2014): Sensortechnik. Handbuch für Praxis und Wissenschaft. 2., völlig neu bearb. Aufl. Berlin: Springer Vieweg (VDI-Buch). Online verfügbar unter http://dx.doi.org/10.1007/978-3-642-29942-1. Webster, John G.; Eren, Halit B. (2014): Measurement, Instrumentation, and Sensors Handbook, Second Edition. Electromagnetic, Optical, Radiation, Chemical, and Biomedical Measurement. 2nd ed. Hoboken: Taylor and Francis. Online verfügbar unter http://gbv.eblib.com/patron/FullRecord.aspx?p=1407945.

Course L2269: Physical Fundamentals of Measurement Technology	
Тур	Lecture
Hrs/wk	2
СР	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Prof. Christian Schroer
Language	DE
Cycle	WiSe
Content	Classical mechanics - kinematics, dynamics, energy, momentum and conservation laws, rigid bodies, translation and rotation, angular momentum. Mechanics of gases and fluids - hydrostatics and hydrodynamics Thermodynamics - temperature, heat, heat transport, ideal gas, changes of state, cyclic processes, laws of thermodynamics Electricity - electrostatics, electrical conduction, magnetism, Lorentz force, Maxwell's equations (integral form)
Literature	Paul A. Tipler, Gene Mosca: Physik für Wissenschaftler und Ingenieure, Spektrum Verlag D. Meschede (Hrsg.): Gerthsen Physik, Springer-Verlag Jay Orear: Physik, Hanser Verlag D. Halliday, R. Resnick, J. Walker: Physik, Wiley VCH

Courses				
		Тур	Hrs/wk	СР
Biological and Biochemical Fundame		Lecture	2	2
undamental Biological and Biocher		Practical Course	3	3 1
	ochemical Practical Course (L2902)	Lecture	1	Ţ
Module Responsible Admission Requirements	None			
		winter semester a lecture with 2 semes	ter hours per week is	offered No previo
Knowledge	The module is divided into two parts. In the winter semester, a lecture with 2 semester hours per week is offered. No previous knowledge is required for this lecture. In the following summer semester, the second part of the module is offered. This is divid into an internship and an introductory lecture. For these two parts of the module, attendance of the lecture in the winter semest is strongly recommended.			
Educational Objectives	After taking part successfully, students have	reached the following learning results		
Professional Competence				
	e The module aims to teach you the basic principles of biological systems and biocatalysts. You will learn how organisms constructed and what basic characteristics can be used to distinguish organisms from the three kingdoms of life. You will lear about the ways in which biological systems can produce energy and you will apply the principles of biological thermodynamics addition, you will learn how enzymes are constructed and, using some classes of enzymes as examples, you will learn he enzymes exert their effect.			
	At the end of the module			
	- you will be able to describe basic principles of living systems and explain the metabolism of organisms by applying them.			
	- you will be able to assign organisms to the three kingdoms of life based on some basic characteristics			
	- you will be able to describe the tasks of enzymes generically on the basis of some example reactions			
	- you will be able to deduce from the basic characteristics of organisms and enzymes which biotechnological applications ar possible with these systems.			
	- you can understand and use the technical vocabulary of biological systems and processes			
	- you will be able to perform simple bioinform	natic operations to assign DNA sequences t	o a function	
	- you can confidently apply the basic principle	es of using primary literature		
	The students master the basic techniques of sterile work and molecular diagnostics. They can independently prepare media a maintain microorganisms in culture. In addition, they can isolate and characterize organisms from enrichment cultures a environmental samples.			
Personal Competence				
Social Competence	The students are able,			
	- to gather knowledge in groups of about 2 to 10 students			
	- to introduce their own knowledge and to argue their view in discussions in teams			
	- to divide a complex task into subtasks, solv	e these and to present the combined result	ts	
-	Students are able to independently structure their internship days and prioritize tasks. Furthermore, they are able to collect a process basic information on microorganisms via a literature search.			
Workload in Hours	Independent Study Time 96, Study Time in Le	ecture 84		
Credit points	6			
	Compulsory Bonus Form	Description	loc Broktikuma	
	Yes None Presentation Written exam	Zusammenstellung der Ergebnisse d	IES FIAKLIKUMS	
	90 min			
diración dilu				
scale				

Course L2900: Biological and Biochemical Fundamentals	
Тур	Lecture
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Prof. Johannes Gescher
Language	DE
Cycle	WiSe
Content	In the lecture we will learn the basic characteristics of organisms of all kingdoms of life. This includes cell biology as well as cell physiology. We understand the energetic foundations of living systems and the variety of possible metabolic concepts of life. From these basic laws we will understand how and to what extent an application and genetic reprogramming of organisms for application can take place.
Literature	Fuchs: Allgemeine Mikrobiologie, 11. vollständig überarbeitete Auflage 2022; ISBN: 9783132434776 Brock: Biology of Microorganisms, ISBN-13: 9780134626109

Course L2901: Fundamental	Biological and Biochemical Practical Course
Тур	Practical Course
Hrs/wk	3
CP	3
Workload in Hours	Independent Study Time 48, Study Time in Lecture 42
Lecturer	Prof. Johannes Gescher
Language	DE
Cycle	SoSe
Content	The aim of the practical course is to teach basic microbiological and molecular biological techniques on the basis of individual research assignments and control experiments. In doing so, organisms are to be isolated in this practical course, which will be further processed by students of the 4th and 6th semester in two independent modules.
Literature	Steinbüchel: Mikrobiologisches Praktikum, ISBN: 978-3-662-63234-5

Course L2902: Introduction to the Biological and Biochemical Practical Course	
Тур	Lecture
Hrs/wk	1
CP	1
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14
Lecturer	Prof. Johannes Gescher
Language	DE
Cycle	SoSe
	The aim of the introductory lecture is to explain different methods used and their range of application. In addition, we will clarify specific physiological characteristics of the microorganisms to be isolated.
Literature	Steinbüchel: Mikrobiologisches Praktikum, ISBN: 978-3-662-63234-5

Courses					
Title			Тур	Hrs/wk	СР
Fundamentals of Fluid Mechanics (.0091)		Lecture	2	2
Fundamentals on Fluid Mechanics (Recitation Section (small)	2	2
Fluid Mechanics for Process Engine	ering (L0092)		Recitation Section (large)	2	2
Module Responsible	Prof. Michael Schlüter				
Admission Requirements	None				
Recommended Previous	Mathematics [+][+][]				
Knowledge	Technical Mechanics I+II				
	Technical Thermodynamics I+II				
	Working with force balances				
	Simplification and solving of parti	al differential equations			
	Integration				
Educational Objectives	After taking part successfully, students	have reached the followi	ing learning results		
Professional Competence					
Knowledge	Students are able to:				
	explain the difference between d	ifferent types of flow			
	 give an overview for different apprendiction 		s Transport-Theorem in proce	ss engineering	
	 explain simplifications of the Con 				ons
			, , , , , , , , , , , , , , , , , , , ,		
Skills	The students are able to				
	 describe and model incompressib 	le flows mathematically			
	 reduce the governing equations of 	of fluid mechanics by sim	plifications to archive quanti	tative solutions e.	g. by integration
	 notice the dependency between 	heory and technical app	olications		
	 use the learned basics for fluid dy 	namical applications in	fields of process engineering		
Personal Competence					
Social Competence	The students				
,					
	are capable to gather information	n from subject related, p	professional publications and	relate that inform	nation to the conte
	of the lecture and	and the state in some line			ffe stimula in Frendi
	able to work together on subject		groups. They are able to pres	ent their results (effectively in Engli
	(e.g. during small group exercise		c to discuss the solutions are	lly and to procept	the reculte
	 are able to work out solutions for 	exercises by themselves		ily and to present	the results.
Autonomy	The students are able to				
	search further literature for each	tonic and to expand the	ir knowledge with this literatu	Ire	
	 work on their exercises by their of 				
			5		
Workload in Hours	Independent Study Time 96, Study Time	e in Lecture 84			
Credit points					
Course achievement	Compulsory Bonus Form No 5 % Midterm	Description			
Examination					
Examination duration and					
scale	5 110415				
Assignment for the	General Engineering Science (German p	rogram, 7 semester): Sp	ecialisation Green Technolog	ies: Compulsory	
Following Curricula	General Engineering Science (German p				npulsory
	Bioprocess Engineering: Core Qualification				
	Chemical and Bioprocess Engineering: C	Core Qualification: Comp	ulsory		
	Green Technologies: Energy, Water, Clir	nate: Core Qualification:	Compulsory		
	Integrated Building Technology: Core Qu	ualification: Compulsory			
	Logistics and Mobility: Specialisation Tra	affic Planning and System	ns: Elective Compulsory		
	Technomathematics: Specialisation III. E	ingineering Science: Elec	ctive Compulsory		
	Process Engineering: Core Qualification:	Compulsory			
	Engineering and Management - Major in	Logistics and Mobility:	Consideration Traffic Diagning	and Customer Fla	

Course L0091: Fundamentals	of Fluid Mechanics
Тур	Lecture
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Prof. Michael Schlüter
Language	DE
Cycle	SoSe
Content	 fluid properties hydrostatic overall balances - theory of streamline overall balances - conservation equations differential balances - Navier Stokes equations irrotational flows - Potenzialströmungen flow around bodies - theory of physical similarity turbulent flows compressible flows
Literature	 Crowe, C. T.: Engineering fluid mechanics. Wiley, New York, 2009. Durst, F.: Strömungsmechanik: Einführung in die Theorie der Strömungen von Fluiden. Springer-Verlag, Berlin, Heidelberg, 2006. Fox, R.W.; et al.: Introduction to Fluid Mechanics. J. Wiley & Sons, 1994 Herwig, H.: Strömungsmechanik: Eine Einführung in die Physik und die mathematische Modellierung von Strömungen. Springer Verlag, Berlin, Heidelberg, New York, 2006 Herwig, H.: Strömungsmechanik: Einführung in die Physik von technischen Strömungen: Vieweg+Teubner Verlag / GWV Fachverlage GmbH, Wiesbaden, 2008 Kuhlmann, H.C.: Strömungsmechanik: Künchen, Pearson Studium, 2007 Oertl, H.: Strömungsmechanik: Grundlagen, Grundgleichungen, Lösungsmethoden, Softwarebeispiele. Vieweg+ Teubner Verlag / GWV Fachverlage GmbH, Wiesbaden, 2009 Schade, H.; Kunz, E.: Strömungslehre. Verlag de Gruyter, Berlin, New York, 2007 Truckenbrodt, E.: Fluidmechanik 1: Grundlagen und elementare Strömungsvorgänge dichtebeständiger Fluide. Springer-Verlag, Berlin, Heidelberg, 2008 Schlichting, H.: Grenzschicht-Theorie. Springer-Verlag, Berlin, 2006 van Dyke, M.: An Album of Fluid Motion. The Parabolic Press, Stanford California, 1882. White, F.: Fluid Mechanics, Mcgraw-Hill, ISBN-10: 0071311211, ISBN-13: 978-0071311212, 2011

Course L2933: Fundamentals	s on Fluid Mechanics
Тур	Recitation Section (small)
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Prof. Michael Schlüter
Language	DE
Cycle	SoSe
Content	In the group exercise, the contents of the lecture are taken up and deepened by means of exercises. The exercise tasks correspond in quality and scope to the tasks of the written exam. Topics: Reynolds transport-theorem, pipe flow, free jet, angular momentum, Navier-Stokes equations, potential theory, mock exam, pipe hydraulics, pump design.
Literature	Heinz Herwig: Strömungsmechanik, Eine Einführung in die Physik und die mathematische Modellierung von Strömungen, Springer Verlag, Berlin, 978-3-540-32441-6 (ISBN) Herbert Oertel, Martin Böhle, Thomas Reviol: Strömungsmechanik für Ingenieure und Naturwissenschaftler, Springer Verlag, Berlin, ISBN: 978-3-658-07786-0 Joseph Spurk, Nuri Aksel: Strömungslehre, Einführung in die Theorie der Strömungen, Springer Verlag, Berlin, ISBN: 978-3-642- 13143-1.

Тур	Recitation Section (large)
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
	Prof. Michael Schlüter
Language	DE
Cycle	
Content	In the exercise-lecture the topics from the main lecture are discussed intensively and transferred into application. For that, the students receive example tasks for download. The students solve these problems based on the lecture material either independently or in small groups. The solution is discussed with the students under scientific supervision and parts of the solutions are presented on the chalk board. At the end of each exercise-lecture, the correct solution is presented on the chalk board. Parallel to the exercise-lecture tutorials are held where the student solve exam questions under a set time-frame in small groups and discuss the solutions afterwards.
Literature	 Crowe, C. T.: Engineering fluid mechanics. Wiley, New York, 2009. Durst, F.: Strömungsmechanik: Einführung in die Theorie der Strömungen von Fluiden. Springer-Verlag, Berlin, Heidelberg, 2006. Fox, R.W.; et al.: Introduction to Fluid Mechanics. J. Wiley & Sons, 1994 Herwig, H.: Strömungsmechanik: Eine Einführung in die Physik und die mathematische Modellierung von Strömungen. Springer Verlag, Berlin, Heidelberg, New York, 2006 Herwig, H.: Strömungsmechanik: Einführung in die Physik von technischen Strömungen: Vieweg+Teubner Verlag / GWV Fachverlage GmbH, Wiesbaden, 2008 Kuhlmann, H.C.: Strömungsmechanik: Grundlagen, Grundgleichungen, Lösungsmethoden, Softwarebeispiele. Vieweg+ Teubner Verlag / GWV Fachverlage GmbH, Wiesbaden, 2009 Schade, H.; Kunz, E.: Strömungslehre. Verlag de Gruyter, Berlin, New York, 2007 Truckenbrodt, E.: Fluidmechanik 1: Grundlagen und elementare Strömungsvorgänge dichtebeständiger Fluide. Springer-Verlag, Berlin, Heidelberg, 2008 Schlichting, H.: Grenzschicht-Theorie. Springer-Verlag, Berlin, 2006 van Dyke, M.: An Album of Fluid Motion. The Parabolic Press, Stanford California, 1882. White, F.: Fluid Mechanics, Mcgraw-Hill, ISBN-10: 0071311211, ISBN-13: 978-0071311212, 2011

Courses				
litle		Turn	Line /····le	CP
	0114)	Typ Lecture	Hrs/wk 2	CP 2
Phase Equilibria Thermodynamics (l Phase Equilibria Thermodynamics (l		Recitation Section (small)	1	2
hase Equilibria Thermodynamics (I		Recitation Section (Januar)	1	2
Module Responsible			_	
-	None			
-		en al manufactura di U		
	Mathematics, Physical Chemistry, There	modynamics I and II		
Knowledge				
Educational Objectives	After taking part successfully, students	have reached the following learning results		
Professional Competence				
Knowledge	equilibria.They learn how state variables these properties.Moreover, the students learn how different phases (vapor, liquid, state)	f thermodynamics, the students learn the mathem are influenced by the mixing of compounds and le ow phase equilibria can be described mathematica olid) coexist in equilibrium. Furthermore the fundam several examples relevant for different kinds of pr preting the equilibria are taught.	arn concepts to qu Ily and which pher entals of reaction e	uantitatively descu nomena may occu equilibria are taug
Skills	 state and know how to simplify t The students know models whic are able to solve the resulting m For specific applications, they ar model parameters in literature s Beside pure compound propertie The students know how to visual 	h can be used to determine the properties of the stathematical relations. The able to self-reliantly find necessary physico-chemources. The students are capable of describing the propertize phase equilibria graphically and they know how be students are able to understand fundamental of	ystem in the equili ical properties of c ies of mixtures. co interpret the occ	brium state and t compounds as wel
Personal Competence Social Competence	The students are able to work in small	groups, to solve the corresponding problems and	to present them or	raly to the tutors
	other students			
Autonomy		cessary information self-reliantly in literature sources ints are able to check their learning progress co pt their learning process.		
Workload in Hours	Independent Study Time 124, Study Tir	ne in Lecture 56		
Credit points	6			
Course achievement	None			
Examination	Written exam			
	120 minutes; theoretical questions and	calculations		
scale	, meeted questions unu			
	General Engineering Science (Gormon	program, 7 semester): Specialisation Green Technolo	nies Focus Ponor	vable Energy: Elec
-	Compulsory	orgram, / semester). Specialisation Green rectifion	gies, i ocus Reliev	able Lifergy. Elec
Following Curricula		program, 7 semester): Specialisation Chemical and E	Ricongineoring: Co	mpulsony
	General Lighteening Science (German)	program, 7 semester). Specialisation chemical and t	noengineering. Col	npulsory
		ion Compulson		
	Bioprocess Engineering: Core Qualificat			
	Bioprocess Engineering: Core Qualificat Chemical and Bioprocess Engineering:	Core Qualification: Compulsory	(o Compulsor)	
	Bioprocess Engineering: Core Qualificat Chemical and Bioprocess Engineering: Green Technologies: Energy, Water, Cli			

Course L0114: Phase Equilib	ria Thermodynamics
Тур	Lecture
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Prof. Irina Smirnova
Language	DE
Cycle	SoSe
Content	
	 Introduction: Applications of thermodynamics of mixtures Thermodynamic equations in multi-component systems: Fundamental equations, chemical potential, fugacity Phase equilibria of pure substances: thermodynamic equilibrium, vapor pressure, Gibbs' phase rule Equations of state: virial equations, van-der-Waals equation, generalized equations of state Mixing properties: ideal and real mixtures, excess properties, partial molar properties Vapor-liquid-equilibria: binary systems, azeotropes, equilibrium condition Gas-liquid-equilibria: equilibrium condition, Henry-coefficient G^E-Models: Hildebrand-model, Flory-Huggins-model, Wilson-model, UNIQUAC, UNIFAC Liquid-liquid-equilibria: equilibrium condition, phase equilibria in binary and ternary systems Solid-liquid-equilibria: equilibrium condition, binary systems Chemical reactions: reaction coordinate, mass action law, influence of pressure and temperature Osmotic pressure
Literature	 Jürgen Gmehling, Bärbel Kolbe: Thermodynamik. VCH 1992 J.M. Prausnitz, R.N. Lichtenthaler, E.G. de Azevedo: Molecular Thermodynamics of Fluid-Phase Equilibria, 3rd ed. Prentice Hall, 1999. J.W. Tester, M. Modell: Thermodynamics and its Applications. 3 rd ed. Prentice Hall, 1997.J.P. O'Connell, J.M. Haile: Thermodynamics. Cambridge University Press, 2005.

Course L0140: Phase Equilib	ria Thermodynamics
Тур	Recitation Section (small)
Hrs/wk	1
CP	2
Workload in Hours	Independent Study Time 46, Study Time in Lecture 14
Lecturer	Prof. Irina Smirnova
Language	DE
Cycle	SoSe
Content	 Introduction: Applications of thermodynamics of mixtures Thermodynamic equations in multi-component systems: Fundamental equations, chemical potential, fugacity Phase equilibria of pure substances: thermodynamic equilibrium, vapor pressure, Gibbs' phase rule Equations of state: virial equations, van-der-Waals equation, generalized equations of state Mixing properties: ideal and real mixtures, excess properties, partial molar properties Vapor-liquid-equilibria: binary systems, azeotropes, equilibrium condition Gas-liquid-equilibria: equilibrium condition, Henry-coefficient G^E-Models: Hildebrand-model, Flory-Huggins-model, Wilson-model, UNIQUAC, UNIFAC Liquid-liquid-equilibria: equilibrium condition, phase equilibria in binary and ternary systems Solid-liquid-equilibria: reaction coordinate, mass action law, influence of pressure and temperature Osmotic pressure The students work on tasks in small groups and present their results in front of all students.
Literature	 Jürgen Gmehling, Bärbel Kolbe: Thermodynamik. VCH 1992 J.M. Prausnitz, R.N. Lichtenthaler, E.G. de Azevedo: Molecular Thermodynamics of Fluid-Phase Equilibria, 3rd ed. Prentice Hall, 1999. J.W. Tester, M. Modell: Thermodynamics and its Applications. 3rd ed. Prentice Hall, 1997.J.P. O'Connell, J.M. Haile: Thermodynamics. Cambridge University Press, 2005.

Course L0142: Phase Equilib	ria Thermodynamics
Тур	Recitation Section (large)
Hrs/wk	1
CP	2
Workload in Hours	Independent Study Time 46, Study Time in Lecture 14
Lecturer	Prof. Irina Smirnova
Language	DE
Cycle	SoSe
Content	 Introduction: Applications of thermodynamics of mixtures Thermodynamic equations in multi-component systems: Fundamental equations, chemical potential, fugacity Phase equilibria of pure substances: thermodynamic equilibrium, vapor pressure, Gibbs' phase rule Equations of state: virial equations, van-der-Waals equation, generalized equations of state Mixing properties: ideal and real mixtures, excess properties, partial molar properties Vapor-liquid-equilibria: binary systems, azeotropes, equilibrium condition Gas-liquid-equilibria: equilibrium condition, Henry-coefficient G^E-Models: Hildebrand-model, Flory-Huggins-model, Wilson-model, UNIQUAC, UNIFAC Liquid-liquid-equilibria: equilibrium condition, phase equilibria in binary and ternary systems Solid-liquid-equilibria: eaction coordinate, mass action law, influence of pressure and temperature Osmotic pressure
Literature	 Jürgen Gmehling, Bärbel Kolbe: Thermodynamik. VCH 1992 J.M. Prausnitz, R.N. Lichtenthaler, E.G. de Azevedo: Molecular Thermodynamics of Fluid-Phase Equilibria, 3rd ed. Prentice Hall, 1999. J.W. Tester, M. Modell: Thermodynamics and its Applications. 3rd ed. Prentice Hall, 1997.J.P. O'Connell, J.M. Haile: Thermodynamics. Cambridge University Press, 2005.

Courses				
itle		Тур	Hrs/wk CF	P
Genetics and Molecular Biology (L0	889)	Project-/problem-based Learning	1 1	
Genetics and Molecular Biology (L0	886)	Lecture	2 2	
ab Course in Microbiology and Bio	chemistry (L0890)	Practical Course	3 3	
Module Responsible	Prof. Johannes Gescher			
Admission Requirements				
Recommended Previous				
Knowledge	-			
	Lecture Microbiology			
Educational Objectives	After taking part successfully, students have reache	ed the following learning results		
Professional Competence				
Knowledge	After successfully finishing this module students are	e able		
	 to give an overview of the basic genetic proc 			
	 to explain basic molecularbiological methods 			
	 to give an overview of -omics strategies 			
	 to explain genetic differences between pro- a 	and eukaryotes		
Skills	Students are able to			
	 consider safety measurements when working 	g in the laboratory		
	work sterile			
	 cultivate microorganisms aerobically 			
	measure enzyme activity			
	 identify microorganisms based and physiolog 	ical assays and 16S rRNA encoding gene seg	uences	
	 apply core knowledge of the lectures "Bioche 			
	 scientific poster design and presentation 			
Personal Competence	Studente are able to			
Social Competence	Students are able to			
	 conduct laboratory experiments in teams 			
	 write protocols in teams 			
	 develop solutions for given problems 			
	 develop and distribute work assignments for 	given problems		
	 present and reflect their specific knowledge i 			
	 present and discuss their own scientific posterior 			
	F F	-		
Autonomy	Students are able to			
	 search information for a given problem by th 	emselves		
	 prepare summaries of their search results for 			
Wendered in Herrie	la desendent Study Time AC, Study Time in Lantwe	04		
Credit points	Independent Study Time 96, Study Time in Lecture	84		
Course achievement		Description		
coarse achievement		Erstellung und Präsentation eines wissenscha	aftlichen Posters	
	practical work	5		
Examination	Written exam			
Examination duration and	60 min			
scale				
Assignment for the	General Engineering Science (German program, 7 s	emester): Specialisation Chemical and Bioend	gineering: Compulso	ry
Following Curricula				
	Chemical and Bioprocess Engineering: Specialisatio	•		
Course L0889: Genetics and				
	Project-/problem-based Learning			
Hrs/wk				
CP	1			

Hrs/wk	1	
CP		
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14	
Lecturer	Prof. Johannes Gescher	
Language	DE	
Cycle	WiSe/SoSe	
Content	See interlocking course	
Literature	See interlocking course	

Course L0886: Genetics and	Molecular Biology
Тур	Lecture
Hrs/wk	2
СР	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Prof. Johannes Gescher
Language	
Cycle	WiSe/SoSe
Content	- Organisation, structure and function of procaryotic DNA
	- DNA replication, transcription, translation
	- Regulation of gene expression
	- Mechanisms of gene transfer, recombination, transposition
	- Mutatuion and DNA repair
	- DNA cloning
	- DNA sequencing
	- Polymerase chain reaction
	- Genome sequencing, (meta)genomics, transcriptomics, proteomics
Literature	Rolf Knippers, Molekulare Genetik, Georg Thieme Verlag Stuttgart
	Munk, K. (ed.), Genetik , 2010, Thieme Verlag
	John Ringo, Genetik kompakt, 2006, Elsevier GmbH, München
	T. A. Brown, Gene und Genome, 2007, 3. Aufl., Spektrum Akademischer Verlag,
	Jochen Graw, Genetik, Springer Verlag, Berlin Heidelberg

	Microbiology and Biochemistry
	Practical Course
Hrs/wk	
СР	
	Independent Study Time 48, Study Time in Lecture 42
	Prof. Johannes Gescher, Dr. Paul Bubenheim
Language	
-	WiSe/SoSe
Content	 Widespread techniques of microbiological, biochemical and genetic approaches will be taught during this course. Before the practical conduct of the experiments a colloquium takes place in which the students explain, reflect and discuss the theoretical basics and their translation into practice. The students write up a report for every experiment. They receive feedback to their level of scientific writing (citation methods labeling of graphs, etc.), so that they can improve their competence in this field over the course of the practical course. Topics and Methods of the course include: Morphology and growth of different bacteria strains Measuring of microbial growth by turbidity Preparation of several culture media Strain identification by gram staining and analytical profile index (API test) Genetic background identification by 165 rRNA analysis Microscopy BLAST analyses Colony PCR procedure Enzyme activity measurements and kinetics (Michaelis-Menten equation, Lineweaver-Burk plot) Enzymes as biocatalysts (exemplarily use of enzymes in detergents) Measurement of protein concentrations (Bradford protein assay) Qualitative and quantitative enzyme activity assay
Literature	Brock Mikrobiologie / Brock Microbiology (Michael T. Madigan, John M. Martinko)
	Mikrobiologisches Grundpraktikum (Steve K. Alexander, Dennis Strete)

Module M0892: Chem	ical Reaction	Engineering				
Courses						
Title				Тур	Hrs/wk	СР
Chemical Reaction Engineering (Fu	ndamentals) (L0204)			Lecture	2	2
Chemical Reaction Engineering (Fu				Recitation Section (large)	2	2
Experimental Course Chemical Eng	ineering (Fundamental	ls) (L0221)		Practical Course	2	2
Module Responsible	Prof. Raimund Horn	I				
Admission Requirements	None					
Recommended Previous	Contents of the pre	evious modules mathe	matics I-III, physical (chemistry, technical thermody	/namics I+II as w	vell as computatio
Knowledge	methods for engine	ers.				
Educational Objectives	After taking part suc	ccessfully, students ha	ave reached the follow	ving learning results		
Professional Competence						
Knowledge	The students are at	ble to explain basic co	ncepts of chemical re	action engineering. They are	able to point out	differences betwe
-				a strong ability to outline pa		
	ideal reactors and to	o describe their prope	rties.			
Skills	After successful con	mpletion of the module	e, students are able to	:		
	 apply different cor 	mputational methods t	o dimension isotherm	al and non-isothermal ideal re	actors,	
	- determine and compute stable operation points for these reactors ,					
	 conduct experime 	nts on a lab-scale pilot	t plants and document	t these according to scientific	guidelines.	
Personal Competence						
Social Competence	After successful cor	mpletition of the lab-c	ourse the students ha	ave a strong ability to organiz	e themselfes in s	small groups to so
, · · · · ·		•		scuss their subject related kr		- ·
	their teachers.	, , , , , , , , , , , , , , , , , , ,		····;··		
Autonomy	The students are	able to obtain furth	er information and	assess their relevance auto	nomously. Stude	nts can apply th
		ly to plan, prepare and			,, ,	
Workload in Hours		Time 96, Study Time i				
Credit points	6					
Course achievement	Compulsory Bonus	Form	Description			
	Yes None	Subject theoreti	cal and			
		practical work				
Examination	Written exam					
Examination duration and	120 min					
scale						
Assignment for the	General Engineering	g Science (German pro	gram, 7 semester): S	pecialisation Chemical and Bio	engineering: Cor	npulsory
Following Curricula		ring: Core Qualification			-	-
-		ocess Engineering: Co		oulsory		
				technologies: Elective Compu	sory	
		g: Core Qualification: C				

Course L0204: Chemical Read	ction Engineering (Fundamentals)
Тур	Lecture
Hrs/wk	2
СР	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Prof. Raimund Horn
Language	DE
Cycle	WiSe
Content	Fundamentals of chemical reaction engineering, definitions, calculation of species concentrations (reactor, reaction mixture, reactants, products, inerts and solvents, reaction volume, Reaktor volume, chemical reaction, mass, moles, mole fraction, volume, density, molar concentration, mass-concentration, molality, partial pressure, hydrodynamic residence time, space time, extent of reaction, reactor throughput, reactor load, conversion, selectivity, yield, concentration calculations in stationary and flowing multicomponent-mixtures) Stoichiometry and stoichiometric calculations (simple reactions, complex reactions, key reactions, key species, matrix of stoichiometric coefficients, linear dependent and independent reactions, element-species-matrix, row reduced form of a matrix, rank of a matrix, Gauss Jordan elimination, relation between stoichiometry and kinetics, calculating the extent of reaction from mole number changes in complex reactions)
	Thermodynamics (What is thermodynamics?, importance of thermodynamics in chemical reaction engineering, zeroth law of thermodynamics, temperature scales, temperature measurements in praxis, first law of thermodynamics, internal energy, enthalpy, calorimeter, heat of reaction, standard heat of formation, Hess law, heat capacity, Kirchhoff law, standard heat of reaction, pressure dependence of the heat of reaction, second law of thermodynamics, reversible and irreversible processes, entropy, Clausius inequality, free energy, Gibbs Energy, chemical potential, chemical equilibrium, activity, van't Hoff law, calculation of chemical equilibrium, principle of Le Chatelier and Braun, equilibrium calculations in multiple reaction systems, Lagrange Multipliers) Chemical kinetics (reversible and irreversible reactions, homogeneous and heterogeneous reactions, elementary step, reaction mechanism, microkinetics, macrokinetics, formal kinetics, reaction rate, rate of change of species mole number, Arrhenius-equation, activation energy and pre-exponential factor for komplex reactions, reactions of 0., 1. and 2. order, analytical integration of rate laws, Damköhler-number, differential and integral method of kinetic analysis, laboratory reactors for kinetic measurements,

	half life, kinetics of complex reactions, parallel reactions, reversible reactions, sequence of reactions, irreversible reaction with pre- equilibrium, reduction of reaction mechanisms, quasi-stationarity principle of Bodenstein, rate limiting step, Michaelis-Menten kinetics, analytical integration of first order differential equations - integrating factor, numerical integration of complex kinetics) Types of chemical Reaktors (chemical reactors in industry and laboratory, ideal vs. real reaktors, discontinuous, half continuous and continuous reactors, single phase - biphasic- and multiphase reactors, batch-reactor, semi-batch reactor, CSTR, Plug Flow reactor, fixed bed reactor, adiabatic staged reactors, rotating furnaces, fluidized bed reactors, gas-liquid-reactors, multi-phase reactors) Isothermal ideal reactors (mole-balance of a chemical reactor, mole balance of a batch reactor, integration of the batch reactor mole balance for various kinetics, partial fraction decomposition, mole balance of the semi-batch reactor, mole balance of the plug flow reactor, analogy batch reactor - plug flow reactor, design of plug flow reactors for reactions with volume change and complex reactions, mole balance of a fixed bed reactor, design of a membrane reactor, mole balance of a continuously stirred tank reactor, comparison of CSTR and PFR with respect to conversion and selectivity, mole-balance of a cascade of tank reactors) non-isothermal ideal reactors (energy balance of a reactor, adiabatic reactor, adiabatic temperature rise, staged reactor for adiabatic exothermic reactions limited by chemical equilibrium, design of an adiabatic plug flow reactor, Levenspiel-plots, heat transfer through a reactor wall, heat transfer by convection, heat conduction, heat transfer through a cylindrical wall, design of a plug flow reactor in parallel and counter flow, heat balance of the cooling fluid, CSTR with heat exchange, multiple stationary states, ignition-extinction behavior, stability of a CSTR, complex reactions in non-isotherm
Literature	lecture notes Raimund Horn
	skript Frerich Keil
	Books:
	M. Baerns, A. Behr, A. Brehm, J. Gmehling, H. Hofmann, U. Onken, A. Renken, Technische Chemie, Wiley-VCH
	G. Emig, E. Klemm, Technische Chemie, Springer
	A. Behr, D. W. Agar, J. Jörissen, Einführung in die Technische Chemie
	E. Müller-Erlwein, Chemische Reaktionstechnik 2012, 2. Auflage, Teubner Verlag
	J. Hagen, Chemiereaktoren: Auslegung und Simulation, 2004, Wiley-VCH
	H. S. Fogler, Elements of Chemical Reaction Engineering, Prentice Hall B
	H. S. Fogler, Essentials of Chemical Reaction Engineering, Prentice Hall
	O. Levenspiel, Chemical Reaction Engineering, John Wiley & Sons, 1998
	L. D. Schmidt, The Engineering of Chemical Reactions, Oxford Univ. Press, 2009
	J. B. Butt, Reaction Kinetics and Reactor Design, 2000, Marcel Dekker
	R. Aris, Elementary Chemical Reactor Analysis, Dover Pubn. Inc., 2000
	M. E. Davis, R. J. Davis, Fundamentals of Chemical Reaction Engineering, McGraw Hill
	G. F. Froment, K. B. Bischoff, J. De Wilde, Chemical Reactor Analysis and Design, John Wiley & Sons, 2010
	A. Jess, P. Wasserscheid, Chemical Technology An Integrated Textbook, WILEY-VCH

ourse L0244: Chemical Read	ction Engineering (Fundamentals)
Тур	Recitation Section (large)
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Prof. Raimund Horn, Dr. Oliver Korup
Language	DE
Cycle	WiSe
	Fundamentals of chemical reaction engineering, definitions, calculation of species concentrations (reactor, reaction mixture, reactants, products, inerts and solvents, reaction volume, Reaktor volume, chemical reaction, mass, moles, mole fraction, volume, density, molar concentration, mass-concentration, molality, partial pressure, hydrodynamic residence time, space time, extent or reaction, reactor throughput, reactor load, conversion, selectivity, yield, concentration calculations in stationary and flowing multicomponent-mixtures) Stoichiometry and stoichiometric calculations (simple reactions, complex reactions, key reactions, key species, matrix o stoichiometric coefficients, linear dependent and independent reactions, element-species-matrix, row reduced form of a matrix rank of a matrix, Gauss Jordan elimination, relation between stoichiometry and kinetics, calculating the extent of reaction from mole number changes in complex reactions? Thermodynamics (What is thermodynamics?, importance of thermodynamics in chemical reaction engineering, zeroth law o thermodynamics, temperature scales, temperature measurements in praxis, first law of thermodynamics, internal energy enthalpy, calorimeter, heat of reaction, standard heat of formation, Hess law, heat capacity, Kirchhoff law, standard heat of

	reaction, pressure dependence of the heat of reaction, second law of thermodynamics, reversible and irreversible processes, entropy, Clausius inequality, free energy, Gibbs Energy, chemical potential, chemical equilibrium, activity, van't Hoff law, calculation of chemical equilibrium, principle of Le Chatelier and Braun, equilibrium calculations in multiple reaction systems, Lagrange Multipliers)
	Chemical kinetics (reversible and irreversible reactions, homogeneous and heterogeneous reactions, elementary step, reaction mechanism, microkinetics, macrokinetics, formal kinetics, reaction rate, rate of change of species mole number, Arrhenius-equation, activation energy and pre-exponential factor for komplex reactions, reactions of 0., 1. and 2. order, analytical integration of rate laws, Damköhler-number, differential and integral method of kinetic analysis, laboratory reactors for kinetic measurements, half life, kinetics of complex reactions, parallel reactions, reversible reactions, sequence of reactions, irreversible reaction with pre-equilibrium, reduction of reaction mechanisms, quasi-stationarity principle of Bodenstein, rate limiting step, Michaelis-Menten kinetics, analytical integration of first order differential equations - integrating factor, numerical integration of complex kinetics)
	Types of chemical Reaktors (chemical reactors in industry and laboratory, ideal vs. real reaktors, discontinuous, half continuous and continuous reactors, single phase - biphasic- and multiphase reactors, batch-reactor, semi-batch reactor, CSTR, Plug Flow reactor, fixed bed reactor, adiabatic staged reactors, rotating furnaces, fluidized bed reactors, gas-liquid-reactors, multi-phase reactors)
	Isothermal ideal reactors (mole-balance of a chemical reactor, mole balance of a batch reactor, integration of the batch reactor mole balance for various kinetics, partial fraction decomposition, mole balance of the semi-batch reactor, mole balance of the plug flow reactor, analogy batch reactor - plug flow reactor, design of plug flow reactors for reactions with volume change and complex reactions, mole balance of a fixed bed reactor, design of a membrane reactor, mole balance of a continuously stirred tank reactor, comparison of CSTR and PFR with respect to conversion and selectivity, mole-balance of a cascade of tank reactors, numerical- interative calculation of a cascade of tank reactors, Newton-Raphson method, graphical analysis of a cascade of tank reactors)
	non-isothermal ideal reactors (energy balance of a reactor, adiabatic reactor, adiabatic temperature rise, staged reactor for adiabatic exothermic reactions limited by chemical equilibrium, design of an adiabatic plug flow reactor, Levenspiel-plots, heat transfer through a reactor wall, heat transfer by convection, heat conduction, heat transfer through a cylindrical wall, design of a plug flow reactor in parallel and counter flow, heat balance of the cooling fluid, CSTR with heat exchange, multiple stationary states, ignition-extinction behavior, stability of a CSTR, complex reactions in non-isothermal reactors, optimum temperature profile of a reactor)
Literature	lecture notes Raimund Horn
	skript Frerich Keil
	Books:
	M. Baerns, A. Behr, A. Brehm, J. Gmehling, H. Hofmann, U. Onken, A. Renken, Technische Chemie, Wiley-VCH
	G. Emig, E. Klemm, Technische Chemie, Springer
	A. Behr, D. W. Agar, J. Jörissen, Einführung in die Technische Chemie
	E. Müller-Erlwein, Chemische Reaktionstechnik 2012, 2. Auflage, Teubner Verlag
	J. Hagen, Chemiereaktoren: Auslegung und Simulation, 2004, Wiley-VCH
	H. S. Fogler, Elements of Chemical Reaction Engineering, Prentice Hall B
	H. S. Fogler, Essentials of Chemical Reaction Engineering, Prentice Hall
	O. Levenspiel, Chemical Reaction Engineering, John Wiley $\&$ Sons, 1998
	L. D. Schmidt, The Engineering of Chemical Reactions, Oxford Univ. Press, 2009
	J. B. Butt, Reaction Kinetics and Reactor Design, 2000, Marcel Dekker
	R. Aris, Elementary Chemical Reactor Analysis, Dover Pubn. Inc., 2000
	R. Aris, Elementary Chemical Reactor Analysis, Dover Pubn. Inc., 2000 M. E. Davis, R. J. Davis, Fundamentals of Chemical Reaction Engineering, McGraw Hill

Course L0221: Experimental	Course Chemical Engineering (Fundamentals)
Тур	Practical Course
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Prof. Raimund Horn
Language	DE/EN
Cycle	SoSe
Content	Performing and evaluation of experiments concerning chemical reaction engineering with emphasis on ideal reactors:
	* Batch reactor - Estimation of kinetic parameters for the saponification of ethylacetate
	*CSTR - Residence time distribution, reaction
	*CSTR in Series - Residence time distribution, reaction
	* Plug Flow Reactor - Residence time distribution, reaction
	Before the practical conduct of the experiments a colloquium takes place in which the students explain, reflect and discuss the theoretical basics and their translation into practice.
	The students write up a report for every experiment. They receive feedback to their level of scientific writing (citation methods, labeling of graphs, etc.), so that they can improve their competence in this field over the course of the practical course.
Literature	Levenspiel, O.: Chemical reaction engineering; John Wiley & Sons, New York, 3. Ed., 1999 VTM 309(LB)
	Praktikumsskript
	Skript Chemische Verfahrenstechnik 1 (F.Keil)

Module M1764: Biopr	ocess Technology I				
Courses					
Title		Тур	Hrs/wk	СР	
Bioprocess Technology I (L2906)		Lecture	2	3	
Bioprocess Technology I (L2907)		Recitation Section (large)	2	1	
Bioprocess Technology I - Fundame	ental Practical Course (L2908)	Practical Course	2	2	
Module Responsible	Prof. Andreas Liese				
Admission Requirements	None				
Recommended Previous	Content of module "Biological and Bioch	homical Fundamentals"			
Knowledge	Content of module Bloogical and Block Content of module "Organic Chemistry"				
	Content of module organic chemistry				
Educational Objectives	After taking part successfully, students have r	eached the following learning results			
Professional Competence					
Knowledge	Upon completion of the module, students will	be able to:			
	e de deservites la sis encorres effeisences				
	 to describe basic processes of bioproce 		h inhibition turner		
	 to assign different types of kinetics to e to name and describe the parameters of 	enzymes and microorganisms and to distinguis	in minibicion cypes,		
	 to explain the mass transport processes in bioreactors fundamentally, to understand and describe the basics of biopresses management (batch and continuously operated) 				
	 to understand and describe the basics of bioprocess management (batch and continuously operated calculation of the batch reaction time,) in great detail, to explain methods for the retention of enzymes and microorganisms by immobilization in bioreactors. 				
Skills	//s After successful completion of this module, students should be able to				
	 using various kinetic approaches, to determine substrate turnover by enzymes as well as their kinetic parameters describe the growth of whole cells with the help of different kinetic approaches as well as to determine to 				
	parameters,				
	• qualitatively predict the effects of enzy	me inhibition on the behavior of enzymes and	on the overall pro	cess,	
	analyze and determine bioprocesses ba	ased on the stoichiometry of the reaction syste	m,		
	differentiate the various basic reactor	types in biotechnological processes and sele	and select them specifically for the respective		
	application,				
	 set up and solve mass balance and diff 	differential equations for the mathematical description of fermentation proce			
	 apply various methods for determining 	ning mass transfer parameters for gases in solution and calculate the correspondi			
	transfer coefficients				
Personal Competence					
	After completing the module, students are ab	e to discuss scientific questions among thems	elves and with ind	lustry representative	
petenee		nem and to work together on given engineering			
Autonomy	After completion of this module participants are able to acquire new sources of knowledge and apply their knowledge to			owledge to previously	
	unknown issues and to present these.				
Workload in Hours	Independent Study Time 96, Study Time in Le	cture 84			
Credit points					
Course achievement					
Examination	Written exam				
Examination duration and	90 min				
scale					
Assignment for the	General Engineering Science (German program	m 7 semester): Specialisation Chemical and Bi	oengineering: Co	mpulsory	
J	Chemical and Bioprocess Engineering: Core Q		congineering. Col	mpaisory	
i onowing curricula	enering and bioprocess Engineering. Core Q	aameadon. compulsory			

Course L2906: Bioprocess Te	ichnology I		
Тур	Lecture		
Hrs/wk	2		
CP	3		
Workload in Hours	dependent Study Time 62, Study Time in Lecture 28		
Lecturer	Prof. Andreas Liese		
Language	DE		
Cycle	WiSe		
Content	 Introduction to enzyme kinetics Immobilisation of enzymes and whole cells Stoichiometry of cell growth and product formation Microbial growth kinetics and growth models Maintenance metabolism Basic bioprocess reactor types Batch, fed-batch, chemostate and turbidostate fermentation Calculation of main parameters of fermentative processes Rheology and mechanical energy input Gassing of bioprocesses (aerobic and microaerobic) Discussion with bioprocess engineers of large and small companies, proportionally alumni of TUHH Repetitorium 		
Literature	 A. Liese, K. Seelbach, C. Wandrey: Industrial Biotransformations, Wiley-VCH,2nd ed. 2006 H.W. Blanch, D. Clark: Biochemical Engineering, Taylor & Francis, 1997 P. M. Doran: Bioprocess Engineering Principles, 2nd. edition, Academic Press, 2013 H. Chmiel, R. Takors, D. Weuster-Botz (Herausgeber): Bioprozeßtechnik, Springer Spektrum, 2018 KE. Jaeger, A. Liese, C. Syldatk: Einführung in die Enzymtechnologie, Springer, 2018 		

Course L2907: Bioprocess Te	urse L2907: Bioprocess Technology I		
Тур	Recitation Section (large)		
Hrs/wk			
СР	1		
Workload in Hours	Independent Study Time 2, Study Time in Lecture 28		
Lecturer	Prof. Andreas Liese		
Language	DE		
Cycle	WiSe		
Content	See interlocking course		
Literature	See interlocking course		

Course L2908: Bioprocess Technology I - Fundamental Practical Course		
Тур	Practical Course	
Hrs/wk	2	
СР	2	
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28	
Lecturer	Prof. Andreas Liese	
Language	DE	
Cycle	WiSe	
Content	In this course fermentation and downstream technologies on the example of the production of an enzyme by means of a recombinant microorganism is learned. Detailed characterization and simulation of enzyme kinetics as well as application of the enzyme in a bioreactor is carried out. The students document their experiments and results in a protocol.	
Literature	Skript	

Courses				
Title		Тур	Hrs/wk	СР
Thermal Separation Processes (L01	18)	Lecture	2	2
Thermal Separation Processes (L0119)		Recitation Section (small)	2	2
Thermal Separation Processes (L0141)		Recitation Section (large)	1	1
Separation Processes (L1159)		Practical Course	1	1
Module Responsible	Prof. Irina Smirnova			
Admission Requirements				
-	Recommended requirements: Thermodynamics III			
Knowledge				
Educational Objectives	After taking part successfully, students have reached th	e following learning results		
Professional Competence				
Knowledge	 The students can distinguish and describe diff adsorption The students develop an understanding for the energy demand of a process, the possibilities of e They have good knowledge of designing methods 	course of concentration during a sepa energy saving, and the selection of sep	aration process, to baration systems	the estimation of
Skills	 Using the gained knowledge the students can select a reasonable system boundary for a given separation process an close the associated energy and material balances The students can use different graphical methods for the designing of a separation process and define the amout theoretical stages required They can select and design a basic type of thermal separation process for a given case based on the advantages disadvantages of the process The students are capable to obtain independently the needed material properties from appropriate sources (diagram tables) They can calculate continuous and discontinuous processes The students are able to prove their theoretical knowledge in the experimental lab work. The students are able to discuss the theoretical background and the content of the experimental work with the teach colloquium. The students are capable of linking their gained knowledge with the content of other lectures and use it together for the solut technical problems. Other lectures such as thermodynamics, fluid mechanics and chemical engineering. 			efine the amount the advantages a purces (diagrams a with the teachers
Personal Competence <i>Social Competence</i> <i>Autonomy</i>	 The students can work technical assignments in small groups and present the combined results in the tutorial The students are able to carry out practical lab work in small groups and organize a functional division of labor them. They are able to discuss their results and to document them scientifically in a report. 		ion of labor betw sess their quality	
Warkload in Harris	Indopendent Study Time 06 Study Time in Leature 04			
	Independent Study Time 96, Study Time in Lecture 84			
Credit points				
Course achievement	None			
Examination	Written exam			
Examination duration and	120 minutes; theoretical questions and calculations			
scale Assignment for the Following Curricula	General Engineering Science (German program, 7 seme Compulsory General Engineering Science (German program, 7 seme Bioprocess Engineering: Core Qualification: Compulsory Chemical and Bioprocess Engineering: Core Qualificatio	ster): Specialisation Chemical and Bio		
	Green Technologies: Energy, Water, Climate: Specialisa Green Technologies: Energy, Water, Climate: Specialisa Process Engineering: Core Qualification: Compulsory	tion Energy Systems / Renewable Energy		ompulsory

Course L0119: Thermal Sepa	ration Processes
Тур	Recitation Section (small)
Hrs/wk	2
СР	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Prof. Irina Smirnova
Language	DE
Cycle	WiSe
Content	 Introduction in the thermal process engineering and to the main features of separation processes Simple equilibrium processes, several steps processes Distillation of binary mixtures, enthalpy-concentration diagrams Extractive and azeotrope distillation, water vapor distillation, stepwise distillation Extraction: separation ternary systems, ternary diagram Multiphase separation including complex mixtures Designing of separation devices without discrete stages Drying Chromatographic separation processes Membrane separation Energy demand of separation processes Advance overview of separation processes Selection of separation processes
Literature	 The students work on tasks in small groups and present their results in front of all students. G. Brunner: Skriptum Thermische Verfahrenstechnik J. King: Separation Processes, McGraw-Hill, 2. Aufl. 1980 Sattler: Thermische Trennverfahren, VCH, Weinheim 1995 J.D. Seader, E.J. Henley: Separation Process Principles, Wiley, New York, 1998. Mersmann: Thermische Verfahrenstechnik, Springer, 1980 Grassmann, Widmer, Sinn: Einführung in die Thermische Verfahrenstechnik, 3. Aufl., Walter de Gruyter, Berlin 1997 Brunner, G.: Gas extraction. An introduction to fundamentals of supercritical fluids and the application to separatio processes. Steinkopff, Darmstadt; Springer, New York; 1994. ISBN 3-7985-0944-1; ISBN 0-387-91477-3. R. Goedecke (Hrsg.): Fluid-Verfahrenstechnik, Wiley-VCH Verlag, Weinheim, 2006. Perry"s Chemical Engineers" Handbook, R.H. Perry, D.W. Green, J.O. Maloney (Hrsg.), 6th ed., McGraw-Hill, New York 1984 Ullmann"s Enzyklopädie der Technischen Chemie

Course L0141: Thermal Sepa	ration Processes
Тур	Recitation Section (large)
Hrs/wk	1
CP	1
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14
Lecturer	Prof. Irina Smirnova
Language	DE
Cycle	WiSe
Content	 Introduction in the thermal process engineering and to the main features of separation processes Simple equilibrium processes, several steps processes Distillation of binary mixtures, enthalpy-concentration diagrams Extractive and azeotrope distillation, water vapor distillation, stepwise distillation Extraction: separation ternary systems, ternary diagram Multiphase separation including complex mixtures Designing of separation devices without discrete stages Drying Chromatographic separation processes Membrane separation Energy demand of separation processes Advance overview of separation processes Selection of separation processes
Literature	 G. Brunner: Skriptum Thermische Verfahrenstechnik J. King: Separation Processes, McGraw-Hill, 2. Aufl. 1980 Sattler: Thermische Trennverfahren, VCH, Weinheim 1995 J.D. Seader, E.J. Henley: Separation Process Principles, Wiley, New York, 1998. Mersmann: Thermische Verfahrenstechnik, Springer, 1980 Grassmann, Widmer, Sinn: Einführung in die Thermische Verfahrenstechnik, 3. Aufl., Walter de Gruyter, Berlin 1997 Brunner, G.: Gas extraction. An introduction to fundamentals of supercritical fluids and the application to separation processes. Steinkopff, Darmstadt; Springer, New York; 1994. ISBN 3-7985-0944-1; ISBN 0-387-91477-3. R. Goedecke (Hrsg.): Fluid-Verfahrenstechnik, Wiley-VCH Verlag, Weinheim, 2006. Perry"s Chemical Engineers" Handbook, R.H. Perry, D.W. Green, J.O. Maloney (Hrsg.), 6th ed., McGraw-Hill, New York 1984 Ullmann"s Enzyklopädie der Technischen Chemie

.1159: Separation Pr	Practical Course
Hrs/wk	
CP	
	-
	Independent Study Time 16, Study Time in Lecture 14
	Prof. Irina Smirnova
Language	
Cycle Content	Wise The students work on eight different experiments in this practical course. For every one of the eight experiments, a colloquiur takes place in which the students explain and discuss the theoretical background and its translation into practice with staff an fellow students.
	The students work small groups with a high degree of division of labor. For every experiment, the students write a report. The receive instructions in terms of scientific writing as well as feedback on their own reports and level of scientific writing so they can increase their capabilities in this area.
	Topics of the practical course:
	 Introduction in the thermal process engineering and to the main features of separation processes Simple equilibrium processes, several steps processes Distillation of binary mixtures, enthalpy-concentration diagrams Extractive and azeotrope distillation, water vapor distillation, stepwise distillation Extraction: separation ternary systems, ternary diagram Multiphase separation including complex mixtures Designing of separation devices without discrete stages Drying Chromatographic separation processes Membrane separation processes Advance overview of separation processes Selection of separation processes
Literature	 G. Brunner: Skriptum Thermische Verfahrenstechnik J. King: Separation Processes, McGraw-Hill, 2. Aufl. 1980 Sattler: Thermische Trennverfahren, VCH, Weinheim 1995 J.D. Seader, E.J. Henley: Separation Process Principles, Wiley, New York, 1998. Mersmann: Thermische Verfahrenstechnik, Springer, 1980 Grassmann, Widmer, Sinn: Einführung in die Thermische Verfahrenstechnik, 3. Aufl., Walter de Gruyter, Berlin 1997 Brunner, G.: Gas extraction. An introduction to fundamentals of supercritical fluids and the application to separatic processes. Steinkopff, Darmstadt; Springer, New York; 1994. ISBN 3-7985-0944-1; ISBN 0-387-91477-3. R. Goedecke (Hrsg.): Fluid-Verfahrenstechnik, Wiley-VCH Verlag, Weinheim, 2006. Perry"s Chemical Engineers" Handbook, R.H. Perry, D.W. Green, J.O. Maloney (Hrsg.), 6th ed., McGraw-Hill, New York 198 Ullmann"s Enzyklopädie der Technischen Chemie

Courses				
Title		Тур	Hrs/wk	СР
Heat and Mass Transfer (L0101)		Lecture	2	2
Heat and Mass Transfer (L0101)		Recitation Section (small)	1	2
Heat and Mass Transfer (L1868)		Recitation Section (large)	1	2
Module Responsible	Prof. Irina Smirnova			
Admission Requirements				
Recommended Previous				
Knowledge	5 ,			
Educational Objectives	After taking part successfully, students have re-	ached the following learning results		
Professional Competence	2			
Knowledge	 The students are capable of explaining q heat exchanger, chemical reactors). They are capable of distinguish and chan transfer and thermal radiation. The students have the ability to expla qualitative and quantitative by using suit 	ualitative and determining quantitative heat t acterize different kinds of heat transfer mech in the physical basis for mass transfer in o table mass transfer theories. The heat- and mass transfer and to describe o	anisms namely h detail and to des	eat conduction, he
Skills	 The students are able to set reasonable and to balance the corresponding energy. They are capable to solve specific heat and to calculate the corresponding heat . Using dimensionless quantities, the stude. They are able to distinguish between diffor the description and design of apparat. In this context, the students are capable application considering their advantages. In addition, they can calculate both, steat. The students are capable to connect. 	transfer problems (e.g. heated chemical reac flows. ents can execute scaling up of technical proce fusion, convective mass transition and mass t us (e.g. extraction column, rectification colum to choose and design fundamental types of he	tors, temperature sses or apparature ransfer. They car n). eat and mass exc ocedural apparat with knowlegde	e alteration in flui s. h use this knowled changer for a spec us. of other courses
Personal Competence Social Competence				
	 The students are able to find and evaluate 	te necessary information from suitable sources		
Autonomy	 They are able to prove their level of k system, exam-like assignments) and on t 	nowledge during the course with accompany this basis they can control their learning proce	sses.	continuously (click
		his basis they can control their learning proce	isses.	continuously (click
	system, exam-like assignments) and on 1 Independent Study Time 124, Study Time in Lev	his basis they can control their learning proce	sses.	continuously (click
Workload in Hours	system, exam-like assignments) and on t Independent Study Time 124, Study Time in Lev 6	his basis they can control their learning proce	sses.	ontinuously (click
Workload in Hours Credit points Course achievement	system, exam-like assignments) and on t Independent Study Time 124, Study Time in Lev 6	his basis they can control their learning proce	sses.	continuously (click
Workload in Hours Credit points Course achievement	system, exam-like assignments) and on t Independent Study Time 124, Study Time in Lev G None Written exam	this basis they can control their learning proce	sses.	continuously (click
Workload in Hours Credit points Course achievement Examination	system, exam-like assignments) and on t Independent Study Time 124, Study Time in Lev Independent Study Time 124, Study Time 124, Study Time in Lev Independent Study Time 124, Study Time	this basis they can control their learning proce	sses.	continuously (click
Workload in Hours Credit points Course achievement Examination Examination duration and scale	system, exam-like assignments) and on t Independent Study Time 124, Study Time in Lev Independent Study Time 124, Study Time in Lev None Written exam 120 minutes; theoretical questions and calculat	this basis they can control their learning proce		continuously (click
Workload in Hours Credit points Course achievement Examination Examination duration and scale Assignment for the	system, exam-like assignments) and on the system, exam-like assignments and on the system, example a signal for the system, example	this basis they can control their learning proce cture 56 ions , 7 semester): Specialisation Green Technolog	ies: Compulsory	
Workload in Hours Credit points Course achievement Examination Examination duration and scale	system, exam-like assignments) and on the system, exam-like assignments) and on the system, example a signal for the system, example a sis signal for the system, example a signal for the system, exa	this basis they can control their learning proce cture 56 ions , 7 semester): Specialisation Green Technolog , 7 semester): Specialisation Chemical and Bio	ies: Compulsory	
Workload in Hours Credit points Course achievement Examination Examination duration and scale Assignment for the	system, exam-like assignments) and on the system, exam-like assignments) and on the system, example a signal for the system, example a signal for the system, example a signal for the system of the s	this basis they can control their learning proce cture 56 ions , 7 semester): Specialisation Green Technolog , 7 semester): Specialisation Chemical and Bio npulsory	ies: Compulsory	
Workload in Hours Credit points Course achievement Examination Examination duration and scale Assignment for the	system, exam-like assignments) and on the system, exam-like assignments) and on the system, examination of the system, examination of the system, examination of the system, examination of the system of the system of the system of the system, examination of the sys	this basis they can control their learning proce cture 56 ions , 7 semester): Specialisation Green Technolog , 7 semester): Specialisation Chemical and Bio npulsory alification: Compulsory	ies: Compulsory	
Workload in Hours Credit points Course achievement Examination Examination duration and scale Assignment for the	system, exam-like assignments) and on the system, exam-like assignments) and on the system, example a signal for the system, example a signal for the system, example a signal for the system of the s	this basis they can control their learning proce cture 56 ions , 7 semester): Specialisation Green Technolog , 7 semester): Specialisation Chemical and Bio npulsory alification: Compulsory ore Qualification: Compulsory	ies: Compulsory	

Course L0101: Heat and Mas	s Transfer
Тур	Lecture
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Prof. Irina Smirnova
Language	DE
Cycle	WiSe
Content	 Heat transfer Introduction, one-dimensional heat conduction Convective heat transfer Multidimensional heat conduction Non-steady heat conduction Thermal radiation Mass transfer one-way diffusion, equimolar countercurrent diffusion boundary layer theory, non-steady mass transfer Heat and mass transfer single particle/ fixed bed Mass transfer and chemical reactions
Literature	 H.D. Baehr und K. Stephan: Wärme- und Stoffübertragung, Springer VDI-Wärmeatlas

Course L0102: Heat and Mas	ourse L0102: Heat and Mass Transfer	
Тур	Recitation Section (small)	
Hrs/wk	1	
CP	2	
Workload in Hours	Independent Study Time 46, Study Time in Lecture 14	
Lecturer	Prof. Irina Smirnova	
Language	DE	
Cycle	WiSe	
Content	See interlocking course	
Literature	See interlocking course	

Course L1868: Heat and Mas	Course L1868: Heat and Mass Transfer	
Тур	Recitation Section (large)	
Hrs/wk	1	
CP	2	
Workload in Hours	Independent Study Time 46, Study Time in Lecture 14	
Lecturer	Prof. Irina Smirnova	
Language	DE	
Cycle	WiSe	
Content	See interlocking course	
Literature	See interlocking course	

Courses				
Title		Тур	Hrs/wk	СР
Material Engineering (L2894)		Lecture	2	3
Module Responsible	Dr. Marko Hoffmann			
Admission Requirements	None			
Recommended Previous	- Concert and Increasin Chemistry			
Knowledge	 General and Inorganic Chemistry Phase Equilibria Thermodynamics 			
Educational Objectives	After taking part successfully, students have reached th	e following learning results		
Professional Competence				
Skills	module therefore focuses on ferrous materials, although of atomic structure, microstructure, phase transformation necessary for materials selection and for the evaluation one-semester module. Students will also have basic knowledge of the main types of steel used in process er of steels in practice in the context of time-temperature to Students will be able to select suitable materials for the strength, ductility, toughness and fatigue strength ar corrosion resistance. In addition to specifying strengt mechanical properties, such as heat treatment processes	on, diffusion, state diagrams n of corrosion and wear proc nowledge in the area of mec on processes that are very re ngineering and knowledge of ransformation diagrams (TTT e design of process plants a te taken into account. Stude th-increasing measures, stud	, and alloy formation, an cesses, which students si chanical properties of ma elevant in practice. In ad the most important heat diagrams). Ind apparatus. Mechanica ents can also specify m	nong other things, hould acquire in ti iterials including ti dition, students ga treatment process al properties such easures to increa
Personal Competence				
	The students are able to work out results in groups an	d document them, provide a	ppropriate feedback and	handle feedback
,	their own performance constructively.			
Autonomy	Students are able to independently assess their level	of loorning and roflact on th	air weaknesses and stre	nothe in the field
Autonomy	materials engineering. Students are also able to independently	-		-
	this to the context of the course, e.g. when selecting a n		, , ,	
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28			
Credit points				
Course achievement	None			
Examination	Written exam			
Examination duration and	90 min			
scale				
Assignment for the	General Engineering Science (German program, 7 seme	ster): Specialisation Chemical	and Bioengineering: Con	npulsory
Following Curricula	, , , , , , , , , , , , , , , , , , , ,		-	
	Chemical and Bioprocess Engineering: Specialisation Bio	Engineering: Elective Compu	ulsory	

Course L2894: Material Engir	ieering
Тур	Lecture
Hrs/wk	2
CP	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Dr. Marko Hoffmann
Language	DE
Cycle	WiSe
Content	 Introduction Atomic structure and bonding Structure of solids Miller indices Imperfections in solids Texture Diffusion Mechanical properties Dislocations and strengthening mechanisms Phase transformations Phase diagrams, iron-carbon phase diagram Metallic materials Corrosion Polymeric materials Ceramic materials
Literature	 Bargel, HJ.; Schulze, G. (Hrsg.): Werkstoffkunde. Berlin u.a., Springer Vieweg, 2012. Bergmann, W.: Werkstofftechnik 1. München u.a., Hanser, 2009. Bergmann, W.: Werkstofftechnik 2. München u.a., Hanser, 2008. Callister, W. D.; Rethwisch, D. G.: Materialwissenschaften und Werkstofftechnik: eine Einführung, Übersetzungshrsg.: Scheffler, M., 1. Auflage, Weinheim, Wiley-VCH, 2013. Seidel, W. W.,Hahn, F.: Werkstofftechnik. München u.a., Hanser, 2012.

Courses						
Title			Ту	yp	Hrs/wk	СР
Particle Technology I (L0434)			Le	ecture	2	3
Particle Technology I (L0435)			Re	ecitation Section (small)	1	1
Particle Technology I (L0440)			Pr	actical Course	2	2
Module Responsible	Prof. Stefan Heinrich					
Admission Requirements	None					
Recommended Previous	keine					
Knowledge						
Educational Objectives	After taking part succ	essfully, students have r	eached the following	learning results		
Professional Competence						
Knowledge	After successful comp	pletion of the module stud	dents are able to			
		ain processes and unit-o				
	 characterize pa 	articles, particle distributi	ions and to discuss th	eir bulk properties		
Skills	Students are able to					
	 choose and design 	sign apparatuses and pro	cesses for solids proc	cessing according to the de	esired solids prop	erties of the produ
	 choose and design apparatuses and processes for solids processing according to the desired solids properties of the produc asses solids with respect to their behavior in solids processing steps 					
	document their work scientifically.					
Personal Competence						
Social Competence			opics orally with othe	er students or scientific p	ersonal and to o	levelop solutions f
	technical-scientific iss					
Autonomy	Students are able to a	analyze and solve question	ons regarding solid pa	rticles independently.		
Workload in Hours	Independent Study Ti	me 110, Study Time in L	ecture 70			
Credit points	6					
Course achievement	Compulsory Bonus	Form	Description			
	Yes None	Written elaboration	sechs Berichte (pro Versuch ein Bericht) à	5-10 Seiten	
Examination	Written exam					
Examination duration and	90 minutes					
scale						
Assignment for the	General Engineering	Science (German progra	m, 7 semester): Spec	ialisation Green Technolog	gies, Focus Wate	r and Environment
Following Curricula	Engineering: Elective	Compulsory				
	General Engineering	Science (German prograr	n, 7 semester): Specia	alisation Chemical and Bio	engineering: Con	npulsory
	Bioprocess Engineerir	ng: Core Qualification: Co	mpulsory			
	Chemical and Bioproc	ess Engineering: Core Qu	ualification: Compulso	ory		
	Green Technologies: I	Energy, Water, Climate: S	Specialisation Water T	Technologies: Elective Com	npulsory	
	Process Engineering:	Core Qualification: Comp	uleen			

Course L0434: Particle Technology I		
Тур	Lecture	
Hrs/wk	2	
CP	3	
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28	
Lecturer	Prof. Stefan Heinrich	
Language	DE	
Cycle	SoSe	
Content	 Description of particles and particle distributions Description of a separation process Description of a particle mixture Particle size reduction Agglomeration, particle size enlargement Storage and flow of bulk solids Basics of fluid/particle flows classifying processes Separation of particles from fluids Basic fluid mechanics of fluidized beds Pneumatic and hydraulic transport 	
Literature	Schubert, H.; Heidenreich, E.; Liepe, F.; Neeße, T.: Mechanische Verfahrenstechnik. Deutscher Verlag für die Grundstoffindustrie, Leipzig, 1990. Stieß, M.: Mechanische Verfahrenstechnik I und II. Springer Verlag, Berlin, 1992.	

ourse L0435: Particle Technology I	
Тур	Recitation Section (small)
Hrs/wk	1
СР	1
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14
Lecturer	Prof. Stefan Heinrich
Language	DE
Cycle	SoSe
Content	See interlocking course
Literature	See interlocking course

ourse L0440: Particle Tech	nology I
Тур	Practical Course
Hrs/wk	2
СР	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Prof. Stefan Heinrich
Language	DE/EN
Cycle	SoSe
Content	 Sieving Bulk properties Size reduction Mixing Gas cyclone Blaine-test, filtration Sedimentation
Literature	Schubert, H.; Heidenreich, E.; Liepe, F.; Neeße, T.: Mechanische Verfahrenstechnik. Deutscher Verlag für die Grundstoffindustrie Leipzig, 1990. Stieß, M.: Mechanische Verfahrenstechnik I und II. Springer Verlag, Berlin, 1992.

ourses						
itle				Тур	Hrs/wk	СР
rocess and Plant Engineering I (LOC				Lecture	2	4
rocess and Plant Engineering I (LOC				Recitation Section (large)	1	1
rocess and Plant Engineering I (L12		1.:		Recitation Section (small)	1	1
Module Responsible		KI				
Admission Requirements Recommended Previous		mal an dmechanical seg	aration processes			
Knowledge	unit operation of them		baración processes			
	chemical reactor eing	ineering				
Educational Objectives	After taking part succ	essfully, students have	reached the followin	g learning results		
Professional Competence	51			5 5		
Knowledge	students can:					
	classify and formulate	e blobal balance equatio	ons of chomical proc			
			ins of chemical proce			
	specify linear compon	ent equations of compl	ex chemical process	es		
	explain linear regress	ion and data reconcillia	tion problems			
	explain pfd-diagrams					
Skills	students are capable	of				
	- formulation of mass	and energy balance eq	uations and estimati	on of product streams		
	- estimation of compo	ment streams of chemic	al plants using linea	r component balance model	s	
	- solution of data reco					
	- conduction of proces	ss synthesis				
	- economic evaluation	n of processes and the e	estimation of product	ion costs		
Personal Competence						
Social Competence	Students are able to v	work together in heterog	geneous small group	s to find solutions.		
Autonomy	Students are able to g	gain knowledge from fur	ther literature on the	e subject.		
Workload in Hours	Indonondont Study Ti	me 124, Study Time in I	Locturo 56			
	6	me 124, Study Time in	Lecture 50			
	Compulsory Bonus	Form	Description			
	Yes 10 %	Subject theoretical	and			
		practical work				
Examination	Written exam					
	120 Min. lectures note	es and books				
scale						
-				cialisation Chemical and Bio	engineering: Cor	npulsory
		ng: Core Qualification: C ess Engineering: Core C		son		
					sorv	
		Energy, water, Climate: Core Qualification: Com		chnologies: Elective Comput	SULY	

Тур	Lecture
Hrs/wk	
CP	4
Workload in Hours	Independent Study Time 92, Study Time in Lecture 28
Lecturer	Prof. Mirko Skiborowski
Language	DE
Cycle	SoSe
Content	1. Introduction
	Structure and operation of production plants
	Operational business process
	Technical process design
	Motivation and targets of process development
	Life cycle of production plants
	2. Engineering methods and tools
	Mass and energy balances
	Strategies of process synthesis
	Graphical representation of processes
	Multidimensional regression
	Data reconciliation and data validation
	3. Process Synthesis
	Decision levels

	 Experimental process development Reactor synthesis Synthesis of separation processes (process alternatives and criteria for selection) Integration of reaction systems/separation systems (interactions, recycle streams) Process safety Cost estimation of production plants Production costs, capital costs, economic evaluation
Literature	C. D. Barriski, J. D. Fair, Jud. Fund. Charm. 20(1000), C. 421, Jud. Fund. Charm. 21(1002), C. 1670.
	S.D. Barnicki, J.R. Fair, Ind. End. Chem., 29(1990), S. 421, Ind. End. Chem., 31(1992), S. 1679 H. Becker, S. Godorr, H. Kreis, Chemical Engineering, January 2001, S. 68-74
	Behr, W. Ebbers, N. Wiese, ChemIngTech. 72(2000)Nr. 10, S.1157
	E. Blass, Entwicklung verfahrenstechnischer Prozesse, Springer-Verlag, 2. Auflage 1997
	M. H. Bauer, J. Stichlmair, ChemIngTech., 68(1996), Nr. 8, 911-916
	R. Dittmeyer, W. Keim, G. Kreysa, A. Oberholz, Chemische Technik. Prozesse und Produkte,
	Band 2, Neue Technologien, 5. Auflage, Wiley-VCH GmbH&Co.KGaA, Weinheim, 2004
	J.M. Douglas, Conceptual Design of Chemical Processes, Mc Graw-Hill, NY, 1988
	G. Fieg, Inz. Chem. Proc., 5(1979), S.15-19
	G. Fieg, G. Wozny, L. Jeromin, Chem. Eng. Technol. 17(1994),5, 301-306
	G. Fieg, Heat and Mass Transfer 32(1996), S. 205-213
	G. Fieg, Chem. Eng. Processing, Vol. 41/2(2001), S. 123-133
	U.H. Felcht, Chemie eine reife Industrie oder weiterhin Innovationsmotor, Universitätsbuchhandlung Blazek und Bergamann, Frankfurt, 2000
	J.P. van Gigch, Systems Design, Modeling and Metamodeling, Plenum Press, New York, 1991
	T.F. Edgar, D.M. Himmelblau, L.S. Lasdon, Optimization of Chemical Processes, McGraw-Hill, 2001
	G. Gruhn, Vorlesungsmanuskript "Prozess- und Anlagentechnik, TU Hamburg-Harburg
	D. Hairston, Chemical Engineering, October 2001, S. 31-37
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	J. Krekel, G. Siekmann, ChemIngTech. 57(1985)Nr. 6, S. 511
	K. Machej, G. Fieg, J. Wojcik, Inz. Chem. Proc., 2(1981), S.815-824
	S. Meier, G. Kaibel, ChemIngTech. 62(1990)Nr. 13, S.169
	J. Mittelstraß, ChemIngTech. 66(1994), S. 309
	P. Li, M. Flender, K. Löwe, G. Wozny, G. Fieg, Fett/Lipid 100(1998), Nr. 12, S. 528-534
	G. Kaibel, Dissertation, TU München, 1987
	G. Kaibel, ChemIngTech. 61 (1989), Nr. 2, S. 104-112
	G. Kaibel, Chem. Eng. Technol., 10(1987), Nr. 2, S. 92-98
	H.J. Lang, Chem. Eng. 54(10),117, 1947
	H.J. Lang, Chem. Eng. 55(6), 112, 1948
	F. Lestak, C. Collins, Chemical Engineering, July 1997, S. 72-76

Course L0096: Process and P	ourse L0096: Process and Plant Engineering I	
Тур	Recitation Section (large)	
Hrs/wk	1	
CP	1	
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14	
Lecturer	Prof. Mirko Skiborowski, Dr. Thomas Waluga	
Language	DE	
Cycle	SoSe	
Content	See interlocking course	
Literature	See interlocking course	

Course L1214: Process and P	ourse L1214: Process and Plant Engineering I	
Тур	Recitation Section (small)	
Hrs/wk	1	
CP	1	
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14	
Lecturer	Prof. Mirko Skiborowski, Dr. Thomas Waluga	
Language	DE	
Cycle	SoSe	
Content	See interlocking course	
Literature	See interlocking course	

Specialization Electrical Engineering

The educational objective of the General Engineering Science BSc program's electrical engineering specialization is to develop the ability to choose and combine fundamental methods and processes in order to solve technical tasks in engineering science and, especially, the specialization subject.

Graduates will have

1) A firm grounding in mathematics, physics, electrical engineering, and computer science

2) A basic knowledge of systems theory, control systems, and electrical power and energy or measurement technology

3) In-depth knowledge of engineering science areas, especially their specialization area (electrical engineering materials and components, semiconductor technology, communications engineering, electromagnetig theory). They will, in particular, have the methodological skills required for applying their knowledge to the solution of technical problems, taking technical, economic and societal requirements into account.

Module M0708: Electrical Engineering III: Circuit Theory and Transients

Courses				
Courses				
Title Circuit Theory (L0566)		Typ Lecture	Hrs/wk 3	CP 4
Circuit Theory (L0566) Circuit Theory (L0567)		Recitation Section (small)	2	2
Module Responsible	Prof. Alexander Kölpin	Rectation Section (Small)	Z	2
Admission Requirements				
	Electrical Engineering I and II, Mathematics I	and II		
Knowledge	Liectrical Engineering Fand II, Mathematics I			
Kilowieuge				
Educational Objectives	After taking part successfully, students have	reached the following learning results		
Professional Competence				
•	Students are able to explain the basic meth	oods for calculating electrical circuits. They know	w the Fourier ser	ies analysis of line
raiomeage	Students are able to explain the basic methods for calculating electrical circuits. They know the Fourier series analysis of lin networks driven by periodic signals. They know the methods for transient analysis of linear networks in time and in freque			-
		quency behaviour and the synthesis of passive tw		
Skills	The students are able to calculate currents	and voltages in linear networks by means of	basic methods,	also when driven l
	periodic signals. They are able to calculate ti	ansients in electrical circuits in time and frequen	cy domain and a	re able to explain t
	respective transient behaviour. They are a	ble to analyse and to synthesize the frequency	/ behaviour of p	assive two-termina
	circuits.			
Personal Competence				
Social Competence	Students work on exercise tasks in small g	juided groups. They are encouraged to present	and discuss the	eir results within t
	group.			
Autonomy	The students are able to find out the require	d methods for solving the given practice probler	ns. Possibilities a	re given to test th
	knowledge during the lectures continuous	y by means of short-time tests. This allows	them to control	independently th
	educational objectives. They can link their ga	ained knowledge to other courses like Electrical E	ingineering I and	Mathematics I.
	Independent Study Time 110, Study Time in	Lecture 70		
Credit points Course achievement				
	Written exam			
Examination duration and				
scale				
Assignment for the	General Engineering Science (German pr	ogram, 7 semester): Specialisation Mechanica	I Engineering,	Focus Mechatroni
Following Curricula	Compulsory			
	General Engineering Science (German progra	am, 7 semester): Specialisation Electrical Enginee	ering: Compulsor	y
	Electrical Engineering: Core Qualification: Co	mpulsory		
	Engineering Science: Specialisation Electrica	l Engineering: Compulsory		
	Computer Science in Engineering: Specialisa	tion II. Mathematics & Engineering Science: Elect	ive Compulsory	
	Mechatronics: Core Qualification: Compulsor	ý		
	Technomathematics: Specialisation III. Engin	eering Science: Elective Compulsory		

Course L0566: Circuit Theory	
Тур	Lecture
Hrs/wk	3
СР	4
Workload in Hours	Independent Study Time 78, Study Time in Lecture 42
Lecturer	Prof. Alexander Kölpin, Dr. Fabian Lurz
Language	DE
Cycle	WiSe
Content	- Circuit theorems
	- N-port circuits
	- Periodic excitation of linear circuits
	- Transient analysis in time domain
	- Transient analysis in frequency domain; Laplace Transform
	- Frequency behaviour of passive one-ports
Literature	- M. Albach, "Grundlagen der Elektrotechnik 1", Pearson Studium (2011)
	- M. Albach, "Grundlagen der Elektrotechnik 2", Pearson Studium (2011)
	- L. P. Schmidt, G. Schaller, S. Martius, "Grundlagen der Elektrotechnik 3", Pearson Studium (2011)
	- T. Harriehausen, D. Schwarzenau, "Moeller Grundlagen der Elektrotechnik", Springer (2013)
	- A. Hambley, "Electrical Engineering: Principles and Applications", Pearson (2008)
	- R. C. Dorf, J. A. Svoboda, "Introduction to electrical circuits", Wiley (2006)
	- L. Moura, I. Darwazeh, "Introduction to Linear Circuit Analysis and Modeling", Amsterdam Newnes (2005)

Course L0567: Circuit Theory	irse L0567: Circuit Theory	
Тур	Recitation Section (small)	
Hrs/wk	2	
CP	2	
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28	
Lecturer	Prof. Alexander Kölpin, Dr. Fabian Lurz	
Language	DE	
Cycle	WiSe	
Content	see interlocking course	
Literature	siehe korrespondierende Lehrveranstaltung	

Courses				
Courses				
Fitle		Typ Lecture	Hrs/wk 3	CP 4
Computer Engineering (L0321) Computer Engineering (L0324)		Recitation Section (small)	1	2
	Prof. Heiko Falk		-	
Module Responsible				
Admission Requirements	None			
Recommended Previous	Basic knowledge in electrical engineering			
Knowledge				
Educational Objectives	After taking part successfully, students have reach	hed the following learning results		
Professional Competence				
Knowledge	This module deals with the foundations of the fu programming down to gates. The module includes		vers the layers fror	n the assembly-le
	Introduction			
	Combinational logic: Gates, Boolean algebra	a Boolean functions hardware synthesis	combinational net	works
	 Sequential logic: Flip-flops, automata, syste 		, combinational nee	
	Technological foundations			
	Computer arithmetic: Integer addition, subt	traction multiplication and division		
	Basics of computer architecture: Programm		re ninelining	
	 Memories: Memory hierarchies, SRAM, DRA 		c, pipeining	
	 Input/output: I/O from the perspective of the 		o-noint connections	husses
	• input/output. i/o nom the perspective of the	e er o, principles of passing data, pointer	5-point connections	, 503363
Skills	The students perceive computer systems from the	e architect's perspective, i.e., they identit	iy the internal struc	ture and the phys
	composition of computer systems. The students c	an analyze, how highly specific and indiv	vidual computers ca	n be built based o
	collection of few and simple components. They a	re able to distinguish between and to e	xplain the different	abstraction layers
	today's computing systems - from gates and circu	its up to complete processors.		
	After successful completion of the module, the s			
	system and the software executed on it. In particu			
	on the hardware-centric abstraction layers from the			
	the impact that these low abstraction levels have	on an entire system's performance and t	o propose feasible (options.
Personal Competence				
	Students are able to solve similar problems alone	or in a group and to present the results a	accordingly	
boendi bonnpeteriee			lecol alligity i	
Autonomy	Students are able to acquire new knowledge from	specific literature and to associate this k	nowledge with othe	er classes.
Workload in Hours	Independent Study Time 124, Study Time in Lectu	ire 56		
Credit points	6			
Course achievement	Compulsory Bonus Form	Description		
	Yes 10 % Excercises			
Examination	Written exam			
Examination duration and	90 minutes, contents of course and labs			
scale				
Assignment for the	General Engineering Science (German program, 7	semester): Specialisation Computer Scie	nce: Compulsory	
Following Curricula	General Engineering Science (German program			Focus Mechatron
· · · · · · · · · · · · · · · · · · ·	Compulsory	.,		
	General Engineering Science (German program,	7 semester): Specialisation Mechanic	al Engineering Fo	cus Aircraft Syste
	Engineering: Compulsory		ar Engineering, ro	
	General Engineering Science (German program, 7	semester): Specialisation Mechanical Fr	naineerina Focus T	heoretical Mechan
	Engineering: Compulsory	semestery. Specialisation mechanical Er	igineering, rocus ri	
	General Engineering Science (German program	m 7 semester). Specialization Macha	nical Engineering	Focus Matoriale
	Engineering Sciences: Compulsory	in, 7 semester). Specialisation Mecha	filear Engineering,	Tocus Materials
	General Engineering Science (German program, 7	7 competer): Specialization Mechanical E	inginooring Focus	Product Dovolopm
		semester). Specialisation Mechanical L	ngineering, rocus r	Toduce Developin
	and Production: Compulsory	7 compostor), Specialization Machanic	al Engineering Eq.	suc Eporal System
	General Engineering Science (German program,	, 7 semester). Specialisation Mechanica	ai Engineering, roo	us Energy System
	Compulsory	- 7 Consisting Mashag	ingly Englished and	Frank Diamarkan
	General Engineering Science (German program	n, / semester): Specialisation Mechan	icai Engineering, I	Focus Biomechan
	Compulsory			
	General Engineering Science (German program, 7			
	General Engineering Science (German program, 7	semester): Specialisation Green Technol	ogies, Focus Renew	able Energy: Elect
	Compulsory			
	Computer Science: Core Qualification: Compulsory			
	Data Science: Core Qualification: Elective Compuls	•		
	Data Science: Specialisation I. Mathematics/Comp			
	Electrical Engineering: Core Qualification: Compute			
	Computer Science in Engineering: Core Qualification	on: Compulsory		
	Integrated Building Technology: Core Qualification			

Course L0321: Computer Eng	gineering
Тур	Lecture
Hrs/wk	3
СР	4
Workload in Hours	Independent Study Time 78, Study Time in Lecture 42
Lecturer	Prof. Heiko Falk
Language	DE/EN
Cycle	WiSe
Content	 Introduction Combinational Logic Sequential Logic Technological Foundations Representations of Numbers, Computer Arithmetics Foundations of Computer Architecture Memories Input/Output
Literature	 A. Clements. The Principles of Computer Hardware. 3. Auflage, Oxford University Press, 2000. A. Tanenbaum, J. Goodman. Computerarchitektur. Pearson, 2001. D. Patterson, J. Hennessy. Rechnerorganisation und -entwurf. Elsevier, 2005.

Course L0324: Computer Eng	urse L0324: Computer Engineering	
Тур	Recitation Section (small)	
Hrs/wk	1	
CP	2	
Workload in Hours	Independent Study Time 46, Study Time in Lecture 14	
Lecturer	Prof. Heiko Falk	
Language	DE/EN	
Cycle	WiSe	
Content	See interlocking course	
Literature	See interlocking course	

Courses				
Title		Тур	Hrs/wk	СР
Theoretical Electrical Engineering I Theoretical Electrical Engineering I	-	Lecture Recitation Section (small)	3 2	5 1
Module Responsible	Prof. Christian Schuster			
Admission Requirements	None			
Recommended Previous Knowledge	Basic principles of electrical engineering and adv	vanced mathematics		
Educational Objectives	After taking part successfully, students have rea	ched the following learning results		
Professional Competence Knowledge	Students can explain the fundamental formulas, They can explicate the principal behavior of e sources. They can describe the properties of c fields. The students are aware of applications for these.	lectrostatic, magnetostatic, and current of omplex electromagnetic fields by means	lensity fields with of superposition of	regard to respective f solutions for simp
Skills	Students can apply Maxwell's Equations in integral notation in order to solve highly symmetrical, time-independen electromagnetic field problems. Furthermore, they are capable of applying a variety of methods that require solving Maxwell Equations for more general problems. The students can assess the principal effects of given time-independent sources of fields ar analyze these quantitatively. They can deduce meaningful quantities for the characterization of electrostatic, magnetostatic, an electrical flow fields (capacitances, inductances, resistances, etc.) from given fields and dimension them for practical applications			
Personal Competence Social Competence	Students are able to work together on subject re during exercise sessions).	elated tasks in small groups. They are able	to present their re	esults effectively (e.
Autonomy	Students are capable to gather necessary inform able to continually reflect their knowledge by me lectures and exercises that are related to the ex- learning process. They are able to draw connect lectures (e.g. Electrical Engineering I, Linear Alge	eans of activities that accompany the lectu am. Based on respective feedback, studen tions between their knowledge obtained	re, such as short o is are expected to	ral quizzes during t adjust their individu
Workload in Hours	Independent Study Time 110, Study Time in Lect	ture 70		
Credit points	6			
Course achievement	None			
Examination	Written exam			
Examination duration and scale	90-150 minutes			
Assignment for the Following Curricula	General Engineering Science (German program, Electrical Engineering: Core Qualification: Compu Computer Science in Engineering: Specialisation	ilsory		у

	ectrical Engineering I: Time-Independent Fields Lecture		
Hrs/wk			
CP			
	Independent Study Time 108, Study Time in Lecture 42		
	Prof. Christian Schuster		
Language	DE		
Cycle	SoSe		
Content	- Maxwell's Equations in integral and differential notation		
	- Boundary conditions		
	- Laws of conservation for energy and charge		
	- Classification of electromagnetic field properties		
	- Integral characteristics of time-independent fields (R, L, C)		
	- Generic approaches to solving Poisson's Equation		
	- Electrostatic fields and specific methods of solving		
	- Magnetostatic fields and specific methods of solving		
	- Fields of electrical current density and specific methods of solving		
	- Action of force within time-independent fields		
	- Numerical methods for solving time-independent problems		
	The practical application of numerical methods will be trained within specifically prepared lectures in an interactive manner usin small MATLAB programs.		
Literature	- G. Lehner, "Elektromagnetische Feldtheorie: Für Ingenieure und Physiker", Springer (2010)		
	- H. Henke, "Elektromagnetische Felder: Theorie und Anwendung", Springer (2011)		
	- W. Nolting, "Grundkurs Theoretische Physik 3: Elektrodynamik", Springer (2011)		
	- D. Griffiths, "Introduction to Electrodynamics", Pearson (2012)		
	- J. Edminister, " Schaum's Outline of Electromagnetics", Mcgraw-Hill (2013)		
	- Richard Feynman, "Feynman Lectures on Physics: Volume 2", Basic Books (2011)		

Course L0181: Theoretical El	urse L0181: Theoretical Electrical Engineering I: Time-Independent Fields	
Тур	Recitation Section (small)	
Hrs/wk	2	
CP	1	
Workload in Hours	Independent Study Time 2, Study Time in Lecture 28	
Lecturer	Prof. Christian Schuster	
Language	DE	
Cycle	SoSe	
Content	See interlocking course	
Literature	See interlocking course	

	ials in Electrical Engineering				
Courses					
Title		Тур	Hrs/wk	СР	
Electrotechnical Experiments (L071		Lecture	1 2	1	
Materials in Electrical Engineering (L0685) Materials in Electrical Engineering (Problem Solving Course) (L0687)		Lecture Recitation Section (small)	2	3 2	
Module Responsible					
Admission Requirements					
Recommended Previous	Highschool level physics and mathematics				
Knowledge					
Educational Objectives	After taking part successfully, students have	ve reached the following learning results			
Professional Competence					
-	 Students can explain the composition and the structural properties of materials used in electrical engineering. Students explicate the relevance of mechanical, electrical, thermal, dielectric, magnetic and chemical properties of materials in view of the applications in electrical engineering. Students can identify appropriate descriptive models and apply them mathematically. They can derive approximative solutions is a structure of the approximative solution. 				
2.002		nance of materials in electrical engineering applic			
Personal Competence					
Social Competence	Students can jointly solve subject related p problem solving course.	roblems in groups. They can present their results	s effectively within	the framework of	
Autonomy	the lecture. They can reflect their acquire	nformation from the provided references and to need level of expertise with the help of lecture a to connect their knowledge with that acquired from	ccompanying mea		
Workload in Hours	Independent Study Time 110, Study Time i	n Lecture 70			
Credit points	6				
Course achievement	None				
Examination	Written exam				
Examination duration and	60 minutes				
scale					
Assignment for the	General Engineering Science (German prog	gram, 7 semester): Specialisation Electrical Engin	eering: Compulsor	у	
Following Curricula	Electrical Engineering: Core Qualification: C	Compulsory			

	ourse L0714: Electrotechnical Experiments		
Тур	Lecture		
Hrs/wk	1		
CP	1		
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14		
Lecturer	Dr. Helge Fielitz		
Language	DE		
Cycle	SoSe		
Content	Agenda:		
	- Natural sources of electricity		
	- Oscilloscope		
	- Characterizing signals		
	- 2 terminal circuit elements		
	- 2-ports		
	- Power		
•	- Matching		
	- Inductive coupling		
	- Resonance		
	- Radio frequencies		
	- Transistor circuits		
	- Electrical measurement		
	- Materials for the EE		
	- Electrical fun		
Literature	Tietze, Schenk: "Halbleiterschaltungstechnik", Springer		

urse L0685: Materials in E	lectrical Engineering
Тур	Lecture
Hrs/wk	
_	Independent Study Time 62, Study Time in Lecture 28
	Prof. Manfred Eich
Language	
Cycle	
Content	The Hamiltonian approach to classical mechanics. Analysis of a simple oscillator. Analysis of vibrations in a one-dimensional lattice.
	Phononic bandgap
	Introduction to quantum mechanics
	Wave function, Schrödinger's equation, observables and measurements.
	Quantum mechanical harmonic oscillator and spectral decomposition.
	Symmetries, conserved quantities, and the labeling of states.
	Angular momentum
	The hydrogen atom
	Waves in periodic potentials
	Reciprocal lattice and reciprocal lattice vectors
	Band gap
	Band diagrams
	The free electron gas and the density of states
	Fermi-Dirac distribution
	Density of charge carriers in semiconductors
	Conductivity in semiconductors. Engineering conductivity through doping.
	The P-N junction (diode)
	Light emitting diodes
	Electromagnetic waves interacting with materials
	Reflection and refraction
	Photonic band gaps
	Origins of magnetization
	Hysteresis in ferromagnetic materials Magnetic domains
Literature	1.Anikeeva, Beach, Holten-Andersen, Fink, Electronic, Optical and Magnetic Properties of Materials,
	Massachusetts Institute of Technology (MIT), 2013
	2.Hagelstein et al., Introductory Applied Quantum and Statistical Mechanics, Wiley 2004
	3.Griffiths, Introduction to Quantum Mechanics, Prentice Hall, 1994
	4.Shankar, Principles of Quantum Mechanics, 2nd ed., Plenum Press, 1994
	5.Fick, Einführung in die Grundlagen der Quantentheorie, Akad. Verlagsges., 1979
	6.Kittel, Introduction to Solid State Physics, 8th ed., Wiley, 2004
	7.Ashcroft, Mermin, Solid State Physics, Harcourt, 1976
	8.Pierret, Semiconductor Fundamentals Vol. 1, Addison Wesley, 1988
	9.Sze, Physics of Semiconductor Devices, Wiley, 1981
	10.Saleh, Teich, Fundamentals of Photonics, 2nd ed., 2007
	11.Joannopoulos, Johnson, Winn Meade, Photonic Crystals, 2nd ed., Princeton Universty Press, 2008
	12.Handley, Modern Magnetic Materials, Wiley, 2000
	13.Wikipedia, Wikimedia
	zostnikijedilu, mikineulu

Course L0687: Materials in E	lectrical Engineering (Problem Solving Course)
Тур	Recitation Section (small)
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Prof. Manfred Eich
Language	DE
Cycle	SoSe
Content	 Atom structure and periodic system Atom binding and crystal structure Structure and properties of alloys: diffusion, phase diagrams, phase separation and grain boundaries Material properties: Mechanical, thermal, electrical, dielectric properties Metals Semiconductors Ceramics and glasses Polymers Magnetic materials Electrochemistry Oxidation numbers, electrolysis, batteries, fuel cells
Literature	H. Schaumburg: Einführung in die Werkstoffe der Elektrotechnik, Teubner (1993)

Madula MOOPA IN I				
Module M0854: Mathe	ematics IV			
Courses				
Title		Тур	Hrs/wk	СР
Differential Equations 2 (Partial Diff	ferential Equations) (L1043)	Lecture	2	1
Differential Equations 2 (Partial Diff	ferential Equations) (L1044)	Recitation Section (small)	1	1
Differential Equations 2 (Partial Diff	ferential Equations) (L1045)	Recitation Section (large)	1	1
Complex Functions (L1038)		Lecture	2	1
Complex Functions (L1041)		Recitation Section (small)	1	1
Complex Functions (L1042)		Recitation Section (large)	1	1
Module Responsible	Prof. Anusch Taraz			
	None			
	Mathematics I - III			
Knowledge	Mathematics I - III			
	After taking part successfully, students have reach	hed the following learning results		
Professional Competence				
Knowledge	Students can name the basic concents in M	athematics IV. They are able to explain the		to overnles
	Students can name the basic concepts in Ma			
	Students can discuss logical connections be	etween these concepts. They are capable	or illustrating the	ese connections wit
	the help of examples.			
	 They know proof strategies and can reprodu 	uce them.		
Skills				
	 Students can model problems in Mathematical 		ed in this course	. Moreover, they ar
	capable of solving them by applying establis	shed methods.		
	 Students are able to discover and verify further 	ther logical connections between the conce	pts studied in the	course.
	 For a given problem, the students can de- 	velop and execute a suitable approach, a	nd are able to c	itically evaluate th
	results.			
Personal Competence				
Social Competence	 Students are able to work together in teams 	s. They are capable to use mathematics as	a common langua	age.
	 In doing so, they can communicate new cor 	ncepts according to the needs of their coo	perating partners	Moreover, they ca
	design examples to check and deepen the u	understanding of their peers.		
		j		
Autonomy	 Students are capable of checking their und 	lerstanding of complex concepts on their c	wn. They can sp	ecify open question
	precisely and know where to get help in sol		- , - , - ,	
	 Students have developed sufficient persist 	-	ls in a goal-orient	ed manner on har
		lence to be able to work for longer period	is in a goal-onen	
	problems.			
Workload in Hours	Independent Study Time 68, Study Time in Lecture	e 112		
Credit points	6			
Course achievement	None			
Examination	Written exam			
	60 min (Complex Functions) + 60 min (Differential	Equations 2)		
	oo min (complex runctions) + oo min (Differential	i LyuauUIIS 2)		
scale				
-	General Engineering Science (German program, 7			
Following Curricula	General Engineering Science (German program	n, 7 semester): Specialisation Mechanica	al Engineering, I	ocus Mechatronic
	Compulsory			
	General Engineering Science (German program, 7	semester): Specialisation Naval Architectur	e: Compulsory	
	General Engineering Science (German program, 7	semester): Specialisation Mechanical Engin	neering, Focus Th	eoretical Mechanic
	Engineering: Elective Compulsory			
	Electrical Engineering: Core Qualification: Compuls	Sory		
	General Engineering Science (English program, 7 s	-	rina: Compulsory	
	Computer Science in Engineering: Specialisation II.			
			e compulsory	
	Mechanical Engineering: Specialisation Mechatroni			
	Mechanical Engineering: Specialisation Theoretical	I Mechanical Engineering: Elective Compuls	or y	
	Mechatronics: Core Qualification: Compulsory		lor y	
		/	-	

Course L1043: Differential Ec	quations 2 (Partial Differential Equations)
Тур	Lecture
Hrs/wk	2
CP	1
Workload in Hours	Independent Study Time 2, Study Time in Lecture 28
Lecturer	Dozenten des Fachbereiches Mathematik der UHH
Language	DE
Cycle	SoSe
Content	Main features of the theory and numerical treatment of partial differential equations
Literature	 Examples of partial differential equations First order quasilinear differential equations Normal forms of second order differential equations Harmonic functions and maximum principle Maximum principle for the heat equation Wave equation Liouville's formula Special functions Difference methods Finite elements http://www.math.uni-hamburg.de/teaching/export/tuhh/index.html

Course L1044: Differential Equations 2 (Partial Differential Equations)	
Тур	Recitation Section (small)
Hrs/wk	1
CP	1
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14
Lecturer	Dozenten des Fachbereiches Mathematik der UHH
Language	DE
Cycle	SoSe
Content	See interlocking course
Literature	See interlocking course

Course L1045: Differential Equations 2 (Partial Differential Equations)	
Тур	Recitation Section (large)
Hrs/wk	1
CP	1
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14
Lecturer	Dozenten des Fachbereiches Mathematik der UHH
Language	DE
Cycle	SoSe
Content	See interlocking course
Literature	See interlocking course

Course L1038: Complex Functions	
Тур	Lecture
Hrs/wk	2
CP	1
Workload in Hours	Independent Study Time 2, Study Time in Lecture 28
Lecturer	Dozenten des Fachbereiches Mathematik der UHH
Language	DE
Cycle	SoSe
Content	Main features of complex analysis
	 Functions of one complex variable Complex differentiation Conformal mappings Complex integration Cauchy's integral theorem Cauchy's integral formula Taylor and Laurent series expansion Singularities and residuals Integral transformations: Fourier and Laplace transformation
Literature	http://www.math.uni-hamburg.de/teaching/export/tuhh/index.html

Course L1041: Complex Functions	
Тур	Recitation Section (small)
Hrs/wk	1
CP	1
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14
Lecturer	Dozenten des Fachbereiches Mathematik der UHH
Language	DE
Cycle	SoSe
Content	See interlocking course
Literature	See interlocking course

Course L1042: Complex Functions	
Тур	Recitation Section (large)
Hrs/wk	1
СР	1
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14
Lecturer	Dozenten des Fachbereiches Mathematik der UHH
Language	DE
Cycle	SoSe
Content	See interlocking course
Literature	See interlocking course

Courses					
Title		Тур	Hrs/wk	СР	
Electrical Machines and Actuators (L0293)	Lecture	3	4	
Electrical Machines and Actuators (L0294)	Recitation Section (large)	2	2	
Module Responsible	Prof. Thorsten Kern				
Admission Requirements	None				
Recommended Previous	Basics of mathematics, in particular compl	exe numbers, integrals, differentials			
Knowledge	Design of electrical angineering and machine	nicol on sin o svin s			
	Basics of electrical engineering and mecha	inical engineering			
Educational Objectives	After taking part successfully, students have	ve reached the following learning results			
Professional Competence					
Knowledge	Students can to draw and explain the basic	c principles of electric and magnetic fields.			
	They can describe the function of the	standard types of electric machines and pre	sent the correspor	ding equations a	
		ives they can explain the major parameters of th			
	from the power grid to the driven engine.		e energy enterency	of the mole syste	
Skills		sional electric and magnetic fields in particular	ferromagnetic circu	uits with air gap. I	
	this they apply the usual methods of the d	esign auf electric machines.			
	They can calulate the operational perform	nance of electric machines from their given cha	racteristic data and	d selected quantit	
	and characteristic curves. They apply the u	usual equivalent circuits and graphical methods.			
Personal Competence					
Social Competence	none				
Autonomy	Autonomy Students are able independently to calculate electric and magnatic fields for applications. They are able to analyse in		nalyse independen		
	the operational performance of electric machines from the charactersitic data and theycan calculate thereof selected quantities				
	and characteristic curves.				
Workload in Hours	Independent Study Time 110, Study Time	in Locture 70			
Credit points	Independent Study Time 110, Study Time				
Course achievement					
	Subject theoretical and practical work				
	Design of four machines and actuators, rev	view of decign files			
scale	Design of four machines and actuators, rev	New of design mes			
	Conoral Engineering Science (Corman pro	gram, 7 semester): Specialisation Electrical Engir	ooring: Elective Co	mpulsony	
Following Curricula		rogram, 7 semester): Specialisation Liectrical Lingi			
· · · · · · · · · · · · · · · · · · ·	Compulsory				
	General Engineering Science (German	program, 7 semester): Specialisation Mechan	ical Engineering,	Focus Mechatroni	
	Compulsory				
	General Engineering Science (German pro	gram, 7 semester): Specialisation Mechanical En	gineering, Focus Th	neoretical Mechani	
	Engineering: Elective Compulsory				
	Digital Mechanical Engineering: Core Quali				
	Electrical Engineering: Core Qualification: I				
	Engineering Science: Specialisation Electric		manula and		
	Green Technologies: Energy, Water, Clima Logistics and Mobility: Specialisation Engin	te: Specialisation Energy Technology: Elective Co seering Science: Elective Compulsory	mpulsory		
		c Planning and Systems: Elective Compulsory			
		iction Management and Processes: Elective Compusity	pulsory		
	Mechanical Engineering: Core Qualification		- ,		
	Mechatronics: Core Qualification: Compuls				
	Technomathematics: Specialisation III. Eng				
	Engineering and Management - Major in Lo	gistics and Mobility: Specialisation Traffic Plannin	ng and Systems: Ele	ective Compulsory	
	Engineering and Management - Major in Compulsory	Logistics and Mobility: Specialisation Production	n Management and	Processes: Elect	

Course L0293: Electrical Mac	hines and Actuators
Тур	Lecture
Hrs/wk	3
СР	4
Workload in Hours	Independent Study Time 78, Study Time in Lecture 42
Lecturer	Prof. Thorsten Kern, Dennis Kähler
Language	DE
Cycle	SoSe
Content	Electric field: Coulomb's law, flux (field) line, work, potential, capacitor, energy, force, capacitive actuators
	Magnetic field: force, flux line, Ampere´s law, field at bounderies, flux, magnetic circuit, hysteresis, induction, self-induction, mutual inductance, transformer, electromagnetic actuators
	Synchronous machines, construction and layout, equivalent single line diagrams, no-load and short-cuircuit characteristics, vector diagrams, motor and generator operation, stepper motors
	DC-Machines: Construction and layout, torque generation mechanismen, torque vs speed characteristics, commutation,
	Asynchronous Machines. Magnetic field, construction and layout, equivalent single line diagram, complex stator current diagram (Heylands'diagram), torque vs. speed characteristics, rotor layout (squirrel-cage vs. sliprings),
	Drives with variable speed, inverter fed operation, special drives
Literature	Hermann Linse, Roland Fischer: "Elektrotechnik für Maschinenbauer", Vieweg-Verlag; Signatur der Bibliothek der TUHH: ETB 313
	Ralf Kories, Heinz Schmitt-Walter: "Taschenbuch der Elektrotechnik"; Verlag Harri Deutsch; Signatur der Bibliothek der TUHH: ETB 122
	"Grundlagen der Elektrotechnik" - anderer Autoren
	Fachbücher "Elektrische Maschinen"

Course L0294: Electrical Machines and Actuators	
Тур	Recitation Section (large)
Hrs/wk	2
СР	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Prof. Thorsten Kern, Dennis Kähler
Language	DE
Cycle	SoSe
Content	See interlocking course
Literature	See interlocking course

Courses						
Title		Тур	Hrs/wk	СР		
	nas, and Electromagnetic Compatibility (L1669) nas, and Electromagnetic Compatibility (L1877)	Lecture Recitation Section (small)	3 2	4		
		Recitation Section (Smail)	Z	Z		
	Prof. Christian Schuster					
Admission Requirements	None					
Recommended Previous	Basic principles of physics and electrical engineering					
Knowledge		fellender le miner versile				
Educational Objectives	After taking part successfully, students have reached th	e following learning results				
Professional Competence						
Knowledge	Students can explain the basic principles, relationship	s, and methods for the design of wa	veguides and an	tennas as well as		
	Electromagnetic Compatibility. Specific topics are:					
	- Fundamental properties and phenomena of electrical of	ircuits				
	- Steady-state sinusoidal analysis of electrical circuits					
	- Fundamental properties and phenomena of electroma	netic fields and waves				
	- Steady-state sinusoidal description of electromagnetic	fields and waves				
	- Useful microwave network parameters					
	- Transmission lines and basic results from transmission line theory					
	- Plane wave propagation, superposition, reflection and refraction					
	- General theory of waveguides					
	- Most important types of waveguides and their properties					
	- Radiation and basic antenna parameters					
	- Most important types of antennas and their properties					
	- Numerical techniques and CAD tools for waveguide and antenna design					
	- Fundamentals of Electromagnetic Compatibility					
	- Coupling mechanisms and countermeasures - Shielding, grounding, filtering					
	- Standards and regulations					
	- EMC measurement techniques					
Skills	Students know how to apply various methods and more	els for characterization and choice of	wavequides and	l antennas. They a		
JKIIIS	Students know how to apply various methods and models for characterization and choice of waveguides and antennas. They ar able to assess and qualify their basic electromagnetic properties. They can apply results and strategies from the field of					
	Electromagnetic Compatibility to the development of electrical components and systems.					
	Election agricale compatibility to the development of ele	cancal components and systems.				
Personal Competence						
Social Competence	Students are able to work together on subject related	tasks in small groups. They are able	to present their	results effectively		
	English (e.g. during small group exercises).					
Autonomy	Chudanta are conclude to active information from out	ant valated avafagaianal publication	a and valate the	t information to th		
Autonomy	Students are capable to gather information from subject related, professional publications and relate that information to the context of the lecture. They are able to make a connection between their knowledge obtained in this lecture with the context of					
	other lectures (e.g. theory of electromagnetic fields, fu					
	problems and physical effects in English.	idamentals of electrical engineering ,	physics). They c	.an uiscuss technic		
Workload in Hours	Independent Study Time 110, Study Time in Lecture 70					
Credit points						
Course achievement				-		
Examination	Oral exam					
Examination duration and	45 min					
scale						
Assignment for the	General Engineering Science (German program, 7 seme		ering: Elective Co	mpulsory		
Following Curricula	Electrical Engineering: Core Qualification: Elective Comp	,				
	Engineering Science: Specialisation Electrical Engineering					
	Aircraft Systems Engineering: Core Qualification: Elective Compulsory					
	Mechatronics: Specialisation System Design: Elective Co	mpulsory				

Тур	Lecture			
Hrs/wk				
CP	4			
Workload in Hours	Independent Study Time 78, Study Time in Lecture 42			
	Prof. Christian Schuster			
Language	DE/EN			
Cycle				
-	This course is intended as an introduction to the topics of wave propagation, guiding, sending, and receiving as well a			
	Electromagnetic Compatibility (EMC). It will be useful for engineers that face the technical challenge of transmitting high frequence			
	/ high bandwidth data in e.g. medical, automotive, or avionic applications. Both circuit and field concepts of wave propagation			
	and Electromagnetic Compatibility will be introduced and discussed.			
	Topics:			
	- Fundamental properties and phenomena of electrical circuits			
	- Steady-state sinusoidal analysis of electrical circuits			
	- Fundamental properties and phenomena of electromagnetic fields and waves			
	- Steady-state sinusoidal description of electromagnetic fields and waves			
	- Useful microwave network parameters			
	- Transmission lines and basic results from transmission line theory			
	- Plane wave propagation, superposition, reflection and refraction			
	General theory of waveguides			
	Most important types of waveguides and their properties			
	Radiation and basic antenna parameters			
	Most important types of antennas and their properties			
	Numerical techniques and CAD tools for waveguide and antenna design			
	Fundamentals of Electromagnetic Compatibility			
	- Coupling mechanisms and countermeasures			
	- Shielding, grounding, filtering			
	- Standards and regulations			
	- EMC measurement techniques			
Literature	- Zinke, Brunswig, "Hochfrequenztechnik 1", Springer (1999)			
	- J. Detlefsen, U. Siart, "Grundlagen der Hochfrequenztechnik", Oldenbourg (2012)			
	- D. M. Pozar, "Microwave Engineering", Wiley (2011)			
	- Y. Huang, K. Boyle, "Antenna: From Theory to Practice", Wiley (2008)			
	- H. Ott, "Electromagnetic Compatibility Engineering", Wiley (2009)			
	- A. Schwab, W. Kürner, "Elektromagnetische Verträglichkeit", Springer (2007)			

Course L1877: Introduction t	purse L1877: Introduction to Waveguides, Antennas, and Electromagnetic Compatibility		
Тур	Recitation Section (small)		
Hrs/wk	2		
CP	2		
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28		
Lecturer	Prof. Christian Schuster		
Language	DE/EN		
Cycle	SoSe		
Content	See interlocking course		
Literature	See interlocking course		

-				
Courses				
Title		Тур	Hrs/wk	СР
	tion to Electrical Power Systems (L1670)	Lecture	3 2	4
	tion to Electrical Power Systems (L1671)	Recitation Section (small)	2	2
Module Responsible				
Admission Requirements	None			
	Fundamentals of Electrical Engineering			
Knowledge				
	After taking part successfully, students have reach	ed the following learning results		
Professional Competence				
Knowledge	Students are able to give an overview of convention			
	evaluate technologies of electric power generation	n, transmission, storage, and distribution as	well as integrati	on of equipment int
	electric power systems.			
Skills	With completion of this module the students ar	e able to apply the acquired skills in ap	olications of the	design, integration
	development of electric power systems and to ass			
Personal Competence				
Social Competence	The students can participate in specialized and interdisciplinary discussions, advance ideas and represent their own work results			
	front of others.			
Autonomy	Students can independently tap knowledge of the emphasis of the lectures.			
Workload in Hours	Independent Study Time 110, Study Time in Lectu	re 70		
Credit points	6			
Course achievement				
Examination	Written exam			
Examination duration and	90 - 150 minutes			
scale				
Assignment for the	General Engineering Science (German program, 7	semester): Specialisation Electrical Enginee	ring: Elective Co	mpulsory
Following Curricula	General Engineering Science (German program, 7		-	
5	Compulsory			55
	Data Science: Core Qualification: Elective Compuls	ory		
	Electrical Engineering: Core Qualification: Elective			
	Energy Systems: Specialisation Energy Systems: E			
	Engineering Science: Specialisation Electrical Engin	neering: Elective Compulsory		
	Green Technologies: Energy, Water, Climate: Spec		rgies: Elective Co	mpulsory
	Computer Science in Engineering: Specialisation II.	. Mathematics & Engineering Science: Elect	ive Compulsory	
	Integrated Building Technology: Core Qualification	: Compulsory		
	Mechatronics: Specialisation Electrical Systems: El	ective Compulsory		
	Renewable Energies: Core Qualification: Compulso	ry		
	Theoretical Mechanical Engineering: Specialisation	Energy Systems: Elective Compulsory		

Тур	Lecture
Hrs/wk	3
CP	4
Workload in Hours	Independent Study Time 78, Study Time in Lecture 42
Lecturer	Prof. Christian Becker
Language	DE
Cycle	WiSe
Content	 fundamentals and current development trends in electric power engineering
	tasks and history of electric power systems
	symmetric three-phase systems
	fundamentals and modelling of eletric power systems
	◦ lines
	• transformers
	 synchronous machines
	 induction machines
	 loads and compensation
	 grid structures and substations
	fundamentals of energy conversion
	 electro-mechanical energy conversion
	 thermodynamics
	 power station technology
	 renewable energy conversion systems
	 steady-state network calculation
	 network modelling
	 load flow calculation
	• (n-1)-criterion
	 symmetric failure calculations, short-circuit power
	control in networks and power stations
	grid protection
	grid planning
	power economy fundamentals
Literature	K. Heuck, KD. Dettmann, D. Schulz: "Elektrische Energieversorgung", Vieweg + Teubner, 9. Auflage, 2013
	A. J. Schwab: "Elektroenergiesysteme", Springer, 5. Auflage, 2017
	R. Flosdorff: "Elektrische Energieverteilung" Vieweg + Teubner, 9. Auflage, 2008

Тур	Recitation Section (small)
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Prof. Christian Becker
Language	DE
Cycle	WiSe
Content	 fundamentals and current development trends in electric power engineering
	tasks and history of electric power systems
	symmetric three-phase systems
	 fundamentals and modelling of eletric power systems
	• lines
	• transformers
	 synchronous machines
	 induction machines
	 loads and compensation
	 grid structures and substations
	fundamentals of energy conversion
	 electro-mechanical energy conversion
	 thermodynamics
	 power station technology
	 renewable energy conversion systems
	steady-state network calculation
	network modelling
	 load flow calculation
	• (n-1)-criterion
	 symmetric failure calculations, short-circuit power
	control in networks and power stations
	grid protection
	grid planning
	power economy fundamentals
Literature	K. Heuck, KD. Dettmann, D. Schulz: "Elektrische Energieversorgung", Vieweg + Teubner, 9. Auflage, 2013
	A. J. Schwab: "Elektroenergiesysteme", Springer, 5. Auflage, 2017
	R. Flosdorff: "Elektrische Energieverteilung" Vieweg + Teubner, 9. Auflage, 2008

Courses						
Title				Тур	Hrs/wk	СР
EE Experimental Lab (L0781)				Practical Course	2	2
Measurements: Methods and Data	Processing (L0779)			Lecture	2	3
Measurements: Methods and Data	Processing (L0780)			Recitation Section (small)	1	1
Module Responsible	Prof. Alexander Schla	aefer				
Admission Requirements	None					
Recommended Previous	principles of mathem	natics				
Knowledge	principles of electrica	al engineering				
Educational Objectives	After taking part suc	cossfully students ha	we reached the follow	ing learning results		
Professional Competence	Arter taking part suc	cessiuily, students ne		ing learning results		
•	The students are ab	le to explain the pur	nose of metrology and	I the acquisition and proces	sing of measurem	ents. They can det
Knowledge				sing of stochastic signals. S	-	-
	describe measured s		and explain the proces	sing of scoendstie signals. S	ducints know meti	ious to aigitalize ai
	describe medsured s	ngriais.				
Skills	The students are able to evaluate problems of metrology and to apply methods for describing and processing of measureme			of measurements.		
					.g p g	
Personal Competence						
Social Competence	The students solve p	problems in small grou	ups.			
Autonomy	The students can ref	lect their knowledge	and discuss and evalu	ate their results.		
Workload in Hours		Time 110, Study Time	in Lecture 70			
Credit points	Compulsory Bonus	Form	Description			
Course achievement	Yes 10 %	Excercises	Description			
Examination						
Examination duration and	90 min					
scale	50					
Assignment for the	General Engineering	Science (German pro	ogram, 7 semester): Sr	pecialisation Electrical Engin	eering: Elective Co	mpulsory
Following Curricula				· · · · · · · · · · · · · · · · · · ·	5	
	-	-	rical Engineering: Elect	tive Compulsory		
				s & Engineering Science: Ele	ctive Compulsory	
	Integrated Building T					

Course L0781: EE Experimen	tal Lab
Тур	Practical Course
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Prof. Alexander Schlaefer, Dozenten des SD E, Prof. Alexander Kölpin, Prof. Bernd-Christian Renner, Prof. Christian Becker, Prof.
	Heiko Falk, Prof. Herbert Werner, Prof. Thorsten Kern
Language	DE
Cycle	WiSe
Content	lab experiments: digital circuits, semiconductors, micro controllers, analog circuits, AC power, electrical machines
Literature	Wird in der Lehrveranstaltung festgelegt

Course L0779: Measurement	s: Methods and Data Processing
Тур	Lecture
Hrs/wk	2
CP	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Prof. Alexander Schlaefer
Language	DE
Cycle	WiSe
Content	introduction, systems and errors in metrology, probability theory, measuring stochastic signals, describing measurements,
	acquisition of analog signals, applied metrology
Literature	Puente León, Kiencke: Messtechnik, Springer 2012
	Lerch: Elektrische Messtechnik, Springer 2012
	Weitere Literatur wird in der Veranstaltung bekanntgegeben.

Course L0780: Measurement	ourse L0780: Measurements: Methods and Data Processing		
Тур	Recitation Section (small)		
Hrs/wk	1		
CP	1		
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14		
Lecturer	Prof. Alexander Schlaefer		
Language	DE		
Cycle	WiSe		
Content	See interlocking course		
Literature	See interlocking course		

Courses					
litle		Тур	Hrs/wk	СР	
heoretical Electrical Engineering II:	Time-Dependent Fields (L0182)	Lecture	3	5	
heoretical Electrical Engineering II:		Recitation Section (small)	2	1	
Module Responsible	Prof. Christian Schuster				
Admission Requirements	None				
Recommended Previous	Electrical Engineering I, Electrical Engineering I	I, Theoretical Electrical Engineering I			
Knowledge	Mathematics I, Mathematics II, Mathematics III,	Mathematics IV			
Educational Objectives	After taking part successfully, students have re	ached the following learning results			
Professional Competence					
1	Students are able to explain fundamental electromagnetic fields. They can assess the pri regard to respective sources. They can descril solutions for simple fields. The students are aw able to explicate these.	incipal behavior and characteristics of quasis be the properties of complex electromagne	stationary and full tic fields by mean	y dynamic fields w s of superposition	
•	s Students are able to apply a variety of procedures in order to solve the diffusion and the wave equation for general time-depend field problems. They can assess the principal effects of given time-dependent sources of fields and analyze these quantitativ. They can deduce meaningful quantities for the characterization of fully dynamic fields (wave impedance, skin depth, Poynti vector, radiation resistance, etc.) from given fields and interpret them with regard to practical applications.				
	petence petence Students are able to work together on subject related tasks in small groups. They are able to present their results en during exercise sessions).			sults effectively (e	
	Students are capable to gather necessary information from provided references and relate this information to the lecture. They able to continually reflect their knowledge by means of activities that accompany the lecture, such as short oral quizzes during lectures and exercises that are related to the exam. Based on respective feedback, students are expected to adjust their indivi learning process. They are able to draw connections between acquired knowledge and ongoing research at the Haml University of Technology (TUHH), e.g. in the area of high frequency engineering and optics.			ral quizzes during t adjust their individu	
Workload in Hours	Independent Study Time 110, Study Time in Le	cture 70			
Credit points	6				
Course achievement	None				
Examination	Written exam				
	90-150 minutes				
scale					
-	General Engineering Science (German program		eering: Compulsor	У	
-					
	Engineering Science: Specialisation Electrical El	naineering. Compulsory			
I	Engineering Science: Specialisation Electrical El Engineering Science: Specialisation Mechatroni Mechatronics: Specialisation Electrical Systems	cs: Elective Compulsory			

Course L0182: Theoretical El	ectrical Engineering II: Time-Dependent Fields
Тур	Lecture
Hrs/wk	3
СР	5
Workload in Hours	Independent Study Time 108, Study Time in Lecture 42
Lecturer	Prof. Christian Schuster
Language	
Cycle	
Content	- Theory and principal characteristics of quasistationary electromagnetic fields
	- Electromagnetic induction and law of induction
	- Skin effect and eddy currents
	- Shielding of time variable magnetic fields
	- Theory and principal characteristics of fully dynamic electromagnetic fields
	- Wave equations and properties of planar waves
	- Polarization and superposition of planar waves
	- Reflection and refraction of planar waves at boundary surfaces
	- Waveguide theory
	- Rectangular waveguide, planar optical waveguide
	- Elektrical and magnetical dipol radiation
	- Simple arrays of antennas
	The practical application of numerical methods will be trained within specifically prepared lectures in an interactive manner using small MATLAB programs.
Literature	- G. Lehner, "Elektromagnetische Feldtheorie: Für Ingenieure und Physiker", Springer (2010)
	- H. Henke, "Elektromagnetische Felder: Theorie und Anwendung", Springer (2011)
	- W. Nolting, "Grundkurs Theoretische Physik 3: Elektrodynamik", Springer (2011)
	- D. Griffiths, "Introduction to Electrodynamics", Pearson (2012)
	- J. Edminister, "Schaum's Outline of Electromagnetics", Mcgraw-Hill (2013)
	- Richard Feynman, "Feynman Lectures on Physics: Volume 2", Basic Books (2011)

Course L0183: Theoretical Electrical Engineering II: Time-Dependent Fields	
Тур	Recitation Section (small)
Hrs/wk	2
СР	1
Workload in Hours	Independent Study Time 2, Study Time in Lecture 28
Lecturer	Prof. Christian Schuster
Language	DE
Cycle	WiSe
Content	See interlocking course
Literature	See interlocking course

Courses				
Title		Тур	Hrs/wk	СР
ntroduction to Communications an	d Random Processes (L0442)	Lecture	3	4
ntroduction to Communications an	d Random Processes (L0443)	Recitation Section (large)	1	1
ntroduction to Communications an	d Random Processes (L2354)	Recitation Section (small)	1	1
Module Responsible	Prof. Gerhard Bauch			
Admission Requirements	None			
Recommended Previous				
Knowledge	Mathematics 1-3			
	 Signals and Systems 			
Educational Objectives	After taking part successfully, students have	reached the following learning results		
Professional Competence				
Knowledge	The students know and understand the fund	amental building blocks of a communications sy	stem. They can o	describe and analy
	the individual building blocks using knowled	ge of signal and system theory as well as the th	neory of stochasti	c processes. The a
	aware of the essential resources and evalua	tion criteria of information transmission and ar	e able to design	and evaluate a ba
	communications system.			
		<u>.</u>		
	The students are familiar with the contents o	f lecture and tutorials. They can explain and app	bly them to new p	roblems.
Skills	The students are able to design and evaluate a basic communications system. In particular, they can estimate the requi			stimate the requir
	resources in terms of bandwidth and power. They are able to assess essential evaluation parameters of a basic communication			
		ror rate and to decide for a suitable transmissio		
Personal Competence				
Social Competence	The students can jointly solve specific proble	ems.		
Autonomy		information from appropriate literature sour	-	ontrol their level
	knowledge during the lecture period by solvin	ng tutorial problems, software tools, clicker syste	em.	
Workload in Hours	Independent Study Time 110, Study Time in	Lecture 70		
Credit points	6			
Course achievement	None			
Examination	Written exam			
Examination duration and	90 min			
scale				
Assignment for the	General Engineering Science (German progra	am, 7 semester): Specialisation Electrical Engine	ering: Compulsor	y
Following Curricula	Data Science: Core Qualification: Elective Con	mpulsory		
	Data Science: Specialisation I. Mathematics/0	Computer Science: Elective Compulsory		
	Electrical Engineering: Core Qualification: Co	mpulsory		
	Computer Science in Engineering: Core Quali	fication: Compulsory		
	Mechatronics: Specialisation Electrical Syster	ns: Compulsory		
	Technomathematics: Specialisation III. Engine	eering Science: Elective Compulsory		

Тур	Lecture
Hrs/wk	3
СР	4
Workload in Hours	Independent Study Time 78, Study Time in Lecture 42
Lecturer	Prof. Gerhard Bauch
Language	DE/EN
Cycle	WiSe
Content	 Introduction to communications engineering Open Systems Interconnection (OSI) reference model Components of a digital communications system
	 Fundamentals of signals and systems Analog and digital signals Principles of Analog-to-digital (A/D) conversion Deterministic and random signals
	 Power and energy of signals Linear time-invariant (LTI) systems Quadrature amplitude modulation (QAM)
	 Introduction to stochastics Probability theory
	 Random experiments Probability model, probability space, sample space Definitions of probability
	 Probability according to Bernoulli/Laplace Probability according to van Mises, relative frequency Bertrand's paradox Axiomatic definition of probability according to Kolmogorov
	 Probability of disjoint and non-disjoint events Venn diagrams

- Continuous and discrete random variables
 - Probability density function (pdf), cululative distribution function (cdf)
 - Expected value, mean, median, quadratic mean, variance, standard deviation, higher moments
 - Examples for probability distributions (Bernoulli distribution, two-point distribution, uniform distribution, Gaussian (normal) distribution, Rayleigh distribution, etc.)
- Multiple random variables
 - Conditional probability, joint probability
 - Conditional and joint probability density function
 - Bayes' rule
 - Correlation coefficient
 - Two-dimensional Gaussian distribution
 - Statistically independent, uncorrelated and orthogonal random variables
 - Independent identically distributed (iid) random variables
 - Properties of expected value and variance
 - Covariance
 - · Probability density function (pdf) and cumulative distribution function (cdf) of the sum of statistically independent random variables
 - Central limit theorem
- Probability density functions (pdfs) in data transmission
- Continuous-time and discrete-time random processes
 - Examples for random processes
 - Ensemble average and time average
 - Ergodic random processes
 - Quadratic mean and variance
 - Probability density function (pdf) and cumulative distribution function (cdf)
 - Joint probability density function (pdf) and joint cumulative distribution function (cdf)
 - · Statistically independent, uncorrelated and orthogonal random processes
 - Stationary random processes
 - Correlation functions: Autocorrelation function, crosscorrelation function, average autocorrelation function of nonstationary random processes, autocorrelation and crosscorrelation function of stationary processes, autocovariance function, crosscovariance function
 - Autocorrelation matrix, crosscorrelation matrix, autocovariance matrix, crosscovariance matrix
 - Pseudo-noise sequences, example: Code division multiple access (CDMA)
 - Autocorrelation function, power spectral density (psd), signal power, Einstein-Wiener-Khintchine relations
 - White (Gaussian) noise
- Filtering of random processes by LTI systems
 - Transformation of the probability density function (pdf)
 - Transformation of the mean
 - Transformation of the power spectral density (psd)
 - Correlation functions of input and output signal
 - Filtering of white Gaussian noise
 - Bandlimitation for noise power limitation
 - Preemphasis and deemphasis
- · Companding, mu-law, A-law
- Functions of random variables
 - Transformation of probabilities and of the probability density function (pdf)
 - Application: Non-linear amplifiers
- Functions of two random variables
 - Probability density function
 - Examples: Rayleigh distribution, magnitude of an OFDM signal, magnitude of a received radio signal
- Transmission channels and channel models
 - Wireline channels: Telephone cable, coaxial cable, optical fiber
 - Wireless channels: Fading radio channel, underwater channels
 - Frequency-flat and frequency-selective channels
 - Additive white Gaussian noise (AWGN) channel
 - Signal to noise power ratio (SNR)
 - Discrete-time channel models
- - Pulse modulation
 - Pulse-amplitude modulation (PAM)
 - Pulse-duration modulation (PDM), pulse-width modulation (PWM)
 - Pulse-position modulation (PPM)
 - Pulse-code modulation (PCM)
 - Quantization
 - Linear guantizaton, midtread and midrise characteristic
 - Quantization error, guantization noise
 - Signal-to-quantization noise ratio
 - Non-linear quantization, compressor characteristics, mu-law, A-law
 - Speech transmission with PCM
 - Differential pulse-code modulation (DPCM)
 - Linear prediction according to the minimum mean squared error (MMSE) criterion.
 - DPCM with forward prediction and backward prediction

- Discrete memoryless channels (DMC)
- Analog-to-digital conversion
 - Sampling
 - Sampling theorem

1	CND server of DDCM server DCM
	 SNR gain of DPCM over PCM Delta modulation
	Fundamentals of information theory and coding
	 Definitions of information: Self-information, entropy
	 Binary entropy function
	 Source coding theorem
	 Source coding: Huffman code
	Mutual information and channel capacity
	Channel capacity of the AWGN channel and the binary input AWGN channel
	Channel coding theorem
	• Principles of channel coding: Code rate and data rate, Hamming distance, minimum Hamming distance, error
	detection and error correction
	• Examples for channel codes: Block codes and convolutional codes, repetition code, single parity check code,
	Hamming code, Turbo codes
	Combinatorics
	 Variation with and without repetition
	Combination with and without repetition
	 Permutation, Permutation of multisets
	Word error probabilities of linear block codes
	Baseband transmission
	 Pulse shaping: Non-return to zero (NRZ) rectangular pulses, Manchester pulses, raised-cosine pulses, square-root
	raised-cosine pulses, Gaussian pulses
	 Transmit signal energy, average energy per symbol
	 Power spectral density (psd) of baseband signals
	Definitions of signal bandwidth
	Bandwidth efficiency
	Intersymbol interference (ISI)
	First and second Nyquist criterion
	Eye patterns Description (http://www.interned.filter.com/actional/actiona
	Receive filter design: Matched filter Matched filter receiver and correlation receiver
	Matched-filter receiver and correlation receiver
	 Square-root Nyquist pulse shaping Discrete-time AWGN channel model
	Maximum a posteriori probability (MAP) and maximum likelihood (ML) detection
	Bit error probability in AWGN channels for binary antipodal and on-off signaling
	Band-pass transmission via carrier modulation
	Amplitude modulation, frequency modulation, phase modulation
	 Linear digital modulation methods: On-off keying (OOK), phase-shift keying (PSK), amplitude shift keying (ASK),
	quadrature amplitude shift keying (QAM)
Litoratura	K Kammayari Nachrichtanükartragung Tauknar
Literature	K. Kammeyer: Nachrichtenübertragung, Teubner
	P.A. Höher: Grundlagen der digitalen Informationsübertragung, Teubner.
	M. Bossert: Einführung in die Nachrichtentechnik, Oldenbourg.
	J.G. Proakis, M. Salehi: Grundlagen der Kommunikationstechnik. Pearson Studium.
	J.G. Proakis, M. Salehi: Digital Communications. McGraw-Hill.
	S. Haykin: Communication Systems. Wiley
	J.G. Proakis, M. Salehi: Communication Systems Engineering. Prentice-Hall.
	J.G. Proakis, M. Salehi, G. Bauch, Contemporary Communication Systems. Cengage Learning.
	nor mound, million, or butter, contemporary communication systems, conguge comming.

Course L0443: Introduction	to Communications and Random Processes
Тур	Recitation Section (large)
Hrs/wk	1
СР	1
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14
Lecturer	Prof. Gerhard Bauch
Language	DE/EN
Cycle	WiSe
Content	See interlocking course
Literature	See interlocking course
Course L2354: Introduction	to Communications and Random Processes
Тур	Recitation Section (small)
Hrs/wk	1
СР	1
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14
Lecturer	Prof. Gerhard Bauch
l anguage	DE/EN

Language	DE/EN
Cycle	WiSe
Content	See interlocking course
Literature	See interlocking course

		Түр		Hrs/wk	СР
		Lecture		3	4
-		Project-/prob	olem-based Learning	2	2
Prof. Hoc Khiem Trieu					
None					
Atomic model and qu	antum theory, electrical o	currents in solid state material	s, basics in solid-stat	e physics	
Successful participation	on of Physics for Enginee	rs and Materials in Electrical E	ngineering or course	s with equival	ent contents
After taking part succ	essfully, students have r	eached the following learning r	esults		
Students are able					
• to represent th	o basics of comiconducto	r physics			
• to represent th	e basics of semiconducto	n physics,			
 to explain the optimized in the optimized in	operating principle of imp	ortant semiconductor devices	,		
to outline device	e characteristics and eq	uivalent circuits as well as to e	xplain their derivatio	on and	
 to discuss the I 	imitation of device mode	ls.			
Students are capable					
 to apply device 	s in basic circuits,				
 to realize the p 	hysical context and to so	lve complex problems by ones	elf		
Students are able to	prepare and perform the	r lab experiments in team wor	k as well as to prese	ent and discus	s the results in fro
of audience.					
Students are capable	to acquire knowledge ba	sed on literature in order to pr	epare their experime	ents.	
Independent Study Ti	me 110, Study Time in Le	ecture 70			
6					
Compulsory Bonus	Form	Description			
Yes 10 %	Subject theoretical				
	practical work				
				suppe ente	ungsauigabe, (
Written exam		initialenen zu dem jenemg	en verbaen genora		
General Engineering	Science (German program	n, 7 semester): Specialisation I	Electrical Engineering	g: Compulsory	1
Electrical Engineering	: Core Qualification: Com	pulsory			
Engineering Science:	Specialisation Electrical I	Engineering: Compulsory			
General Engineering	Science (English program	, 7 semester): Specialisation E on II. Mathematics & Engineeri			
	None Atomic model and qui Successful participatio After taking part succe Students are able • to represent th • to explain the o • to outline device • to discuss the l Students are capable • to apply device • to realize the p Students are able to p of audience. Students are capable Independent Study Ti 6 Compulsory Bonus Yes 10 % Written exam 120 min General Engineering S	Atomic model and quantum theory, electrical of Successful participation of Physics for Enginee After taking part successfully, students have re- Students are able • to represent the basics of semiconductor • to explain the operating principle of imp • to outline device characteristics and equ • to discuss the limitation of device mode Students are capable • to apply devices in basic circuits, • to realize the physical context and to so Students are able to prepare and perform their of audience. Students are capable to acquire knowledge ba Independent Study Time 110, Study Time in Le 6 Compulsory Bonus Form Yes 10 % Subject theoretical practical work Written exam 120 min General Engineering Science (German program Electrical Engineering: Core Qualification: Com	Project-/prot Prof. Hoc Khiem Trieu None Atomic model and quantum theory, electrical currents in solid state materials Successful participation of Physics for Engineers and Materials in Electrical En After taking part successfully, students have reached the following learning r Students are able to represent the basics of semiconductor physics, to explain the operating principle of important semiconductor devices, to outline device characteristics and equivalent circuits as well as to e to discuss the limitation of device models. Students are capable to acquire knowledge based on literature in order to pr Independent Study Time 110, Study Time in Lecture 70 G Compulsory Bonus Form Description Yes 10 % Subject theoretical andStudierenden erarbeiten practical work demonstrieren dieses i Diskussion. Darüber hin inhaltlich zu dem jeweilig Written exam I20 min General Engineering: Core Qualification: Compulsory	Lecture Project-/problem-based Learning Prof. Hoc Khiem Trieu None Atomic model and quantum theory, electrical currents in solid state materials, basics in solid-stat Successful participation of Physics for Engineers and Materials in Electrical Engineering or course After taking part successfully, students have reached the following learning results Students are able • to represent the basics of semiconductor physics, • to explain the operating principle of important semiconductor devices, • to outline device characteristics and equivalent circuits as well as to explain their derivatio • to discuss the limitation of device models. Students are capable • to realize the physical context and to solve complex problems by oneself Students are capable to acquire knowledge based on literature in order to prepare their experimed induce. Students are capable to acquire knowledge based on literature in order to prepare their experimed induce. Students are capable to acquire knowledge based on literature in order to prepare their experimed induce. Students are capable to acquire knowledge based on literature in order to prepare their experimed induce. Students are capable to acquire knowledge based on literature in order to prepare their experimed induce. Students are capable to acquire knowledge based on literature in order to prepare theire experimed induce. S	Lecture 3 Project-/problem-based Learning 2 Prof. Hoc Khiem Trieu None Atomic model and quantum theory, electrical currents in solid state materials, basics in solid-state physics Successful participation of Physics for Engineers and Materials in Electrical Engineering or courses with equival After taking part successfully, students have reached the following learning results Students are able • to represent the basics of semiconductor physics, • to outline device characteristics and equivalent circuits as well as to explain their derivation and • to discuss the limitation of device models. Students are capable • to realize the physical context and to solve complex problems by oneself Students are capable • to realize the physical context and to solve complex problems by oneself Students are capable to acquire knowledge based on literature in order to prepare their experiments. Independent Study Time 110, Study Time in Lecture 70 G Computery Bonus Form Description Yes 10 % Subject theoretical andStudierendne erarbeiten in Kleingruppen Wissen zu einem practical work Yes 10 % Subject theoretical andStudierendne erarbeiten in Kleingruppen Wissen zu einem inhaltlich zu dem jeweiligen Versuch gehört.

Course L0720: Electronic Dev	vices
Тур	Lecture
Hrs/wk	3
CP	4
Workload in Hours	Independent Study Time 78, Study Time in Lecture 42
Lecturer	Prof. Hoc Khiem Trieu
Language	DE
Cycle	WiSe
Content	 Uniformly doped semiconductor (semiconductor, crystal structure, energy band diagram, effective mass, density of state, probability of occupancy, mass action law, generation and recombination processes, generation and recombination lifetime, carrier transport mechanisms: drift current, diffusion current; equilibriums in semiconductor, semiconductor equations) pn-junction (zero applied bias, energy band diagram in thermal equilibrium, current-voltage characteristics, derivation of diode equation, consideration of space charge recombination, transient behaviour, breakdown mechanisms, various types of diodes: Zener diode, tunnel diode, backward diode, photo diode, LED, laser diode) Bipolar transistor (principle of operation, current-voltage characteristics: calculation of base, collector and emitter current, operating modes; non-ideality: actual doping profile, Early effect, breakdown, generation and recombination current and high injection; Ebers-Moll model: family of characteristics, equivalent circuit; frequency response, switching characteristics, heterojunction bipolar transistor) Unipolar devices (surface effects: surface states, work function, energy band diagram; metal-semiconductor junctions: Schottky contact, current-voltage characteristics, ohmic contact; junction field effect transistor: operating principle, current-voltage characteristics, small-signal model, breakdown characteristics; MOSFET: operating principle, depletion mode and enhancement mode MESFET; MIS structure: accumulation, depletion, inversion, strong inversion, flatband voltage, oxide charges, threshold voltage, capacitance voltage characteristics; MOSFET: basic structure, principle of operation, current voltage characteristics, frequency response, subthreshold behaviour, threshold voltage, device scaling; CMOS)
Literature	 S.M. Sze: Semiconductor devices, Physics and Technology, John Wiley & Sons (1985)F. Thuselt: Physik der Halbleiterbauelemente, Springer (2011) T. Thille, D. Schmitt-Landsiedel: Mikroelektronik, Halbleiterbauelemente und deren Anwendung in elektronischen Schaltungen, Springer (2004) B.L. Anderson, R.L. Anderson: Fundamentals of Semiconductor Devices, McGraw-Hill (2005) D.A. Neamen: Semiconductor Physics and Devices, McGraw-Hill (2011) M. Shur: Introduction to Electronic Devices, John Wiley & Sons (1996) S.M. Sze: Physics of semiconductor devices, John Wiley & Sons (2007) H. Schaumburg: Halbleiter, B.G. Teubner (1991) A. Möschwitzer: Grundlagen der Halbleiter-&Mikroelektronik, Bd1 Elektronische Halbleiterbauelemente, Carl Hanser (1992) HG. Unger, W. Schultz, G. Weinhausen: Elektronische Bauelemente und Netzwerke I, Physikalische Grundlagen der Halbleiterbauelemente, Vieweg (1985)

Course L0721: Electronic Devices	
Тур	Project-/problem-based Learning
Hrs/wk	2
СР	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Prof. Hoc Khiem Trieu
Language	DE
Cycle	WiSe
Content	See interlocking course
Literature	See interlocking course

Courses				
		_		
Title		Typ Lecture	Hrs/wk	СР
	rogramming Concepts, Data Handling & Communication (L2689) rogramming Concepts, Data Handling & Communication (L2690)	Recitation Section (small)	3 2	3 3
Module Responsible		Rectation Section (Smail)	L	5
	None			
Recommended Previous	None			
Knowledge				
-	After taking part successfully, students have reached the fo	lowing loarning rocults		
Professional Competence	Arter taking part successfully, students have reached the to	lowing learning results		
Knowledge				
Skills				
SKIIIS				
Personal Competence				
Social Competence				
Autonomy				
Workload in Hours	Independent Study Time 110, Study Time in Lecture 70			
Credit points	6			
Course achievement	Compulsory Bonus Form Descriptio			
		inden semesterbegleitend statt.		
Examination				
Examination duration and	120 min			
scale				
-	General Engineering Science (German program, 7 sem	ester): Specialisation Mechanica	I Engineering, F	ocus Biomechani
Following Curricula				
	General Engineering Science (German program, 7 semester			
	General Engineering Science (German program, 7 semester	: Specialisation Green Technolog	les, Focus Renew	able Energy: Elect
	Compulsory General Engineering Science (German program, 7 semes	ter): Specialisation Mechanical	Engineering Foc	us Energy System
	Compulsory	ter). Specialisation mechanical	Lingineering, Toe	us Energy Syster
	General Engineering Science (German program, 7 seme	ster): Specialisation Mechanical	Engineering, Foc	us Aircraft Syste
	Engineering: Compulsory		5,	
	General Engineering Science (German program, 7 sem	ester): Specialisation Mechanica	al Engineering, I	ocus Mechatroni
	Compulsory			
	General Engineering Science (German program, 7 semeste	r): Specialisation Mechanical Eng	ineering, Focus P	roduct Developm
	and Production: Elective Compulsory			
	General Engineering Science (German program, 7 semester): Specialisation Mechanical Engi	neering, Focus Th	eoretical Mechani
	Engineering: Elective Compulsory			
	General Engineering Science (German program, 7 semester	: Specialisation Electrical Engine	ering: Elective Co	mpulsory
	Bioprocess Engineering: Core Qualification: Compulsory			
	Chemical and Bioprocess Engineering: Core Qualification: Co	ompulsory		
	Electrical Engineering: Core Qualification: Compulsory	Eporar Systems / Bonowable Epo	raioci Electivo Co	mpulcony
	Green Technologies: Energy, Water, Climate: Specialisation Logistics and Mobility: Specialisation Information Technolog		ingres. Elective Co	mpuisoi y
	Mechatronics: Specialisation Robot- and Machine-Systems: (
	Mechatronics: Specialisation Medical Engineering: Compulse			
	Mechatronics: Specialisation Dynamic Systems and AI: Com	,		
	Mechatronics: Specialisation Electrical Systems: Elective Co			
	Process Engineering: Core Qualification: Compulsory			
	5 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5			

Course L2689: Computer Science for Engineers - Programming Concepts, Data Handling & Communication		
Тур	Lecture	
Hrs/wk	3	
CP	3	
Workload in Hours	Independent Study Time 48, Study Time in Lecture 42	
Lecturer	Prof. Sibylle Fröschle	
Language	DE	
Cycle	SoSe	
Content		
Literature	John V. Guttag: Introduction to Computation and Programming Using Python.	
	With Application to Understanding Data. 2nd Edition. The MIT Press, 2016.	

Course L2690: Computer Sci	Course L2690: Computer Science for Engineers - Programming Concepts, Data Handling & Communication	
Тур	Recitation Section (small)	
Hrs/wk	2	
CP	3	
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28	
Lecturer	Prof. Sibylle Fröschle	
Language	DE	
Cycle	SoSe	
Content	See interlocking course	
Literature	See interlocking course	

Courses						
Title		Turn	Hrs/wk	СР		
Gemiconductor Circuit Design (L07)	33)	Typ Lecture	3	4		
Semiconductor Circuit Design (L08)		Recitation Section (small)	1	2		
Module Responsible	NN					
Admission Requirements	None					
Recommended Previous	Fundamentals of electrical engineering					
Knowledge	·					
	Basics of physics, especially semiconducto	r physics				
Educational Objectives	After taking part successfully, students have	ve reached the following learning results				
Professional Competence	51	5 5				
Knowledge						
5	 Students are able to explain the fun 	ctionality of different MOS devices in electronic cir	cuits.			
		alog circuits functions and where they are applied				
		ctionality of fundamental operational amplifiers ar				
		ital logic circuits and can discuss their advantages		25.		
		mory circuits and can explain their functionality a	nd specifications.			
	 Students know the appropriate field 	s for the use of bipolar transistors.				
Chille						
Skills	 Students can calculate the specifica 	tions of different MOS devices and can define the	parameters of elec	ctronic circuits.		
	Students are able to develop differe	nt logic circuits and can design different types of I	ogic circuits.			
	 Students can use MOS devices, oper 	rational amplifiers and bipolar transistors for speci	fic applications.			
Personal Competence						
Social Competence	 Students are able work officiently in 	beteregeneous teams				
	 Students are able work efficiently in Students working together in small. 	groups can solve problems and answer profession	al questions			
	• Students working together in sindi	groups can solve problems and answer profession	ar questions.			
Autonomy						
Autonomy	 Students are able to assess their level 	vel of knowledge.				
	Independent Study Time 124, Study Time	in Lecture 56				
Credit points						
Course achievement						
Examination						
Examination duration and	120 min					
scale	Conoral Engineering Science (Corman pro	gram, 7 semester): Specialisation Electrical Engine	oring: Compulsor	,		
Following Curricula		program, 7 semester): Specialisation Electrical Engine				
ronowing curricula	Compulsory	program, 7 semester). Specialisation mechanic	ai Engineering, i	ocus mechanor		
	Data Science: Core Qualification: Elective (Compulsory				
	Electrical Engineering: Core Qualification:					
	Engineering Science: Specialisation Electric					
	Engineering Science: Specialisation Mecha	5 5 1 5				
		ram, 7 semester): Specialisation Electrical Engine	ering: Compulsory			
	General Engineering Science (English program, 7 semester): Specialisation Electrical Engineering. Compulsory					
	Computer Science in Engineering: Speciali	sation II. Mathematics & Engineering Science: Elec	tive Compulsory			
	Mechanical Engineering: Specialisation Me					
	Mechatronics: Specialisation Electrical Syst	tems: Compulsory				
	Mechatronics: Core Qualification: Compuls	ory				
	Mechatronics: Specialisation Robot- and M	achine-Systems: Elective Compulsory				

urse L0763: Semiconducto	r Circuit Design
Тур	Lecture
Hrs/wk	3
CP	4
Workload in Hours	Independent Study Time 78, Study Time in Lecture 42
Lecturer	Prof. Matthias Kuhl
Language	DE
Cycle	SoSe
Content	 Repetition Semiconductorphysics and Diodes Functionality and characteristic curve of bipolar transistors Basic circuits with bipolar transistors Functionality and characteristic curve of MOS transistors Basic circuits with MOS transistors for amplifiers Operational amplifiers and their applications Typical applications for analog and digital circuits Realization of logical functions Basic circuits with MOS transistors for combinational logic Memory circuits Basic circuits with MOS transistors for sequential logic Basic concepts of analog-to-digital and digital-to-analog-converters
Literature	U. Tietze und Ch. Schenk, E. Gamm, Halbleiterschaltungstechnik, Springer Verlag, 14. Auflage, 2012, ISBN 3540428496 R. J. Baker, CMOS - Circuit Design, Layout and Simulation, J. Wiley & Sons Inc., 3. Auflage, 2011, ISBN: 0471700555 H. Göbel, Einführung in die Halbleiter-Schaltungstechnik, Berlin, Heidelberg Springer-Verlag Berlin Heidelberg, 2011, ISBN 9783642208874 ISBN: 9783642208867 URL: http://site.ebrary.com/lib/alltitles/docDetail.action?docID=10499499 URL: http://dx.doi.org/10.1007/978-3-642-20887-4 URL: http://ebooks.ciando.com/book/index.cfm/bok_id/319955 URL: http://www.ciando.com/img/bo

Course L0864: Semiconducto	or Circuit Design
Тур	Recitation Section (small)
Hrs/wk	1
CP	2
Workload in Hours	Independent Study Time 46, Study Time in Lecture 14
Lecturer	Prof. Matthias Kuhl, Weitere Mitarbeiter
Language	DE
Cycle	SoSe
Content	 Basic circuits and characteristic curves of bipolar transistors Basic circuits and characteristic curves of MOS transistors for amplifiers Realization and dimensioning of operational amplifiers Realization of logic functions Basic circuits with MOS transistors for combinational and sequential logic Memory circuits Circuits for analog-to-digital and digital-to-analog converters Design of exemplary circuits
Literature	 U. Tietze und Ch. Schenk, E. Gamm, Halbleiterschaltungstechnik, Springer Verlag, 14. Auflage, 2012, ISBN 3540428496 R. J. Baker, CMOS - Circuit Design, Layout and Simulation, J. Wiley & Sons Inc., 3. Auflage, 2011, ISBN: 0471700555 H. Göbel, Einführung in die Halbleiter-Schaltungstechnik, Berlin, Heidelberg Springer-Verlag Berlin Heidelberg, 2011, ISBN: 9783642208874 ISBN: 9783642208867 URL: http://site.ebrary.com/lib/alltitles/docDetail.action?docID=10499499 URL: http://dx.doi.org/10.1007/978-3-642-20887-4 URL: http://ebooks.ciando.com/book/index.cfm/bok_id/319955 URL: http://www.ciando.com/img/bo

Module M0734: Electr	ical Engineering Project Labo	ratory			
Courses					
Title Electrical Engineering Project Labor	ratory (L0640)		yp oject-/problem-based Learning	Hrs/wk	CP 6
Module Responsible					
Admission Requirements					
	Electrical Engineering I, Electrical Engineerir	na II			
Knowledge	5 5 . 5	5			
Educational Objectives	After taking part successfully, students have	e reached the following	learning results		
Professional Competence					
Knowledge	Students are able to give a summary of				
	respective relationships. They are capable technical language. They can explain the type technical language.				
	technical language. They can explain the ty	pical process of solving	practical problems and prese	ni relateu resul	
Skills	The students can transfer their fundament	tal knowledge on elect	rical engineering to the proc	ess of solving i	practical problems.
	They identify and overcome typical problem				
	able to develop, compare, and choose conce	eptual solutions for non-	-standardized problems.		
Personal Competence					
Social Competence	Students are able to cooperate in small, mix context of electrical engineering. They are			-	-
	qualified audience. Students have the				
	independently or in groups and discuss adva				5
Autonomy	Students are capable of independently solv	ing electrical engineering	ng problems using provided li	terature. They a	are able to fill gaps
	in as well as extent their knowledge using				
	meaningfully extend given problems and pro	agmatically solve them	by means of corresponding so	olutions and cor	ncepts.
Workload in Hours	Independent Study Time 68, Study Time in I	Lecture 112			
	6				
Course achievement	None				
Examination	Subject theoretical and practical work				
Examination duration and	based on task + presentation				
scale					
Assignment for the	General Engineering Science (German progr	ram, 7 semester): Speci	alisation Electrical Engineerin	g: Compulsory	
Following Curricula					
	Engineering Science: Specialisation Electrica		-		
	Engineering Science: Specialisation Electrica	5 5	1 3		
	Technomathematics: Specialisation III. Engin	neering Science: Electiv	e compulsory		

Course L0640: Electrical Eng	gineering Project Laboratory
Тур	Project-/problem-based Learning
Hrs/wk	. 8
СР	6
Workload in Hours	Independent Study Time 68, Study Time in Lecture 112
Lecturer	r Prof. Christian Becker, Dozenten des SD E
Language	DE
Cycle	SoSe
Content	Topics and projects cover the entire field of applications of electrical engineering. Typically, the students will prototype functional units and self-contained systems, such as radar devices, networks of sensors, amateur radio transceiver, power electronics based inverters, discrete computers, or atomic force microscopes. Different projects are devised on a yearly basis.
Literature	Alle zur Durchführung der Projekte sinnvollen Quellen (Skripte, Fachbücher, Manuals, Datenblätter, Internetseiten). / All sources that are useful for completion of the projects (lecture notes, textbooks, manuals, data sheets, internet pages).

Specialization Green Technologies

Module M1711: Green Technologies I Courses Typ Hrs/wk CP Tritoduction (reven Technologies (12727) Servinar 2 2 Meteorology and Climate systems - Introduction (12756) Lacture 2 2 Meteorology and Climate systems - Introduction (12839) Recitation Section (small) 2 2 Module Responsible Prof. Martin Katschmitt American Section (small) 2 2 Module Responsible Prof. Martin Katschmitt American Section (small) 2 2 Module Responsible Prof. Martin Katschmitt American Section (small) 2 2 Module Responsible Prof. Martin Katschmitt American Section (small) 2 2 Educational Objectives After taking part successfully, students have reached the following learning results Professional Competence Section Competence Now edge Education defend it in discussions. In addition, students can give an overview of the basics of meterology and climate. Skills The students are able to apply the knowledge they have acquired on sustainable technologies in the area of the environmentalil and climate in reservice provision. In addition, students can
Title Typ Hrsi/wk CP introduction Green Technologies (L727) Seminar 2 2 Meteorology and Climate Systems - Introduction (L276) Lecture 2 2 Meteorology and Climate Systems - Introduction (L276) Recitation Section (small) 2 2 Module Responsible (Provides) None Recitation Section (small) 2 2 Module Responsible (Provides) None Recitation Section (small) 2 2 Recommended Previous none Knowledge Upon completion of this module, students will be able to describe and critically evaluate current environmental and climate problems, especially in Memburg, Furthermore, they are able to find and process suitable approaches to solutions. The students can compare learned technologies in the field of climate and environmental protection, develop and take a standpoint on ther and defend it in discussions. In addition, students can give an overview of the basics of meterology and climate. First State State The students are able to apply the knowledge they have acquired on sustainable technologies in the area of the environmental and indiction, develop and take a standpoint on ther and defend it in discussions. In addition, students can • work together in a team of about 3-5 people, • discuss tastak on the topics of environmental, resource and climate protectio
Title Typ Hrsiwk CP Introduction Green Technologies (L227) Seminar 2 2 Meteorology and Climate Systems - Introduction (L226) Lecture 2 2 Medua Responsible Provides None Recitation Section (smail) 2 2 Module Responsible Provides None Recitation Section (smail) 2 2 Admission Requirements None Recommended Previous None Recitation Section (smail) 2 2 Recommended Previous none Knowledge Upon completion of this module, students will be able to describe and critically evaluate current environmental and climate problems. especially in Hamburg. Furthermore, they are able to find and process suitable approaches to solutions. The students can compare learned technologies in the field of climate and environmental protection, develop and take a standpoint on ther and defend it ni discussions. In addition, students can give an overview of the basics of meterology and climate. Field Field The students are able to apply the knowledge they have acquired on sustainable technologies in the ara of the environmental and climate and climate friendly water, energy and climate nexus in order to explain solution approaches for a supply-secure provision. Furthermore, the students are able to apophy the knowledge they have acquired on sustainable te
Introduction Green Technologies (1.272) Seminar 2 2 2 Meteorology of Climate Systems - Introduction (1.2829) Recitation Section (small) 2 2 Meteorology of Climate Systems - Introduction (1.2829) Recitation Section (small) 2 2 Meteorology of Climate Systems - Introduction (1.2829) Recitation Section (small) 2 2 Meteorology of Climate Systems - Introduction (1.2829) Recitation Section (small) 2 2 Meteorology of Climate Systems - Introduction (1.2829) Recitation Section (small) 2 2 Meteorology of Climate Systems - Introduction (1.2829) Recitation Section (small) 2 2 Meteorology of Climate Systems - Introduction (1.2829) Recitation Section (small) 2 2 Meteorology of Climate Systems - Introduction (1.2829) Recitation Section (small) 2 Professional Competence Knowledge Upon completion of this module, students will be able to describe and critically evaluate current environmental and climate problems, especially in Hamburg, Furthermore, they are able to find and process suitable approaches to solutions. The students can compare learned technologies in the field of climate and environmental protection, develop and take a standpoint on ther and climate friendly water, energy and climate news in order to explain solution approaches for a supply-secure provision. Furthermore, the students are able to apply the knowledge they have acquired on sustainable technologies in the area of the environmentally and climate friendly water, energy and climate news in order to explain solution approaches for a supply-secure provision. Furthermore, the students are able to apply the knowledge they have acquired on sustainable technologies in the area of the environmental, reserved and water reserves of their own performance and develop ioni solutions, and climate friendly water, energy and climate protection in a subject-specific manner and develop ioni solutions, is present their own work results to fellow students and exects take on the topics of environmental, resorate and climate in the morked unither envises and the work step
Meteorology and Climate Systems - introduction (12726) Ledure 2 2 Module Responsible Port Martin Katschmit 2 2 Module Responsible Port Martin Katschmit None Recommended Previous none 1 Knowledge Upon completion of this module, students will be able to describe and critically evaluate current environmental and climate problems, especially in Hamburg. Furthermore, they are able to find and process sublable approaches to solutions. The students can compare learning technically in the Mowledge they have acquired on sustainable technologies in the ast of the invironmental and climate and environmental protection in a subject-specific manner and develop and apply them to renewable energy projects in the context of other modules. Personal Competence Success the topics of environmental, resource and climate protection in a subject-specific manner and develop joint solutions, in the students in a beat to doptic students in comparison to their own performance of fellow students in comparison to their own performance and deal with feedback on their own performance of fellow students in comparison to their own performance and deal with feedback on their own performance of fellow students in comparison to their own performance and deal with feedback on their own performance of fellow students in comparison to their own performance and deal with feedback on their own performance of fellow students in comparison to their own performance and deal with feedback on their own performance of fellow students in comparison to their own performance and deal with feedback on their own performance of fellow students in comparison to their own performance and deal with feedback on their own performance of fellow students in comparison to their own performance and deal with feedback on their own performance and deal with f
Meteorology and Climate System:: Introduction (12829) Reclation Section (mail) 2 2 Module Responsible For, Martin Katachmitt Interpretation (1282) Interpretation (1282)<
Admission Requirements None Recommended Previous inome None Recommended Previous Knowledge Atter taking part successfully, students have reached the following learning results Professional Competence Knowledge Upon completion of this module, students will be able to describe and critically evaluate current environmental and climate problems, especially in Hamburg. Furthermore, they are able to find and process suitable approaches to solutions. The students can compare learned technologies in the field of climate and environmental protection, develop and take a standpoint on ther and defend it in discussions. In addition, students can give an overview of the basics of meterology and climate. Skills The students are able to apply the knowledge they have acquired on sustainable technologies in the area of the environmentally and climate-friendly water, energy and climate nexus in order to explain solution approaches for a supply-secure provision. Furthermore, the students are able to apply the knowledge they have acquired on sustainable technologies in the area of the environmental or newable energy projects in the context of other modules. Personal Competence Social Competence Students can • work together in a team of about 3-5 people. • discuss tasks on the topics of environmental, resource and climate protection in a subject-specific manner and develop joint solutions, • present their own work results to fellow students and • assess the performance. Autonomy
Recommended Previous Knowledge none Educational Objectives After taking part successfully, students have reached the following learning results Professional Competence Upon completion of this module, students will be able to describe and critically evaluate current environmental and climate problems, especially in Hamburg, Furthermore, they are able to find and process suitable approaches to solutions. The students can compare learned technologies in the field of climate and environmental protection, develop and take a standpoint on them and defend ti in discussions. In addition, students are able to apply the knowledge they have acquired on sustainable technologies in the area of the environmentally and climate-friendly water, energy and climate nexus in order to explain solution approaches for a supply-secure provision. Furthermore, the students are able to explain the procedures and basics on the topics of climate and meterology and apply them to renewable energy projects in the context of other modules. Personal Competence Social Competence Students can • work together in a team of about 3-5 people, • discuss tasks on the topics of environmental, resource and climate protection in a subject-specific manner and develop joint solutions, • present their own work results to fellow students and • assess the performance. Autonamy The students are able to independently access sources about the question to be worked on. They are able to assess their respective learning status in consultation with supervisors and, on this basis, define further questions and the work steps necessary to solve them. Workload in Hours
Knowledge Intermediation Bitucational Objectives After taking part successfully, students have reached the following learning results Professional Competence Upon completion of this module, students will be able to describe and critically evaluate current environmental and climate problems, especially in Hamburg. Furthermore, they are able to find and protection, develop and take a standpoint on ther and defend it in discussions. In addition, students can give an overview of the basics of meterology and climate. In addition, students can give an overview of the basics of meterology and climate. Skills The students are able to apply the knowledge they have acquired on sustainable technologies in the area of the environmentally and climate-friendly water, energy and climate nexus in order to explain solution approaches for a supply-secure provision. Furthermore, the students are able to explain the procedures and basics on the topics of climate and meterology and apply them to renewable energy projects in the context of other modules. Personal Competence Social Competence Social Competence Social Competence Social Competence Social Competence Autonom The students are able to independently access sources about the question to be worked on. They are able to assess their respective learning status in consultation with supervisors and, on this basis, define further questions and the work steps necessary to solve them. Workload in Howas Independent Study Time 96, Study Time i
Educational Objectives After taking part successfully, students have reached the following learning results Professional Competence Knowledge Upon completion of this module, students will be able to describe and critically evaluate current environmental and climate problems, especially in Hamburg. Furthermore, they are able to find and process suitable approaches to solutions. The students can compare learned technologies in the field of climate and environmental protection, develop and take a standpoint on them and defend it in discussions. In addition, students can give an overview of the basics of meterology and climate. Skills Skills The students are able to apply the knowledge they have acquired on sustainable technologies in the area of the environmentall and climate. Skills The students are able to apply the knowledge they have acquired on sustainable technologies in the area of the environmentall and climate. Furthermore, the students are able to explain the procedures and basics on the topics of climate and meterology and apply them to renewable energy projects in the context of other modules. Personal Competence Students can Social Campetence • work together in a team of about 3-5 people, • discuss tasks on the topics of environmental, resource and climate protection in a subject-specific manner and develop joint solutions, • present their own work results to fellow students in comparison to their own performance and deal with feedback on their own performance. Autonomy The s
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Examination duration and 60 min
scale
Assignment for the General Engineering Science (German program, 7 semester): Specialisation Green Technologies: Compulsory
Following Curricula Green Technologies: Energy, Water, Climate: Core Qualification: Compulsory
Orientation Studies: Core Qualification: Elective Compulsory
Course L2727: Introduction Green Technologies

	5
Тур	Seminar
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Prof. Martin Kaltschmitt, Dr. Marvin Scherzinger
Language	DE
Cycle	WiSe
Content	 Preliminary discussion of the seminar Interesting presentations by people responsible for climate and environmental protection in Hamburg, keyword: Green Port of Hamburg Handing out of topics and tasks from the area of the seminar topic (green port of Hamburg) to individual students / groups of students (depending on the number of participating students Presentation of the task / the topic to be worked on with PPT presentation or poster presentation of the results
Literature	Eigenständiges Literaturstudium in der Bibliothek und aus anderen Quellen.

Course L2726: Meteorology a	and Climate Systems - Introduction			
Тур	Lecture			
Hrs/wk	2			
CP	2			
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28			
Lecturer	Prof. Dr. Stefan Bühler, Prof. Dr. Felix Ament			
Language	DE			
Cycle	WiSe			
Content	The Earth's energy balance			
	Conservation of energy, radiation, greenhouse effect, radiation balance, radiative forcing			
	Local climate			
	Energy balance at the surface, canopy effects (vegetation, city,), topography effects, evaporation, role of the pedosphere			
	The water cycle			
	Reservoirs of water, Clausius-Clapeyron, hydrological sensitivity, extreme precipitation			
	The vertical structure of the atmosphere			
	lydrostatics, stability, spheres and pauses, radiative-convective equilibrium			
	Clouds			
	Life cycle of a cloud, from water vapour to precipitation			
	A windy planet			
	Pressure gradient force, Coriolis force, global wind system, turbulence and log. wind profile Wind profile			
	Climate sensitivity			
	Forcing-response approach, climate sensitivity, methods of determination, current knowledge			
	Synoptics			
	High and low pressure areas, air masses and fronts, instabilities			
	Fast feedbacks in climate			
	Water vapour, temperature gradient, ice albedo, clouds			
	Weather and climate modelling			
	Discretisation and num. Solution, parametrisation, data assimilation, boundary conditions, ensemble predictions, chaos, parallel			
	computers			
	Carbon cycle and earth history			
	Reservoirs of carbon, fossil fuels, earth ages, Urey reaction			
	Weather extremes			
	Rain, wind and heat - meteorological basics, statistical description & climate trends			
	Ice and sea level			
	Is the sea level rising? Role of ice in Earth's history, snowballs and greenhouses, Milankovitch cycles			
	The view from space			
Literature	Folien aus Vorlesung			

Course L2829: Meteorology	and Climate Systems - Introduction			
Тур	Recitation Section (small)			
Hrs/wk	2			
CP	2			
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28			
Lecturer	Prof. Dr. Stefan Bühler, Prof. Dr. Felix Ament			
Language	DE			
Cycle	WiSe			
Content	The Earth's energy balance			
	Conservation of energy, radiation, greenhouse effect, radiation balance, radiative forcing			
	Local climate			
	Energy balance at the surface, canopy effects (vegetation, city,), topography effects, evaporation, role of the pedosphere			
	The water cycle			
	Reservoirs of water, Clausius-Clapeyron, hydrological sensitivity, extreme precipitation			
	The vertical structure of the atmosphere			
	- Hydrostatics, stability, spheres and pauses, radiative-convective equilibrium			
	Clouds			
	Life cycle of a cloud, from water vapour to precipitation			
	A windy planet			
	Pressure gradient force, Coriolis force, global wind system, turbulence and log. wind profile Wind profile			
	Climate sensitivity			
	Forcing-response approach, climate sensitivity, methods of determination, current knowledge			
	Synoptics			
	High and low pressure areas, air masses and fronts, instabilities			
	Fast feedbacks in climate			
	Water vapour, temperature gradient, ice albedo, clouds			
	Weather and climate modelling			
	Discretisation and num. Solution, parametrisation, data assimilation, boundary conditions, ensemble predictions, chaos, parallel			
	computers			
	Carbon cycle and earth history			
	Reservoirs of carbon, fossil fuels, earth ages, Urey reaction			
	Weather extremes			
	Rain, wind and heat - meteorological basics, statistical description & climate trends			
	Ice and sea level			
	Is the sea level rising? Role of ice in Earth's history, snowballs and greenhouses, Milankovitch cycles			
	The view from space			
Literature	Folien aus Übung			

C					
Courses					
Title Practical Course Measurement Tecl	hpology (12270)		Typ Practical Course	Hrs/wk	CP 2
Measurement Technology (L2268)	IIII0I0gy (L2270)		Lecture	2	2
Physical Fundamentals of Measure	ment Technology (L22	69)	Lecture	2	2
Module Responsible					
Admission Requirements	None				
Recommended Previous		logical skills, integral-	and differential calculus, basic physical con	cepts such as tempera	ature, mass, veloci
Knowledge	echnical interest, logical skills, integral- and differential calculus, basic physical concepts such as temperature, mass, velo etc				
Educational Objectives	After taking part su	iccessfully, students ha	ave reached the following learning results		
Professional Competence					
Knowledge	Physical basics: ki	inematics and dynam	ics (theory of motion), rotation of rigid be	odies, energy and m	omentum, electric
	magnetism, basics	of hydrodynamics, ten	nperature and heat, ideal gas.		
	Metrology: SI units	. measurement and m	neasurement uncertainty, basics of sensor te	chnology, physical pr	inciples, temperat
			vel measurement, flow measurement. Usage		
			calorimetry, image data acquisition, flow mea		
	mass transfer, capacitive measurements of solid concentrations, spectroscopy, error calculation, chromatography				
Skills	Literature research, categorisation of thematical topics, analysis of an experimental test stand, preparation of test protocol, fin				
	programming with Matlab, use of relevant laboratory measurement technology, preparation of a test protocol, execution				
	calculations.		5		
Personal Competence					
Social Competence	-		ctical training and learning groups, assessme		-
	experimental stand in groups, consultation with persons responsible for teaching, presentation of the pre experiment, tolerance of frustration				e preparation of
	experiment, tolerar	nce of frustration			
Autonomy	tonomy Time management of the workload, independent development of the thematic basics, personal responsibility				ty for the provision
	protective equipment and work clothing, practice of presentation in front of a group, active participation in the lecture				
	formulation of enquiries/detailed questions by using clicker.				
Workload in Hours		Time 96, Study Time i	n Lecture 84		
Credit points	6 Compulsory Bonus	Form	Description		
Course achievement	No 20 %	Excercises	Popup-Quizzes währen der Vorlesur	a	
Examination	Written exam			- 5	
Examination duration and					
scale	120 11111				
	General Engineerin	a Science (German nr	ogram, 7 semester): Specialisation Process En	aineering: Compulsory	,
	-				
ronowing curricula	General Engineering Science (German program, 7 semester): Specialisation Green Technologies: Compulsory General Engineering Science (German program, 7 semester): Specialisation Chemical and Bioengineering: Compulsory				
	Bioprocess Engineering: Core Qualification: Compulsory				
	Chemical and Bioprocess Engineering: Core Qualification: Compulsory				
	Green Technologies: Energy, Water, Climate: Core Qualification: Compulsory				
	Orientation Studies: Core Qualification: Elective Compulsory				

Course L2270: Practical Cour	rse Measurement Technology
Тур	Practical Course
Hrs/wk	2
СР	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Prof. Alexander Penn
Language	DE
Cycle	WiSe
	In the Practical Course in Measurement Technology the theory from the lectures "Physical Fundamentals of Measurement Technology" and "Measurement Technology" will be applied in practice. In small groups students learn how to handle different measurement techniques from industry and research. During the practical course, a wide range of different measurement methods will be taught, including the use of HLPC columns for qualitative mass analysis, the determination of mass transfer coefficients using optical oxygen sensors or the evaluation of image data to obtain process parameters. The practical course also teaches how measurement data are statistically evaluated and experiments are correctly documented.
Literature	Hug, H.: Instrumentelle Analytik. Theorie und Praxis. Verlag Europa-Lehrmittel, Haan-Gruiten, 2015. Kamke, W.: Der Umgang mit experimentellen Daten, insbesondere Fehleranalyse, im physikalischen Anfänger-Praktikum. Eine elementare Einführung. W. Kamke, Kirchzarten [Keltenring 197], 2010. Strohrmann, G.: Messtechnik im Chemiebetrieb. Einführung in das Messen verfahrenstechnischer Größen. Oldenbourg, München, 2004.

Course L2268: Measurement	Technology
Тур	Lecture
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Prof. Alexander Penn
Language	DE
Cycle	WiSe
Content	Basic introduction to measurement technology for process engineers. Includes error calculation, measurement units, calibration, measurement data analysis, measurement techniques and sensors. Particular attention is paid to the measurement of temperature, pressure, flow and level. The lecture provides insights into the latest developments in sensor technology in measurement technology and process engineering.
Literature	 Fraden, Jacob (2016): Handbook of Modern Sensors. Physics, Designs, and Applications. 5th ed. 2016. Cham, New York: Springer. Online verfügbar unter http://search.ebscohost.com/login.aspx?direct=true&scope=site&db=nlebk&AN=1081958. Hering, Ekbert; Schönfelder, Gert (2018): Sensoren in Wissenschaft und Technik. Funktionsweise und Einsatzgebiete. 2. Aufl. 2018. Online verfügbar unter http://dx.doi.org/10.1007/978-3-658-12562-2. Strohrmann, Günther (2004): Messtechnik im Chemiebetrieb. Einführung in das Messen verfahrenstechnischer Größen. 10., durchges. Aufl. München: Oldenbourg. Tränkler, Hans-Rolf; Reindl, Leonhard M. (2014): Sensortechnik. Handbuch für Praxis und Wissenschaft. 2., völlig neu bearb. Aufl. Berlin: Springer Vieweg (VDI-Buch). Online verfügbar unter http://dx.doi.org/10.1007/978-3-642-29942-1. Webster, John G.; Eren, Halit B. (2014): Measurement, Instrumentation, and Sensors Handbook, Second Edition. Electromagnetic, Optical, Radiation, Chemical, and Biomedical Measurement. 2nd ed. Hoboken: Taylor and Francis. Online verfügbar unter http://gbv.eblib.com/patron/FullRecord.aspx?p=1407945.

Course L2269: Physical Fundamentals of Measurement Technology			
Тур	Lecture		
Hrs/wk	2		
CP	2		
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28		
Lecturer	Prof. Christian Schroer		
Language	DE		
Cycle	WiSe		
Content	Classical mechanics - kinematics, dynamics, energy, momentum and conservation laws, rigid bodies, translation and rotation, angular momentum. Mechanics of gases and fluids - hydrostatics and hydrodynamics Thermodynamics - temperature, heat, heat transport, ideal gas, changes of state, cyclic processes, laws of thermodynamics Electricity - electrostatics, electrical conduction, magnetism, Lorentz force, Maxwell's equations (integral form)		
Literature	Paul A. Tipler, Gene Mosca: Physik für Wissenschaftler und Ingenieure, Spektrum Verlag D. Meschede (Hrsg.): Gerthsen Physik, Springer-Verlag Jay Orear: Physik, Hanser Verlag D. Halliday, R. Resnick, J. Walker: Physik, Wiley VCH		

Courses					
Title			Тур	Hrs/wk	СР
Fundamentals of Fluid Mechanics (L0091)			Lecture	2	2
Fundamentals on Fluid Mechanics (L2933)			Recitation Section (small)	2	2
Fluid Mechanics for Process Engine			Recitation Section (large)	2	2
Module Responsible					
Admission Requirements Recommended Previous	None				
Keconniended Previous Knowledge	Mathematics I+II+III				
Kilowieuge	 Technical Mechanics I+II 				
	 Technical Thermodynamic 	cs I+II			
	 Working with force balan 				
	 Simplification and solving 	of partial differential equa	ations		
	 Integration 				
Educational Objectives	After taking part successfully, students have reached the following learning results				
Professional Competence					
Knowledge	Students are able to:				
	 explain the difference be 	ween different types of flo	W		
			ynolds Transport-Theorem in proce	ess engineering	
			-Stokes-Equation by using physical		ions
Chille	The students are able to				
SKIIIS	The students are able to				
	 describe and model incor 	npressible flows mathema	tically		
	 reduce the governing equipation 	ations of fluid mechanics	by simplifications to archive quantit	tative solutions e	.g. by integration
	 notice the dependency b 				
	 use the learned basics fo 	fluid dynamical application	ons in fields of process engineering		
Personal Competence					
Social Competence	The students				
	 are capable to gather inf 	ormation from subject rela	ted, professional publications and	relate that inform	nation to the conte
	 are capable to gather information from subject related, professional publications and relate that information to the con of the lecture and 				
	 able to work together on subject related tasks in small groups. They are able to present their results effectively in Ei 			effectively in Engl	
	(e.g. during small group exercises)				
	are able to work out solutions for exercises by themselves, to discuss the solutions orally and to present the results.			t the results.	
Autonomy	The students are able to				
Autonomy					
			nd their knowledge with this literatu		
	 work on their exercises b 	/ their own and to evaluat	e their actual knowledge with the fe	eedback.	
Workload in Hours	Independent Study Time 96, Stu	dy Time in Lecture 84			
Credit points	6				
Course achievement		Descript	ion		
	No 5 % Midterm				
Examination	Written exam				
Examination duration and scale	3 hours				
	General Engineering Science (G	erman program 7 semest	er): Specialisation Green Technolog	ies: Compulsory	
Following Curricula			er): Specialisation Chemical and Bio		mpulsory
i onowing curricula	Bioprocess Engineering: Core Q		.,. specialisation enemical and bio	congreening, cor	
	Chemical and Bioprocess Engine		Compulsory		
	Green Technologies: Energy, W	-			
	Integrated Building Technology				
	Logistics and Mobility: Specialis	tion Traffic Planning and S	Systems: Elective Compulsory		
	Technomathematics: Specialisa	ion III. Engineering Scienc	e: Elective Compulsory		
	Process Engineering: Core Qual	fication: Compulsory			
	Engineering and Management -	Major in Logistics and Moh	ility: Specialization Traffic Planning	and Evetomer El	

Course L0091: Fundamentals	of Fluid Mechanics		
Тур	Lecture		
Hrs/wk	2		
CP	2		
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28		
Lecturer	Prof. Michael Schlüter		
Language	DE		
Cycle	SoSe		
Content	 fluid properties hydrostatic overall balances - theory of streamline overall balances- conservation equations differential balances - Navier Stokes equations irrotational flows - Potenzialströmungen flow around bodies - theory of physical similarity turbulent flows compressible flows 		
Literature	 Crowe, C. T.: Engineering fluid mechanics. Wiley, New York, 2009. Durst, F.: Strömungsmechanik: Einführung in die Theorie der Strömungen von Fluiden. Springer-Verlag, Berlin, Heidelberg, 2006. Fox, R.W.; et al.: Introduction to Fluid Mechanics. J. Wiley & Sons, 1994 Herwig, H.: Strömungsmechanik: Eine Einführung in die Physik und die mathematische Modellierung von Strömungen. Springer Verlag, Berlin, Heidelberg, New York, 2006 Herwig, H.: Strömungsmechanik: Eine Einführung in die Physik von technischen Strömungen: Vieweg+Teubner Verlag / GWV Fachverlage GmbH, Wiesbaden, 2008 Kuhlmann, H.C.: Strömungsmechanik: Grundlagen, Grundgleichungen, Lösungsmethoden, Softwarebeispiele. Vieweg+ Teubner Verlag / GWV Fals, Kuz, E.: Strömungslehre. Verlag de Gruyter, Berlin, New York, 2007 Truckenbrodt, E.: Fluidmechanik 1: Grundlagen und elementare Strömungsvorgänge dichtebeständiger Fluide. Springer-Verlag, Berlin, Heidelberg, 2008 Schlichting, H.: Grenzschicht-Theorie. Springer-Verlag, Berlin, 2006 van Dyke, M.: An Album of Fluid Motion. The Parabolic Press, Stanford California, 1882. White, F.: Fluid Mechanics, Mcgraw-Hill, ISBN-10: 0071311211, ISBN-13: 978-0071311212, 2011 		

Course L2933: Fundamentals on Fluid Mechanics			
Тур	Recitation Section (small)		
Hrs/wk	2		
CP	2		
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28		
Lecturer	Prof. Michael Schlüter		
Language	DE		
Cycle	le SoSe		
Content	nt In the group exercise, the contents of the lecture are taken up and deepened by means of exercises. The exercise correspond in quality and scope to the tasks of the written exam. Topics: Reynolds transport-theorem, pipe flow, free jet, an momentum, Navier-Stokes equations, potential theory, mock exam, pipe hydraulics, pump design.		
Literature	Heinz Herwig: Strömungsmechanik, Eine Einführung in die Physik und die mathematische Modellierung von Strömungen, Springer Verlag, Berlin, 978-3-540-32441-6 (ISBN) Herbert Oertel, Martin Böhle, Thomas Reviol: Strömungsmechanik für Ingenieure und Naturwissenschaftler, Springer Verlag, Berlin, ISBN: 978-3-658-07786-0 Joseph Spurk, Nuri Aksel: Strömungslehre, Einführung in die Theorie der Strömungen, Springer Verlag, Berlin, ISBN: 978-3-642- 13143-1.		

Course L0092: Fluid Mechani	Recitation Section (large)		
Hrs/wk			
СР			
	Independent Study Time 32, Study Time in Lecture 28		
Lecturer	Prof. Michael Schlüter		
Language	DE		
Cycle	SoSe		
Content	In the exercise-lecture the topics from the main lecture are discussed intensively and transferred into application. For that, the students receive example tasks for download. The students solve these problems based on the lecture material either independently or in small groups. The solution is discussed with the students under scientific supervision and parts of the solutions are presented on the chalk board. At the end of each exercise-lecture, the correct solution is presented on the chalk board. Paralle to the exercise-lecture tutorials are held where the student solve exam questions under a set time-frame in small groups and discuss the solutions afterwards.		
Literature	 Crowe, C. T.: Engineering fluid mechanics. Wiley, New York, 2009. Durst, F.: Strömungsmechanik: Einführung in die Theorie der Strömungen von Fluiden. Springer-Verlag, Berlin, Heidelberg, 2006. Fox, R.W.; et al.: Introduction to Fluid Mechanics. J. Wiley & Sons, 1994 		
	 Herwig, H.: Strömungsmechanik: Eine Einführung in die Physik und die mathematische Modellierung von Strömungen Springer Verlag, Berlin, Heidelberg, New York, 2006 Herwig, H.: Strömungsmechanik: Einführung in die Physik von technischen Strömungen: Vieweg+Teubner Verlag / GWV Fachverlage GmbH, Wiesbaden, 2008 Kuhlmann, H.C.: Strömungsmechanik. München, Pearson Studium, 2007 		
	 Oertl, H.: Strömungsmechanik: Grundlagen, Grundgleichungen, Lösungsmethoden, Softwarebeispiele. Vieweg+ Teubner Verlag / GWV Fachverlage GmbH, Wiesbaden, 2009 Schade, H.; Kunz, E.: Strömungslehre. Verlag de Gruyter, Berlin, New York, 2007 Truckenbrodt, E.: Fluidmechanik 1: Grundlagen und elementare Strömungsvorgånge dichtebeständiger Fluide. Springer- Verlag, Berlin, Heidelberg, 2008 		
	 Schlichting, H. : Grenzschicht-Theorie. Springer-Verlag, Berlin, 2006 van Dyke, M.: An Album of Fluid Motion. The Parabolic Press, Stanford California, 1882. White, F.: Fluid Mechanics, Mcgraw-Hill, ISBN-10: 0071311211, ISBN-13: 978-0071311212, 2011 		

Courses				
Title		Тур	Hrs/wk	СР
Power Industry (L0316)		Lecture	1	1
Energy markets and energy trading	j (L2744)	Lecture	2	2
Fossil Energy Systems (L2745)		Lecture	2	2
Fossil Energy Systems (L2746)		Recitation Section (large)	1	1
Module Responsible				
Admission Requirements	None			
Recommended Previous	none			
Knowledge				
Educational Objectives	After taking part successfully, students	s have reached the following learning results		
Professional Competence		dents will be able to provide an overview of char		
Skills	 which is applicable to almost all energy systems, in particular detail for conventional energy systems and take a critical stance of them. Furthermore, they can explain the environmental impact of using conventional energy systems. They also have an overvie of reserves and resources as well as global and national market volumes. This also includes the legal framework, which shou especially take into account the mitigation of climate change. Students are able to apply methodologies for determining energy demand or energy supply to different types of energy systems Furthermore, they can evaluate energy systems technically, ecologically and economically as well as systemically and are alsable to design them under certain given conditions. They are able to select the regulations necessary for this in a subject-specific manner, especially by means of non-standard solutions to a problem. Students are able to orally explain issues from the subject area and approaches to dealing with them and to classify them in threspective context. 			
Personal Competence				
	criteria under sustainability aspects.	table technical alternatives and to assess them w		
Autonomy	Students can independently exploit so questions.	ources , acquire the particular knowledge about th	ne subject area and	I transform it to r
Workload in Hours	Independent Study Time 96, Study Tim	ne in Lecture 84		
Credit points	6			
Course achievement	None			
Examination	Written exam			
Examination duration and	90 min			
scale				
Assignment for the	General Engineering Science (German	program, 7 semester): Specialisation Green Techno	logies: Compulsory	
Assignment for the Following Curricula		program, 7 semester): Specialisation Green Techno program, 7 semester): Specialisation Green Techno		

Course L0316: Power Industr	CY CY		
Тур	Lecture		
Hrs/wk	1		
CP	1		
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14		
Lecturer	Prof. Martin Kaltschmitt, Prof. Andreas Wiese		
Language	DE		
Cycle	SoSe		
Content	 Electrical energy in the energy system Demand and use of electrical energy (households, industry, "new" buyers (including e-mobility)) Electricity generation electricity generation technologies using fossil fuels and their characteristics combined heat and power technologies and their production characteristics electricity generation from renewable energy technologies and their characteristics electricity generation of electrical energy challenges of fluctuating electricity generation by distributed systems (electricity market, electricity stock exchange, emissions trading) District heating industry Legal and administrative aspects support instruments for renewable energy CHP Act Cost and efficiency calculation 		
Literature	Cost and efficiency calculation Folien der Vorlesung		

Course L2744: Energy marke	ts and energy trading
Тур	Lecture
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Dr. Christian Wulf
Language	DE
Cycle	SoSe
Content	This lecture addresses the mechanisms by which price formation works in global and national energy markets. For this purpose, the global price formation mechanism for crude oil and for natural gas and coal is explained. The national energy markets (e.g. power exchange, gas markets) are also discussed. The legal framework, which is ultimately decisive for market price formation, is always addressed. In this context, the various instruments with which the energy markets are to be influenced in such a way that climate protection already takes effect with market-based measures are also discussed. The expected future development/change of the energy markets against the background of the increasing use of renewable energies will also be addressed.
Literature	

Course L2745: Fossil Energy	Systems
Тур	Lecture
Hrs/wk	2
СР	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Prof. Martin Kaltschmitt
Language	DE
Cycle	SoSe
Content	The aim of this lecture is to present and discuss the different fossil energy systems in their entirety. This includes the petroleum, natural gas, hard coal, lignite and nuclear energy systems. In each case, the formation processes, the exploration technologies, the exploration processes, the extraction technologies, the further processing processes and the corresponding utilization are presented. In addition, the respective markets and their development, the existing reserves and resources, and the environmental effects associated with extraction and utilization are discussed. A total system approach is pursued, which includes a presentation of the entire energy systems including the given interdependencies and (geo)political dependencies. The current changes in these energy systems for Germany and internationally, and those that are expected in the coming years, are also discussed. In addition, the respective reserve and resource availability is illuminated.
Literature	Vorlesungsunterlagen

Course L2746: Fossil Energy	Systems
	Recitation Section (large)
Hrs/wk	1
CP	1
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14
Lecturer	Prof. Martin Kaltschmitt
Language	DE
Cycle	SoSe
Content	The goal of this exercise is to present and discuss the different fossil energy systems in their entirety. This includes the petroleum, natural gas, hard coal, lignite and nuclear energy systems. In each case, the formation processes, the exploration technologies, the exploration processes, the extraction technologies, the further processing processes and the corresponding utilization are presented. In addition, the respective markets and their development, the existing reserves and resources, and the environmental effects associated with extraction and utilization are discussed. A total system approach is pursued, which includes a presentation of the entire energy system including the given interdependencies and (geo)political dependencies. The current changes in these energy systems for Germany and internationally, and those that are expected to occur in the coming years, are also discussed. In
Literature	addition, the respective reserve and resource availability is illuminated.

Courses				
Title		Тур	Hrs/wk	СР
Renewable Energies I (L2740)		Lecture	2	2
Renewable Energies I (L2742)		Recitation Section (large)	1	1
Renewable Energies II (L2741)		Lecture	2	2
Renewable Energies II (L2743)		Recitation Section (large)	1	1
Module Responsible	Prof. Martin Kaltschmitt			
Admission Requirements	None			
Recommended Previous	none			
Knowledge				
Educational Objectives	After taking part successfully, students	have reached the following learning results		
Professional Competence				
	will be able to explain the issues that a energy distribution and energy trading can explain this knowledge in detail fo	ts will be able to provide an overview of characteris inise in these systems. Furthermore, they are able in this context, taking into account contexts border r such energy systems and take a critical stand o ble energy systems and have an overview of the e	to explain knowled ing on specific disc n it. Furthermore,	lge of energy supp ciplines. The stude they can explain
	systems. Furthermore, they can evalua and also design them under certain give manner, especially by means of non-sta	es for determining energy demand or energy supply te such energy systems technically, ecologically ar en conditions. They are able to select the regulation ndard solutions to a problem. es from the subject area and approaches to dealin	nd economically as s necessary for thi	s well as systemica s in a subject-spec
	respective context.			
Personal Competence				
	Students are able to investigate suitab ecological criteria - and thus from a sus	le technical alternatives and ultimately evaluate the tainability perspective.	nem based on tecl	hnical, economic a
Autonomy	Students will be able to independently a	access sources about the field, acquire knowledge a	nd transform it to a	address new issue
Workload in Hours	Independent Study Time 96, Study Time	e in Lecture 84		
Credit points	6			
Course achievement	None			
Examination	Written exam			
	90 min			
scale				
Assignment for the	General Engineering Science (German n	orogram, 7 semester): Specialisation Green Technolo	aies: Compulsory	
-		program, 7 semester): Specialisation Green Technolo		
-		pecialisation Civil Engineering: Elective Compulsory		
		pecialisation Traffic and Mobility: Elective Compulsory		
			-	
		pecialisation Water and Environment: Elective Comp	JuisOly	
		Specialisation Chemical Engineering: Compulsory		
	Green Technologies: Energy, Water, Clir	nate. Core Qualification: Compulsory		

Course L2740: Renewable En	nergies I
Тур	Lecture
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Prof. Martin Kaltschmitt
Language	DE
Cycle	SoSe
Content	This module includes a presentation of the renewable energy supply and a discussion of the respective technologies for providing the desired final or useful energy. Specifically, this includes the options for solar energy use for heat and power generation (i.e., passive solar energy use, solar collectors for low-temperature heat provision, solar thermal power generation, photovoltaic power generation), wind energy use for power generation (i.e. onshore and offshore wind power use), hydroelectric power use for electricity generation (i.e., run-of-river and storage hydroelectric power), ocean energy use for electricity generation (including tidal power plants), and geothermal energy use for heat and electricity generation (i.e., near-surface use by means of heat pumps, deep geothermal energy use for heat and/or electricity generation).
Literature	Kaltschmitt, M.; Streicher, W.; Wiese, A. (Hrsg.): Erneuerbare Energien - Systemtechnik, Wirtschaftlichkeit, Umweltaspekte; Springer, Berlin, Heidelberg, 2020, 6. Auflage

Course L2742: Renewable Er	ergies I
Тур	Recitation Section (large)
Hrs/wk	1
CP	1
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14
Lecturer	Prof. Martin Kaltschmitt
Language	DE
Cycle	SoSe
Content	Students work on different tasks in the field of renewable energies. They present their solutions in the exercise lesson and discuss it with other students and the lecturer. Possible tasks in the field of renewable energies are: • Solar thermal heat • Concentrating solare power • Photovoltaic • Windenergie
Literature	Hydropower Heat pump Deep geothermal energy Kaltschmitt, M.; Streicher, W.; Wiese, A. (Hrsg.): Erneuerbare Energien - Systemtechnik, Wirtschaftlichkeit, Umweltaspekte; Springer, Berlin, Heidelberg, 2020, 6. Auflage

Course L2741: Renewable En	ergies II
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Prof. Martin Kaltschmitt
Language	DE
Cycle	SoSe
Content	This lecture covers all options for energy supply from biomass; this includes the supply of heat, electricity and fuels. The biomass resource and its origin will be discussed first. Afterwards the biomass supply is addressed, which bridges the gap between biomass generation and utilization. Subsequently, the different conversion options are discussed. Only those options are presented in depth that have a corresponding significance on the market in Germany and Europe. This includes (a) heat generation from biogenic solid fuels in small and large-scale plants (b) power generation from solid biomass via combustion (c) a biogas production from residues, by-products and waste, (d) alcohol production from sugar and starch (e) biodiesel production from vegetable oils. Special attention is also paid to the corresponding environmental aspects. An economic classification of the various options is also provided.
Literature	Unterlagen der Vorlesung

Course L2743: Renewable En	nergies II
Тур	Recitation Section (large)
Hrs/wk	1
CP	1
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14
Lecturer	Prof. Martin Kaltschmitt
Language	DE
Cycle	SoSe
Content	The students work on tasks in the field of renewable energies the field "energy from biomass". They present their solution approaches in the exercise group and discuss them with their fellow students and the teaching staff afterwards.
Literature	Unterlagen der Vorlesung

Courses				
Title		Тур	Hrs/wk	СР
Vastewater Disposal (L0276)		Lecture	2	2
Vastewater Disposal (L0278)		Recitation Section (large)	1	1
Drinking Water Supply (L0306)		Lecture	2	1
Drinking Water Supply (L0308)		Recitation Section (large)	1	2
Module Responsible	Prof. Ralf Otterpohl			
Admission Requirements	None			
Recommended Previous	Basic knowledge on Chemistry and	d Biology		
Knowledge	 Hydraulics of pipe systems and op 			
		ement: water quantity and water quality		
	Basic knowledge on Environmenta			
Educational Objectives	After taking part successfully, students h	nave reached the following learning results		
Professional Competence				
Knowledge	The students can examplify their expert	knowledge on urban water infrastructures. They c	an present the de	erivation and detaile
	explanation of important standards for the	he design of drinking water supply and wastewater	disposal systems	in Germany and th
	are capable of reproducing the relevant	empiricals assumptions and scientific simplifcations	. The students ar	e able to present a
	discuss sanitary engineering processes	and the technologies used for drinking and waster	vater treatment.	They can also asse
	existing problems in the field of sanitary	engineering by considering legal, risk and saftey as	spects. Furthermo	re, they know how
	draft the features and effectiveness of i	mportant technologies of the future such as high-	and low-pressure	e membrane filtrati
	systems and techniques for the removal	of trace pollutants.		
Skills		vant standards and guidelines for the design and op		
		s expert skills to design drinking water supply and		
	associated treatment facilities. Besides t	the acquirement of technical skills the students are	able to address a	and solve biochemio
	problems in the filed of drinking water	and wastewater treatment. The students are also	able to develop	ideas of their own
	improve the existing water related infras	structures, systems and concepts.		
Deveral Competence				
Personal Competence	Cosial skills are not torrested in this medu			
Social Competence	Social skills are not targeted in this mode	ule.		
Autonomy	Students are able to form concepts on	their own to optimize urban water infrastructure	processes. Theref	ore they can acqu
	appropriate knowledge when being give	en some clues or information with regard to the a	proach to proble	ems (preparation a
	follow-up of the exercises).			
Workload in Hours	Independent Study Time 96, Study Time	in Lecture 84		
Credit points	6			
Examination	Written exam			
Examination duration and				
ceste	1			
scale	Conoral Engineering Science (Correspond	rogram 7 competer): Specialization Croop Tacharles	nios: Compulsers	
Assignment for the		rogram, 7 semester): Specialisation Green Technolog	gies: Compulsory	
		ore Qualification: Compulsory	gies: Compulsory	

Тур	Lecture
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Prof. Ralf Otterpohl
Language	DE
Cycle	SoSe
Content	This lecture focusses on urban drainage and wastewater treatment.
	Urban Drainage
	 Design of urban drainage systems (combined and separate sewer systems)
	Special structures
	Rainwater management
	Wastewater treatement
	 Mechanical treatment (Screens, Grit chamber, Preliminary Sedimentation, Secondary Settlement Tanks, Membra Filtration)
	Biological Treatment (aerobic, anaerobic, anoxic)
	Special Wastewater Treatment Processes (Ozonation, Adsorption)
Literature	Die hier aufgeführte Literatur ist in der Bibliothek der TUHH verfügbar.
	The literature listed below is available in the library of the TUHH.
	 Taschenbuch der Stadtentwässerung : mit 10 Tafeln und 67 Tabellen, Imhoff, K., & . (2009). (31., verbesserte Aufl München: Oldenbourg Industrieverl.
	Abwasser : Technik und Kontrolle. Neitzel, Volkmar, and Weinheim [u.a.]: Wiley-VCH, 1998.
	 Kommunale Kläranlagen : Bemessung, Erweiterung, Optimierung, Betrieb und Kosten, (2009). Günthert, F. Wolfgang: völlig neu bearb. Aufl.). Renningen: expert-Verl.
	 Water and wastewater technology Hammer, M. J. 1., & . (2012). (7. ed., internat. ed.). Boston [u.a.]: Pearson Educat International.
	 Water and wastewater engineering : design principles and practice: Davis, M. L. 1. (2011) New York, NY: McGraw-Hill. Biological wastewater treatment: (2011). C. P. Leslie Grady, Jr. (3. ed.). London, Boca Raton, Fla. [u.a.]: IWA Publ.

Course L0278: Wastewater D	Disposal
Тур	Recitation Section (large)
Hrs/wk	1
CP	1
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14
Lecturer	Prof. Ralf Otterpohl
Language	DE
Cycle	SoSe
Content	See interlocking course
Literature	See interlocking course

cs and pump systems are presented (system curve and pump curve). Students learn how the duty point
Mathias Ernst water supply provides students with a basic understanding of the entire water supply system, hment, water treatment including pump systems, water storage, and the distribution system that carries cs and pump systems are presented (system curve and pump curve). Students learn how the duty point
Mathias Ernst
Mathias Ernst water supply provides students with a basic understanding of the entire water supply system, hment, water treatment including pump systems, water storage, and the distribution system that carries cs and pump systems are presented (system curve and pump curve). Students learn how the duty point
water supply provides students with a basic understanding of the entire water supply system, hment, water treatment including pump systems, water storage, and the distribution system that carries cs and pump systems are presented (system curve and pump curve). Students learn how the duty point
hment, water treatment including pump systems, water storage, and the distribution system that carries cs and pump systems are presented (system curve and pump curve). Students learn how the duty point
hment, water treatment including pump systems, water storage, and the distribution system that carries cs and pump systems are presented (system curve and pump curve). Students learn how the duty point
hment, water treatment including pump systems, water storage, and the distribution system that carries cs and pump systems are presented (system curve and pump curve). Students learn how the duty point
vater demand and derive planning values for designing the different elements of a water supply system ments). The functions of reservoirs, their design and arrangement in the water supply system are be able to design simple water distribution systems.
ture deals with the processes involved in drinking water supply. This includes a presentation of the d layout parameters for sedimentation, filtration, coagulation, membrane treatment, adsorption, water ion exchange and disinfection. The basics of process treatment technology will be built on with parallel chemical and physical water quality parameters.
ngswasserwirtschaft. 3., bearb. Aufl., Springer-Verlag. r, K., Hoffmann, F. (2005): Wasserversorgung. 12., vollst. überarb. Aufl., Teubner Verlag

Course L0308: Drinking Wate	er Supply
Тур	Recitation Section (large)
Hrs/wk	1
CP	2
Workload in Hours	Independent Study Time 46, Study Time in Lecture 14
Lecturer	Dr. Klaus Johannsen, Prof. Mathias Ernst
Language	DE
Cycle	SoSe
Content	See interlocking course
Literature	See interlocking course

6				
Courses				
Title	achaology (11297)	Typ	Hrs/wk 1	CP 1
Practical Exercise Environmental Te Pollutant analysis (L2996)	echnology (E1387)	Practical Course Lecture	2	3
Environmental Technologie (L0326)	Lecture	2	2
	Dr. Marvin Scherzinger			
Admission Requirements	-			
Recommended Previous	Fundamentals of inorganic/organic chemistry and	l biology.		
Knowledge				
Educational Objectives	After taking part successfully, students have read	hed the following learning results		
Professional Competence				
Knowledge	With the completion of this modul the students of the behaviour of chemicals in the environment. terms and allocate them to related methods.			
	Additional students acquire in-depth knowledge of occur from production processes, projects or con- are competent in dealing with different methods to estimate the complexity of these environmenta	struction measures. They have knowled and instruments to assess environmen	ge about the method tal impacts. Besides t	blogical diversity a he students are at
Skills	Students are able to propose appropriate management and mitigation measures for environmental problems. They are able t determine geochemical parameters and to assess the potential of pollutants to migrate and transform. The students are able t work out well founded opinions on how Environmental Technology contributes to sustainable development, and they can preser and defend these opinons in front of and against the group.			
	The students are able to select a suitable metho can develop suitable solutions for managing and out Life Cycle Impact Assessments independent After finishing the course the students have environmental impacts.	mitigating environmental problems in a ly and can apply the software program	a business context. The openLCA and the	hey are able to can database Ecolnve
Personal Competence				
-	The students are able to discuss the various tech to develop different approaches to the task as a g	· · · · ·		
	Due to the selected lecture topics, the students re concept of sustainability. Their sensitivity and c awareness of their future social responsibilities in	onsciousness towards these subjects a		
Autonomy	The students learn to research, process and pr scientific work. They can solve an environmental			
Workload in Hours	Independent Study Time 110, Study Time in Lect	ure 70		
Credit points				
Course achievement	None			
Examination	Written exam			
Examination duration and	120 min			
scale				
Assignment for the	General Engineering Science (German program, 7	7 semester): Specialisation Green Techn	ologies: Compulsory	
Following Curricula	Green Technologies: Energy, Water, Climate: Cord		5	
5	Computer Science in Engineering: Specialisation I			

Course L1387: Practical Exer	cise Environmental Technology
Тур	Practical Course
Hrs/wk	1
CP	1
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14
Lecturer	Prof. Martin Kaltschmitt, Dr. Marvin Scherzinger
Language	DE
Cycle	SoSe
Content	The practical course Environmental Engineering currently consists of 5 experiments, which deal with the different focal points of
	environmental engineering in the areas of air, water, soil, energy and noise. The following experiments are carried out for this
	purpose:
	biological degradation of artificial materials,
	fine dust measurement in the air,
	water analysis,
	noise emission measurement,
	photovoltaic energy
	Within the lab course students discuss the various technical and scientific tasks, both subject-specific and multidisciplinary. They discuss different approaches to the task as well as it's theoretical or practical implementation.
Literature	Folien der Einführungsveranstaltung

Course L2996: Pollutant ana	lysis
Тур	Lecture
Hrs/wk	2
CP	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Dr. Marvin Scherzinger
Language	DE
Cycle	WiSe
Content	In this course, modern analytical methods are presented that are used for the quantification of pollutants in the environmental compartments soil, water and air. In doing so, the students deepen their theoretical knowledge with regard to working with standardized methods and learn to make statements about the quality of test results.
Literature	Vorlesungsfolien

Course L0326: Environmenta	ıl Technologie
Тур	Lecture
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Prof. Martin Kaltschmitt, Dr. Marvin Scherzinger
Language	DE
Cycle	WiSe
Content	 Introductory seminar on environmental science: Environmental impact and adverse effects Wastewater technology Air pollution control Noise protection Waste and recycling management Soil and ground water protection Renewable energies Resource conservation and energy efficiency
Literature	Förster, U.: Umweltschutztechnik; 2012; Springer Berlin (Verlag) 8., Aufl. 2012; 978-3-642-22972-5 (ISBN)

Courses				
Title		Тур	Hrs/wk	СР
Heat and Mass Transfer (L0101)		Lecture	2	2
Heat and Mass Transfer (L0102)		Recitation Section (small)	1	2
Heat and Mass Transfer (L1868)		Recitation Section (large)	1	2
Module Responsible	Prof. Irina Smirnova			
Admission Requirements	None			
Recommended Previous	Basic knowledge: Technical Thermodynamics			
Knowledge				
Educational Objectives	After taking part successfully, students have reached	the following learning results		
Professional Competence		5 5		
Knowledge				
······································	 The students are capable of explaining qualitation 	ive and determining quantitative heat t	ransfer in proced	dural apparatus (e.
	heat exchanger, chemical reactors).			
	 They are capable of distinguish and characterized 	ze different kinds of heat transfer mech	anisms namely h	leat conduction, he
	transfer and thermal radiation.			
	 The students have the ability to explain the 		letail and to de	scribe mass trans
	qualitative and quantitative by using suitable n			
	 They are able to depict the analogy between he 	eat- and mass transfer and to describe c	omplex linked pr	rocesses in detail.
Skills				
	 The students are able to set reasonable syste 	m boundaries for a given transport pro	blem by using th	ne gained knowled
	and to balance the corresponding energy and r	nass flow, respectively.		
	 They are capable to solve specific heat transfer 	er problems (e.g. heated chemical reac	tors, temperatur	e alteration in flui
	and to calculate the corresponding heat flows.			
	 Using dimensionless quantities, the students ca 			
	They are able to distinguish between diffusion,			n use this knowled
	for the description and design of apparatus (e.g			
	 In this context, the students are capable to choose and all and the students are capable to choose and all and the students are capable to choose and all and the students are capable to choose and all and the students are capable to choose and all and the students are capable to choose and all and the students are capable to choose and all and the students are capable to choose and all and the students are capable to choose and all and the students are capable to choose and all and the students are capable to choose and all and the students are capable to choose and all and the students are capable to choose and all and the students are capable to choose and all and the students are capable to choose and all and the students are capable to choose are capable to choose and all and the students are capable to choose are capable to choo		eat and mass exc	changer for a spec
	application considering their advantages and d			
	 In addition, they can calculate both, steady-sta The students are capable to connect their 			
	 The students are capable to connect their particular the courses thermodynamics, fluid 	-	-	
	problems.	meenames and chemical process engi	ficering) to solv	e concrete techni
	problems.			
Porsonal Compotonco				
Personal Competence				
Social Competence	 The students are capable to work on subject-s 	pecific challenges in teams and to pres	ent the results o	orally in a reasona
	manner to tutors and other students.			
Autonomy	The students are able to find and evaluate nec	essary information from suitable sources	5	
	 They are able to prove their level of knowled 			continuously (click
	system, exam-like assignments) and on this ba	sis they can control their learning proce	sses.	
Workload in Hours	Independent Study Time 124, Study Time in Lecture 5	66		
Credit points	6			
Course achievement				
Examination				
Examination duration and	120 minutes; theoretical questions and calculations			
scale	220 million di calculations and calculations			
Assignment for the	General Engineering Science (German program, 7 ser	nester): Specialisation Groop Technologi	es: Compulsory	
-	General Engineering Science (German program, 7 ser General Engineering Science (German program, 7 ser			mulson
Following Curricula	Bioprocess Engineering: Core Qualification: Compulso		engineering: Cor	npulsory
	Chemical and Bioprocess Engineering: Core Qualificat Green Technologies: Energy, Water, Climate: Core Qu			
	Technomathematics: Specialisation III. Engineering Sc			

Course L0101: Heat and Mas	is Transfer
Тур	Lecture
Hrs/wk	2
СР	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Prof. Irina Smirnova
Language	DE
Cycle	WiSe
Content	 Heat transfer Introduction, one-dimensional heat conduction Convective heat transfer Multidimensional heat conduction Non-steady heat conduction Thermal radiation Mass transfer one-way diffusion, equimolar countercurrent diffusion boundary layer theory, non-steady mass transfer Heat and mass transfer single particle/ fixed bed Mass transfer and chemical reactions
Literature	 H.D. Baehr und K. Stephan: Wärme- und Stoffübertragung, Springer VDI-Wärmeatlas

Course L0102: Heat and Mas	s Transfer
Тур	Recitation Section (small)
Hrs/wk	1
CP	2
Workload in Hours	Independent Study Time 46, Study Time in Lecture 14
Lecturer	Prof. Irina Smirnova
Language	DE
Cycle	WiSe
Content	See interlocking course
Literature	See interlocking course

Course L1868: Heat and Mas	s Transfer
Тур	Recitation Section (large)
Hrs/wk	1
СР	2
Workload in Hours	Independent Study Time 46, Study Time in Lecture 14
Lecturer	Prof. Irina Smirnova
Language	DE
Cycle	WiSe
Content	See interlocking course
Literature	See interlocking course

Focus Renewable Energy

Module M1713: Greer	n Technologies III			
Courses				
Title		Тур	Hrs/wk	СР
Study Work Green Technologies (L2	2766)	Project Seminar	2	4
Scientific Work and Writing (L2765)		Seminar	2	2
_	Dozenten des Studiengangs			
Admission Requirements	None			
Recommended Previous	keine			
Knowledge				
Educational Objectives	After taking part successfully, students have reache	d the following learning results		
Professional Competence	······			
Knowledge	The students, based on a literature survey, learn to	study in detail a subject theme from	the disciplines of are	en technologies and
Knowledge	deliver afterwards a summary presentation to a spe			-
	preferred, when selecting the thematic area of these			
	overview over the subject and practice technical	-		
	specialised subject matter.	······		····· ····· ··························
Skills	The students can, when working on a technical topic	not familiar to them:		
	 conduct a literature survey 			
	 choose the relevant information for their pres 	entation		
	 prepare a written summary 			
	 prepare a written summary present results in front of peers and staff 			
	 correctly cite and reference sources. 			
Personal Competence				
Social Competence	The students practice a critical assessment of the I	iterature in a predefined specialised	theme and learn to g	ive presentations on
	their own technical sub-topic tailored to their publi	c and discuss with the audience. Wh	en attending technica	al presentations, the
	students can formulate questions to other speakers	and participate in the ensuing discus	sion.	
	The fulfilment of the tasks combines independent w	ork with group and teamwork		
	The fulliment of the tasks combines independent w	ork with group and teamwork.		
Autonomy	The students can, guided by instructors, critically re	flect on their learning and work status	s, and write a scientif	ic report.
Workload in Hours	Independent Study Time 124, Study Time in Lecture	56		
Credit points				
Course achievement	None			
-				
Examination duration and	2			
scale				
Assignment for the	General Engineering Science (German program, 7 se	mester): Specialisation Green Technol	ologies Focus Renew	able Energy: Elective
Following Curricula		inestery. Specialisation oreen reching	logics, rocus nellew	able Energy. Elective
. eenning curricula	General Engineering Science (German program, 7 s	semester): Specialisation Green Tech	nologies, Focus Water	and Environmental
	Engineering: Elective Compulsory			
	Green Technologies: Energy, Water, Climate: Specia	lisation Energy Technology: Elective	Compulsory	
	Green Technologies: Energy, Water, Climate: Specia Green Technologies: Energy, Water, Climate: Specia			
	Green Technologies: Energy, Water, Climate: Specia Green Technologies: Energy, Water, Climate: Specia	-		mpulsory
	Green Technologies: Energy, Water, Climate: Specia Green Technologies: Energy, Water, Climate: Specia			
	ereen rechnologies. Energy, water, chinate. Specia	instant Distectionologies. Elective Coll		

Course L2766: Study Work G	reen Technologies
Тур	Project Seminar
Hrs/wk	2
CP	4
Workload in Hours	Independent Study Time 92, Study Time in Lecture 28
Lecturer	Dozenten des Studiengangs
Language	DE
Cycle	WiSe
Content	Students carry out a research project in a scientific field under the guidance of an academic staff member. For this purpose, the student can approach the staff of the respective institute and discuss a topic. The topic is then worked on within 4 weeks and regular consultations are held with the supervisor. The student research project should be the size of a scientific article.
Literature	

Hrs/wk
СР
Workload in Hours
Lecturer
Language
Cycle
Content
Literature

Courses					
Fitle Gas and Steam Power Plants (L020)	5)		Typ Lecture	Hrs/wk	CP 5
Gas and Steam Power Plants (L020)			Recitation Section (large)		1
Module Responsible				_	_
-					
Admission Requirements	None				
Recommended Previous	 "Technica 	I Thermodynamics I and II"			
Knowledge	 "Heat Tra 	nsfer"			
	 "Fluid Me 	chanics"			
Educational Objectives	After taking part	successfully, students have	reached the following learning results		
Professional Competence					
Knowledge	The students ca	in evaluate the developmen	t of the electricity demand and the energy	y conversion routes i	n the thermal pov
	plant, describe t	he various types of power pl	ant and the layout of the steam generator	block. They are also a	able to determine t
	operation chara	cteristics of the power pla	nt. Additionally they can describe the e	xhaust gas cleaning	apparatus and t
	combination pos	ssibilities of conventional for	ssil-fuelled power plants with solar therma	al and geothermal po	ower plants or pla
	equipped with C	arbon Capture and Storage.			
	The students ha	ve basic knowledge about th	e principles, operation and design of turbor	hachinery	
Skills	The students w	ill be able, using theories a	nd methods of the energy technology from	m fossil fuels and ba	ased on well-found
			of gas and steam power plants, to identify b		
	-		solutions. Through analysis of the problem		
			dents are endowed with the capability and		
			the production of heat. From the technical		
	-				
	follow better the deliberations on the electricity mix composition within the energy-political triangle (economy, secure supply a environmental protection).				
		,			
	Within the frame	ework of the exercise the stu	dents learn the use of the specialised softwa	are suite EBSILON Pro	fessional TM . With
	tool small practi	cal tasks are solved with the	PC, to highlight aspects of the design and d	evelopment of power	plant cycles.
		e able to do simplified calcu	lations on turbomachinery either as part of	r a plant, as single co	omponent or at sta
	level.				
Personal Competence					
-	An excursion wit	hin the framework of the lec	ture is planned for students that are interes	ted. The students get	in this manner dire
Social competence			egion. The students will obtain first-hand e	-	
		s into the conflicts between t	-	Aperience man a por	
Autonomy			ble to develop alone simple simulation mode	als and run with these	scenario analyses
Autonomy		-			-
	this manner the theoretical and practical knowledge from the lecture is consolidated and the potential effects from differe process combinations and boundary conditions highlighted. The students are able independently to analyse the operation				
			ulate selected quantities and characteristic		light the operation
	performance of	steam power plants and cale		curves.	
Workload in Hours	Independent Stu	dy Time 124, Study Time in	Lecture 56		
Credit points	6				
Course achievement	Compulsory Bonu	s Form	Description		
	No 5 %	Presentation	15-minütiges, unbenotetes Testa	at über EBSILON	Professional; n
			bestanden/nicht bestanden (keine an	teiligen Punkte)	
	No 5 %	Excercises	10 Übungsaufgaben im Laufe der Vor	lesungen à 5 Minuter	n; bis zu 5 % Bonus
			nach Anteil richtiger Abgaben		
	No 5%	Group discussion	gemeinsame Erarbeitung von Inhalte	n	
	No 5 %	Written elaboration	Zusammenfassung von Literatur		
Examination	Written exam				
Examination duration and	Written examina	ation of 120 min			
scale					
Assignment for the	General Enginee	ring Science (German progra	am, 7 semester): Specialisation Green Techr	ologies Focus Popor	vable Energy: Elect
Following Curricula	-	and science (German progra	in, / semester, specialisation dreen fech	iologica, i ocus kellev	able Lifergy. Elect
Following Curricula	a Compulsory Energy Systems: Technical Complementary Course Core Studies: Elective Compulsory				

Course L0206: Gas and Stea	m Power Plants
Тур	Lecture
Hrs/wk	3
CP	5
Workload in Hours	Independent Study Time 108, Study Time in Lecture 42
Lecturer	Dr. Kristin Abel-Günther
Language	DE
Cycle	WiSe
Content	In the 1 st part of the lecture an overview on thermal power plants is offered, including:
	Electricity demand and Forecasting
	Thermodynamic fundamentals
	Energy Conversion in thermal power plants
	Types of power plant
	Layout of the power plant block
	Individual elements of the power plant
	Cooling systems
	Flue gas cleaning
	Operation characteristics of the power plant
	Construction materials for power plants
	Location of power plants
	Solar thermal plants/geothermal plants/Carbon Capture and Storage plants.
	These are complemented in the 2 nd part of the module by the more specialised issues:
	Energy balance of a turbomachine
	Theory of turbine and compressor stage
	Equal and positive pressure blading
	Flow losses
	Characteristic numbers
	Axial and radial design
	Design features
	Hydraulic turbomachines
	Pump and water turbine designs
	Design examples of reciprocating engines and turbomachinery
	Steam power plants
	Gas turbine systems.
Literature	
	Kalide: Kraft- und Arbeitsmaschinen
	Thomas, H.J.: Thermische Kraftanlagen. Springer-Verlag, 1985
	Strauß, K.: Kraftwerkstechnik. Springer-Verlag, 2006
	Kugeler und Phlippen: Energietechnik. Springer-Verlag, 1990
	Bohn, T. (Hrsg.): Handbuchreihe Energie, Band 7: Gasturbinenkraftwerke, Kombikraftwerke, Heizkraftwerke und
	Industriekraftwerke, Technischer Verlag Resch / Verlag TÜV Rheinland

ourse L0210: Gas and Stear	n Power Plants
Тур	Recitation Section (large)
Hrs/wk	
CP	
	- Independent Study Time 16, Study Time in Lecture 14
	Dr. Kristin Abel-Günther
Language	
Cycle	
Content	In the 1 st part of the lecture a general introduction into fluid-flow machines and steam power plants is offered, including:
	Energy balance of a fluid-flow machine
	Theory of turbine and compressor stage
	Equal and positive pressure blading
	Flow losses
	Characteristic numbers
	Axial and radial design
	Design features
	Hydraulic fluid-flow machines
	Pump and water turbine designs
	Design examples of reciprocating engines and turbomachinery
	Steam power plants
	Gas turbine systems
	Diesel engine systems
	Waste heat utilisation
	followed by the more specialised issues:
	Electricity Demand and Forecasting
	Thermodynamic fundamentals
	Energy Conversion in Thermal Power Plants
	Types of Power Plant
	Layout of the power plant block
	Individual elements of the power plant
	Cooling systems
	Flue gas cleaning
	Operation characteristics of the power plant
	Construction materials
	Location of power plants
	The environmental impact of acidification, fine particulate or CO ₂ emissions and the resulting climatic effects are a special focus
	the lecture and the lecture hall exercise. The challenges in plant operation from interconnecting conventional power plants a renewable energy sources are discussed and the technical options for providing security of supply and network stability presented, also under consideration of cost effectiveness. In this critical review, focus is especially placed on the compatibility the different solutions with the environment and climate. With this, the awareness for the responsibility of an engineer's o actions are emphasized and the potential extent of the different solutions presented clearly.
	Within the framework of the exercise the students learn the use of the specialised software suite EBSILON Professional TM . With tool small tasks are solved on the PC, to highlight aspects of the design and development of power plant cycles. The stude present their results orally and can afterwards ask questions and get feedback. The course work has a positive effect on students final grade.
Literature	 Skripte Kalide: Kraft- und Arbeitsmaschinen Thomas, H.J.: Thermische Kraftanlagen. Springer-Verlag, 1985 Strauß, K.: Kraftwerkstechnik. Springer-Verlag, 2006 Kugeler und Phlippen: Energietechnik. Springer-Verlag, 1990 T. Bohn (Hrsg.): Handbuchreihe Energie, Band 7: Gasturbinenkraftwerke, Kombikraftwerke, Heizkraftwerke u Industriekraftwerke, Technischer Verlag Resch / Verlag TÜV Rheinland

Courses				
Title		Тур	Hrs/wk	СР
Thermal Separation Processes (L01	18)	Lecture	2	2
Thermal Separation Processes (L01		Recitation Section (small)	2	2
Thermal Separation Processes (L01		Recitation Section (large)	1	1
Separation Processes (L1159)		Practical Course	1	1
Module Responsible	Prof Irina Smirnova			
Admission Requirements	None			
Recommended Previous	Recommended requirements: Thermodynamics III			
Knowledge				
Educational Objectives	After taking part successfully, students have reached	the following learning results		
Professional Competence				
Knowledge				
5	 The students can distinguish and describe d 	fferent types of separation processes	such as distillat	tion, extraction,
	adsorption			
	 The students develop an understanding for the 	e course of concentration during a sepa	aration process, t	he estimation of
	energy demand of a process, the possibilities o	f energy saving, and the selection of sep	paration systems	
	 They have good knowledge of designing method 	ds for separation processes and devices	- 5	
Skills				
entite entite	 Using the gained knowledge the students can 	select a reasonable system boundary fo	r a given separa	tion process and
	close the associated energy and material balan	ces		
	• The students can use different graphical met	hods for the designing of a separation	n process and d	efine the amoun
	theoretical stages required			
	- · ·	hormal constation process for a given	case based on	the advantages
	They can select and design a basic type of t	nermal separation process for a given	case based on	the advantages
	disadvantages of the process			
	 The students are capable to obtain independe 	ntly the needed material properties from	m appropriate so	urces (diagrams
	tables)			
	They can calculate continuous and discontinuous	us processes		
	 The students are able to prove their theoretical 	knowledge in the experimental lab wor	k.	
	 The students are able to discuss the theoretical 	÷ ,		with the teacher
	colloquium.			
	conoquium.			
	The students are capable of linking their gained know	edge with the content of other lectures	and use it togeth	ner for the solutio
	technical problems. Other lectures such as thermodyr	amics, fluid mechanics and chemical er	igineering.	
Personal Competence				
Social Competence				
	 The students can work technical assignments in 	n small groups and present the combine	d results in the t	utorial
	 The students are able to carry out practical la 	b work in small groups and organize a	functional divisi	on of labor betw
	them. They are able to discuss their results and	to document them scientifically in a re	port.	
Autonomy	The students are capable to obtain the needed	information from suitable sources by th	omsolves and as	soss thoir quality
	• The students can proof the state of their kn	bwiedge with exam resembling assign	ments and in tr	iis way control t
	learning process			
Warkland in Une	Independent Study Time 06 Study Time in Lesting 04			
Workload in Hours Credit points	Independent Study Time 96, Study Time in Lecture 84	·		
Course achievement				
Examination				
Examination duration and	120 minutes; theoretical questions and calculations			
scale				
Assignment for the	General Engineering Science (German program, 7 sen	nester): Specialisation Green Technologi	es, Focus Renew	able Energy: Elec
Following Curricula	Compulsory			
<u> </u>	General Engineering Science (German program, 7 sen	nester): Specialisation Chemical and Bio	engineerina: Con	npulsorv
	Bioprocess Engineering: Core Qualification: Compulso			,
		•		
	Chemical and Bioprocess Engineering: Core Qualificat		ning Flant's	
	Green Technologies: Energy, Water, Climate: Specialis			mpulsory
	Green Technologies: Energy, Water, Climate: Specialis	ation Biotechnologies: Elective Compuls	sory	
	Process Engineering: Core Qualification: Compulsory			

avT	Lecture
Hrs/wk	
CP	
-	Independent Study Time 32, Study Time in Lecture 28
	Prof. Irina Smirnova
Language	
Cycle	
Content	 Introduction in the thermal process engineering and to the main features of separation processes Simple equilibrium processes, several steps processes Distillation of binary mixtures, enthalpy-concentration diagrams Extractive and azeotrope distillation, water vapor distillation, stepwise distillation Extraction: separation ternary systems, ternary diagram Multiphase separation including complex mixtures Designing of separation devices without discrete stages Drying Chromatographic separation processes Membrane separation Energy demand of separation processes Advance overview of separation processes Selection of separation processes
Literature	 G. Brunner: Skriptum Thermische Verfahrenstechnik J. King: Separation Processes, McGraw-Hill, 2. Aufl. 1980 Sattler: Thermische Trennverfahren, VCH, Weinheim 1995 J.D. Seader, E.J. Henley: Separation Process Principles, Wiley, New York, 1998. Mersmann: Thermische Verfahrenstechnik, Springer, 1980 Grassmann, Widmer, Sinn: Einführung in die Thermische Verfahrenstechnik, 3. Aufl., Walter de Gruyter, Berlin 1997 Brunner, G.: Gas extraction. An introduction to fundamentals of supercritical fluids and the application to separat processes. Steinkopff, Darmstadt; Springer, New York; 1994. ISBN 3-7985-0944-1 ; ISBN 0-387-91477-3 . R. Goedecke (Hrsg.): Fluid-Verfahrenstechnik, Wiley-VCH Verlag, Weinheim, 2006. Perry"s Chemical Engineers" Handbook, R.H. Perry, D.W. Green, J.O. Maloney (Hrsg.), 6th ed., McGraw-Hill, New York

Course L0119: Thermal Sepa	ration Processes
Тур	Recitation Section (small)
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Prof. Irina Smirnova
Language	DE
Cycle	WiSe
Content	 Introduction in the thermal process engineering and to the main features of separation processes Simple equilibrium processes, several steps processes Distillation of binary mixtures, enthalpy-concentration diagrams Extractive and azeotrope distillation, water vapor distillation, stepwise distillation Extraction: separation ternary systems, ternary diagram Multiphase separation including complex mixtures Designing of separation devices without discrete stages Drying Chromatographic separation processes Membrane separation Energy demand of separation processes Advance overview of separation processes Selection of separation processes The students work on tasks in small groups and present their results in front of all students.
Literature	 G. Brunner: Skriptum Thermische Verfahrenstechnik J. King: Separation Processes, McGraw-Hill, 2. Aufl. 1980 Sattler: Thermische Trennverfahren, VCH, Weinheim 1995 J.D. Seader, E.J. Henley: Separation Process Principles, Wiley, New York, 1998. Mersmann: Thermische Verfahrenstechnik, Springer, 1980 Grassmann, Widmer, Sinn: Einführung in die Thermische Verfahrenstechnik, 3. Aufl., Walter de Gruyter, Berlin 1997 Brunner, G.: Gas extraction. An introduction to fundamentals of supercritical fluids and the application to separation processes. Steinkopff, Darmstadt; Springer, New York; 1994. ISBN 3-7985-0944-1; ISBN 0-387-91477-3. R. Goedecke (Hrsg.): Fluid-Verfahrenstechnik, Wiley-VCH Verlag, Weinheim, 2006. Perry"s Chemical Engineers" Handbook, R.H. Perry, D.W. Green, J.O. Maloney (Hrsg.), 6th ed., McGraw-Hill, New York 1984 Ullmann"s Enzyklopädie der Technischen Chemie

Course L0141: Thermal Sepa	ration Processes
Тур	Recitation Section (large)
Hrs/wk	1
CP	1
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14
Lecturer	Prof. Irina Smirnova
Language	DE
Cycle	WiSe
Content	 Introduction in the thermal process engineering and to the main features of separation processes Simple equilibrium processes, several steps processes Distillation of binary mixtures, enthalpy-concentration diagrams Extractive and azeotrope distillation, water vapor distillation, stepwise distillation Extraction: separation ternary systems, ternary diagram Multiphase separation including complex mixtures Designing of separation devices without discrete stages Drying Chromatographic separation processes Membrane separation Energy demand of separation processes Advance overview of separation processes Selection of separation processes
Literature	 G. Brunner: Skriptum Thermische Verfahrenstechnik J. King: Separation Processes, McGraw-Hill, 2. Aufl. 1980 Sattler: Thermische Trennverfahren, VCH, Weinheim 1995 J.D. Seader, E.J. Henley: Separation Process Principles, Wiley, New York, 1998. Mersmann: Thermische Verfahrenstechnik, Springer, 1980 Grassmann, Widmer, Sinn: Einführung in die Thermische Verfahrenstechnik, 3. Aufl., Walter de Gruyter, Berlin 1997 Brunner, G.: Gas extraction. An introduction to fundamentals of supercritical fluids and the application to separation processes. Steinkopff, Darmstadt; Springer, New York; 1994. ISBN 3-7985-0944-1; ISBN 0-387-91477-3. R. Goedecke (Hrsg.): Fluid-Verfahrenstechnik, Wiley-VCH Verlag, Weinheim, 2006. Perry"s Chemical Engineers" Handbook, R.H. Perry, D.W. Green, J.O. Maloney (Hrsg.), 6th ed., McGraw-Hill, New York 1984 Ullmann"s Enzyklopädie der Technischen Chemie

L1159: Separation Pr	Practical Course
Hrs/wk	
CP	
	Independent Study Time 16, Study Time in Lecture 14
	Prof. Irina Smirnova
Language	
Cycle Content	Wise The students work on eight different experiments in this practical course. For every one of the eight experiments, a colloquiu takes place in which the students explain and discuss the theoretical background and its translation into practice with staff ar fellow students.
	The students work small groups with a high degree of division of labor. For every experiment, the students write a report. The receive instructions in terms of scientific writing as well as feedback on their own reports and level of scientific writing so they ca increase their capabilities in this area.
	Topics of the practical course:
	 Introduction in the thermal process engineering and to the main features of separation processes Simple equilibrium processes, several steps processes Distillation of binary mixtures, enthalpy-concentration diagrams Extractive and azeotrope distillation, water vapor distillation, stepwise distillation Extraction: separation ternary systems, ternary diagram Multiphase separation including complex mixtures Designing of separation devices without discrete stages Drying Chromatographic separation processes Membrane separation processes Advance overview of separation processes Selection of separation processes
Literature	 G. Brunner: Skriptum Thermische Verfahrenstechnik J. King: Separation Processes, McGraw-Hill, 2. Aufl. 1980 Sattler: Thermische Trennverfahren, VCH, Weinheim 1995 J.D. Seader, E.J. Henley: Separation Process Principles, Wiley, New York, 1998. Mersmann: Thermische Verfahrenstechnik, Springer, 1980 Grassmann, Widmer, Sinn: Einführung in die Thermische Verfahrenstechnik, 3. Aufl., Walter de Gruyter, Berlin 1997 Brunner, G.: Gas extraction. An introduction to fundamentals of supercritical fluids and the application to separatic processes. Steinkopff, Darmstadt; Springer, New York; 1994. ISBN 3-7985-0944-1; ISBN 0-387-91477-3. R. Goedecke (Hrsg.): Fluid-Verfahrenstechnik, Wiley-VCH Verlag, Weinheim, 2006. Perry"s Chemical Engineers" Handbook, R.H. Perry, D.W. Green, J.O. Maloney (Hrsg.), 6th ed., McGraw-Hill, New York 198 Ullmann"s Enzyklopädie der Technischen Chemie

Courses				
Title		Тур	Hrs/wk	СР
System Integration Renewable Ene	rgies I (L2767)	Lecture	2	2
System Integration Renewable Energies I (L2768)		Recitation Section (small)	1	1
System Integration Renewable Energies II (L2769)		Lecture	2	2
System Integration Renewable Ene		Recitation Section (small)	1	1
	Prof. Martin Kaltschmitt			
Admission Requirements				
	Fundamentals of renewable energies and th	e energy system		
Knowledge				
Educational Objectives	After taking part successfully, students have	After taking part successfully, students have reached the following learning results		
Professional Competence				
Skills	fields of renewable energies. Current problems concerning the integration of renewable energies in the energy system presented and analyzed. In particular, the sectors electricity, heat and mobility will be addressed, giving students insights sector coupling activities. By completing this module, students can apply the basics learned to various sector coupling problems and, in this context, as			
Personal Competence	the potentials as well as the limits of sector coupling in the German energy system. In particular, the students should use t application and linking of already learned methods and knowledge here, so that a vision of the different technologies is achieved			
•			energies	
boelar competence	The students will be able to discuss problems in the areas of sector coupling and the integration of renewable energies.		energiesi	
Autonomy	The students are able to acquire own sources based on the main topics of the lecture and to increase their knowledge Furthermore, the students can search further technologies and interconnection possibilities for the energy system itself.			
Workload in Hours	Independent Study Time 96, Study Time in Lecture 84			
Credit points	6			
Course achievement	None			
Examination	Written exam			
Examination duration and	120 min			
scale				
Assignment for the	General Engineering Science (German progr	ram, 7 semester): Specialisation Green Technolog	ies, Focus Renew	able Energy: Elect
Following Curricula	Compulsory			
	Green Technologies: Energy, Water, Climate			

Type Lecture Hrs/wk 2 Workload in Hours Independent Study Time 32, Study Time in Lecture 28 Workload in Hours Dr. Volker Lenz Lecture Dr. Volker Lenz Mission Interduction Scottent 1. Introduction Scottent 2. Fossil-dominated energy system Mega trends in energy transition 4. Characteristics of renewable energy provision technologies - electricity Scottent 5. Integration of renewables - electricity I 6. Integration of renewables - electricity I 7. Characteristics of renewable energy provision technologies - heat 8. Integration of renewables - heat I 9. Integration of renewables - heat I 9. Integration of renewables - heat I 10. Characteristics of renewable energy provision technologies - mobility 11. Integration of renewables - heat I 11. Integration of renewables - heat I 9. Integration of renewables - heat I 10. Characteristics of renewable energy provision technologies - mobility 11. Integration of renewables - mobility 11. Integration of renewables - mobility 12. Communications technology and control engineering
CP 2 Workload in Hours Independent Study Time 32, Study Time in Lecture 28 Lecturer Dr. Volker Lenz Language DE Cycle WiSe Content 1. Introduction 2. Fossil-dominated energy system 3. Mega trends in energy transition 4. Characteristics of renewable energy provision technologies - electricity 5. Integration of renewables - electricity I 6. Integration of renewables - electricity II 7. Characteristics of renewable energy provision technologies - heat 8. Integration of renewables - heat I 9. Integration of renewables - heat II 10. Characteristics of renewable energy provision technologies - mobility
Workload in Hours Independent Study Time 32, Study Time in Lecture 28 Lecturer Dr. Volker Lenz Language DE Cycle WiSe Content 1. Introduction 2. Fossil-dominated energy system 3. Mega trends in energy transition 4. Characteristics of renewable energy provision technologies - electricity 5. Integration of renewables - electricity I 6. Integration of renewable energy provision technologies - heat 8. Integration of renewables - electricity II 7. Characteristics of renewable energy provision technologies - heat 8. Integration of renewables - heat I 9. Integration of renewables - heat II 10. Characteristics of renewable energy provision technologies - mobility 11. Integration of renewables - mobility
Lecturer Dr. Volker Lenz Language DE Cycle WiSe Content 1. Introduction 2. Fossil-dominated energy system 3. Mega trends in energy transition 4. Characteristics of renewable energy provision technologies - electricity 5. Integration of renewables - electricity I 6. Integration of renewable energy provision technologies - heat 8. Integration of renewables - electricity II 7. Characteristics of renewable energy provision technologies - heat 8. Integration of renewables - heat I 9. Integration of renewables - heat II 10. Characteristics of renewable energy provision technologies - mobility 11. Integration of renewables - mobility
Language DE Cycle WiSe Content 1. Introduction 2. Fossil-dominated energy system 3. Mega trends in energy transition 4. Characteristics of renewable energy provision technologies - electricity 5. Integration of renewables - electricity I 6. Integration of renewables - electricity II 7. Characteristics of renewable energy provision technologies - heat 8. Integration of renewables - heat I 9. Integration of renewables - heat II 10. Characteristics of renewable energy provision technologies - mobility 11. Integration of renewables - mobility
Cycle WiSe Content 1. Introduction 2. Fossil-dominated energy system 3. Mega trends in energy transition 3. Mega trends in energy transition 4. Characteristics of renewable energy provision technologies - electricity 5. Integration of renewables - electricity I 6. Integration of renewables - electricity II 7. Characteristics of renewable energy provision technologies - heat 8. Integration of renewables - heat I 9. Integration of renewables - heat II 10. Characteristics of renewable energy provision technologies - mobility 11. Integration of renewables - mobility
Content 1. Introduction 2. Fossil-dominated energy system 3. Mega trends in energy transition 4. Characteristics of renewable energy provision technologies - electricity 5. Integration of renewables - electricity I 6. Integration of renewables - electricity II 7. Characteristics of renewable energy provision technologies - heat 8. Integration of renewables - heat I 9. Integration of renewables - heat II 10. Characteristics of renewable energy provision technologies - mobility 11. Integration of renewables - heat II
 Reduction in consumption Load management

Course L2768: System Integr	ration Renewable Energies I
Тур	Recitation Section (small)
Hrs/wk	1
CP	1
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14
Lecturer	Dr. Volker Lenz
Language	DE
Cycle	WiSe
Content	See interlocking course
Literature	See interlocking course

Тур	Lecture
Hrs/wk	2
CP	2
Norkload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Dr. Volker Lenz
Language	DE
Cycle	SoSe
Content	 Introduction Power-to-Hydrogen Power-to-Gas Power-to-Liquid Power-to-Heat Hybrid Technologies Combined Technology Concepts I Combined Technology Concepts II Link-up with renewable industrial production Utilization of residual materials from renewable energy provision Biomass as system stabilizer I Biomass as system stabilizer II System modelling - fundamentals System modelling - approaches and results Planning tools
Literature	 D. Thrän (editor): Smart Bioenergy. Technologies and concepts for a more flexible bioenergy provision in future energy systems. Springer, Cham, Heielberg, New York, Dordrecht, London, 2015 R. von Miller (Hrsg.): Lexikon der Energietechnik und Kraftmaschinen Band 6 und 7. Deutsche Verlags-Anstalt Stuttgart 1965 K. Naumann et. al.: Monitoring Biokraftstoffsektor. 3. Auflage, DBFZ Report Nr. 1, Leipzig, 2016 M. Kaltschmitt, W. Streicher, A. Wiese (Hrsg.): Erneuerbare Energien. Systemtechnik, Wirtschaftlichkeit, Umweltaspekte. 4 Auflage, Springer Berlin Heidelberg, 2006 Bundesministerium für Wirtschaft und Energie: Die Energie der Zukunft.

Тур	Recitation Section (small)
Hrs/wk	
CP	
	Independent Study Time 16, Study Time in Lecture 14
	Dr. Volker Lenz
Language	
Cycle	SoSe
Content	
	1. Introduction
	2. Power-to-Hydrogen
	3. Power-to-Gas
	4. Power-to-Liquid
	5. Power-to-Heat
	6. Hybrid Technologies
	7. Combined Technology Concepts I
	8. Combined Technology Concepts II
	9. Link-up with renewable industrial production
	10. Utilization of residual materials from renewable energy provision
	11. Biomass as system stabilizer I
	12. Biomass as system stabilizer II
	13. System modelling - fundamentals
	14. System modelling - approaches and results
	15. Planning tools
Literature	
	 D. Thrän (editor): Smart Bioenergy. Technologies and concepts for a more flexible bioenergy provision in future energy systems. Springer, Cham, Heielberg, New York, Dordrecht, London, 2015
	 R. von Miller (Hrsg.): Lexikon der Energietechnik und Kraftmaschinen Band 6 und 7. Deutsche Verlags-Anstalt Stuttg 1965
	• K. Naumann et. al.: Monitoring Biokraftstoffsektor. 3. Auflage, DBFZ Report Nr. 1, Leipzig, 2016
	 M. Kaltschmitt, W. Streicher, A. Wiese (Hrsg.): Erneuerbare Energien. Systemtechnik, Wirtschaftlichkeit, Umweltaspekte. Auflage, Springer Berlin Heidelberg, 2006
	Bundesministerium für Wirtschaft und Energie: Die Energie der Zukunft.

-				
Courses				
Title		Тур	Hrs/wk	СР
	tion to Electrical Power Systems (L1670)	Lecture	3 2	4
	tion to Electrical Power Systems (L1671)	Recitation Section (small)	2	2
Module Responsible				
Admission Requirements	None			
	Fundamentals of Electrical Engineering			
Knowledge				
	After taking part successfully, students have reach	ed the following learning results		
Professional Competence				
Knowledge	Students are able to give an overview of convention			
	evaluate technologies of electric power generation	n, transmission, storage, and distribution as	well as integrati	on of equipment int
	electric power systems.			
Skills	With completion of this module the students ar	e able to apply the acquired skills in ap	olications of the	design, integration
	development of electric power systems and to ass			
Personal Competence				
Social Competence	The students can participate in specialized and int	erdisciplinary discussions, advance ideas a	nd represent the	r own work results i
	front of others.			
Autonomy	Students can independently tap knowledge of the	emphasis of the lectures.		
Workload in Hours	Independent Study Time 110, Study Time in Lectu	re 70		
Credit points	6			
Course achievement				
Examination	Written exam			
Examination duration and	90 - 150 minutes			
scale				
Assignment for the	General Engineering Science (German program, 7	semester): Specialisation Electrical Enginee	ring: Elective Co	mpulsory
Following Curricula	General Engineering Science (German program, 7		-	
5	Compulsory			55
	Data Science: Core Qualification: Elective Compuls	ory		
	Electrical Engineering: Core Qualification: Elective			
	Energy Systems: Specialisation Energy Systems: E			
	Engineering Science: Specialisation Electrical Engin	neering: Elective Compulsory		
	Green Technologies: Energy, Water, Climate: Spec		rgies: Elective Co	mpulsory
	Computer Science in Engineering: Specialisation II.	. Mathematics & Engineering Science: Elect	ive Compulsory	
	Integrated Building Technology: Core Qualification	: Compulsory		
	Mechatronics: Specialisation Electrical Systems: El	ective Compulsory		
	Renewable Energies: Core Qualification: Compulso	ry		
	Theoretical Mechanical Engineering: Specialisation	Energy Systems: Elective Compulsory		

Тур	Lecture
Hrs/wk	3
CP	4
Workload in Hours	Independent Study Time 78, Study Time in Lecture 42
Lecturer	Prof. Christian Becker
Language	DE
Cycle	WiSe
Content	
	fundamentals and current development trends in electric power engineering
	tasks and history of electric power systems
	symmetric three-phase systems
	 fundamentals and modelling of eletric power systems
	• lines
	• transformers
	 synchronous machines
	 induction machines
	loads and compensation
	 grid structures and substations
	fundamentals of energy conversion
	 electro-mechanical energy conversion
	• thermodynamics
	 power station technology
	 renewable energy conversion systems
	steady-state network calculation
	network modelling
	 load flow calculation
	• (n-1)-criterion
	 symmetric failure calculations, short-circuit power
	control in networks and power stations
	grid protection
	grid planning
	power economy fundamentals
	• power economy fundamentals
Literature	K. Heuck, KD. Dettmann, D. Schulz: "Elektrische Energieversorgung", Vieweg + Teubner, 9. Auflage, 2013
	A. J. Schwab: "Elektroenergiesysteme", Springer, 5. Auflage, 2017
	R. Flosdorff: "Elektrische Energieverteilung" Vieweg + Teubner, 9. Auflage, 2008

Тур	Recitation Section (small)
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Prof. Christian Becker
Language	DE
Cycle	WiSe
Content	 fundamentals and current development trends in electric power engineering
	tasks and history of electric power systems
	symmetric three-phase systems
	 fundamentals and modelling of eletric power systems
	• lines
	• transformers
	 synchronous machines
	 induction machines
	 loads and compensation
	 grid structures and substations
	fundamentals of energy conversion
	 electro-mechanical energy conversion
	 thermodynamics
	 power station technology
	 renewable energy conversion systems
	steady-state network calculation
	network modelling
	 load flow calculation
	• (n-1)-criterion
	 symmetric failure calculations, short-circuit power
	control in networks and power stations
	grid protection
	grid planning
	power economy fundamentals
Literature	K. Heuck, KD. Dettmann, D. Schulz: "Elektrische Energieversorgung", Vieweg + Teubner, 9. Auflage, 2013
	A. J. Schwab: "Elektroenergiesysteme", Springer, 5. Auflage, 2017
	R. Flosdorff: "Elektrische Energieverteilung" Vieweg + Teubner, 9. Auflage, 2008

C				
Courses				
Title		Тур	Hrs/wk	СР
	rogramming Concepts, Data Handling & Communication (L26 rogramming Concepts, Data Handling & Communication (L26		3 2	3 3
		(Sinal)	Z	3
Module Responsible				
Admission Requirements	None			
Recommended Previous				
Knowledge				
	After taking part successfully, students have reached th	e following learning results		
Professional Competence				
Knowledge				
Skills				
Personal Competence				
Social Competence				
Autonomy				
Workload in Hours	Independent Study Time 110, Study Time in Lecture 70			
Credit points	6			
		iption		
Course achievement		ate finden semesterbegleitend stat	t.	
Examination				
Examination duration and				
scale	120 (1)(1)			
Assignment for the	General Engineering Science (German program, 7	omostor): Specialization Mechan	ical Engineering Ec	cus Biomochani
Following Curricula		emester). Specialisation Mechan	iicai Liigineening, ro	cus biomechani
I blowing curricula	General Engineering Science (German program, 7 seme	ster): Specialisation Biomedical En	aineerina: Compulsor	- 1
	General Engineering Science (German program, 7 seme			
	Compulsory	stery. specialisation creen recimo	logies, i ocus nenewa	bie Energy. Elect
	General Engineering Science (German program, 7 se	mester): Specialisation Mechanic	al Engineering Focu	s Energy System
	Compulsory	mester). Specialisation mechanic	ar Engineering, rocu	s Energy System
	General Engineering Science (German program, 7 se	mester): Specialisation Mechanic	al Engineering Focu	is Aircraft System
	Engineering: Compulsory	mester). Specialisation meename	ur Engliteering, roee	is Allerate System
	General Engineering Science (German program, 7	semester): Specialisation Mechar	nical Engineering. Fo	ocus Mechatroni
	Compulsory		, j, j, j,	
	General Engineering Science (German program, 7 sem	ester): Specialisation Mechanical E	naineerina. Focus Pr	oduct Developme
	and Production: Elective Compulsory		5 5.	
	General Engineering Science (German program, 7 seme	ster): Specialisation Mechanical Er	ngineering, Focus The	oretical Mechani
	Engineering: Elective Compulsory		5 5.	
	General Engineering Science (German program, 7 seme	ster): Specialisation Electrical Engi	neering: Elective Con	npulsory
	Bioprocess Engineering: Core Qualification: Compulsory			
	Chemical and Bioprocess Engineering: Core Qualificatio	1: Compulsory		
	Electrical Engineering: Core Qualification: Compulsory			
	Green Technologies: Energy, Water, Climate: Specialisa	ion Energy Systems / Renewable E	Energies: Elective Cor	npulsory
	Logistics and Mobility: Specialisation Information Techn	ology: Compulsory		
	Mechatronics: Specialisation Robot- and Machine-System	ns: Compulsory		
	Mechatronics: Specialisation Medical Engineering: Comp	ulsory		
	Mechatronics: Specialisation Dynamic Systems and AI: 0	Compulsory		
	Mechatronics: Specialisation Electrical Systems: Elective	Compulsory		
	Process Engineering: Core Qualification: Compulsory			

Course L2689: Computer Sci	ence for Engineers - Programming Concepts, Data Handling & Communication
Тур	Lecture
Hrs/wk	3
CP	3
Workload in Hours	Independent Study Time 48, Study Time in Lecture 42
Lecturer	Prof. Sibylle Fröschle
Language	DE
Cycle	SoSe
Content	
Literature	John V. Guttag: Introduction to Computation and Programming Using Python.
	With Application to Understanding Data. 2nd Edition. The MIT Press, 2016.

Course L2690: Computer Sci	ence for Engineers - Programming Concepts, Data Handling & Communication
Тур	Recitation Section (small)
Hrs/wk	2
CP	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Prof. Sibylle Fröschle
Language	DE
Cycle	SoSe
Content	See interlocking course
Literature	See interlocking course

Courses				
Fitle		Тур	Hrs/wk	СР
Basics of climate change and its ef	iects (1 2749)	Lecture	2	2
Technical measures to mitigate gre		Lecture	2	2
Fechnical measures to mitigate gre		Recitation Section (small)	2	2
Module Responsible	Prof. Alexander Penn			
Admission Requirements				
Recommended Previous	none			
Knowledge				
Educational Objectives	After taking part successfully, students have	e reached the following learning results		
Professional Competence				
Knowledge	Upon completion of the module, students w	ill be able to use and apply the previously learne	d technical basics	s of the various fi
5		nical climate protection in an interdisciplinary ma		
		ne mitigation of climate change and the impact		
	described and discussed.			
	described and discussed.			
Skills	Upon completion of this module, students will be able to apply the fundamentals they have learned to various cross-secto			
	problems and, in this context, assess and	I evaluate the potentials but also the limitation	ns of technical se	olutions for redu
		act on climate change. In particular, the applic		
		by the students here, so that a broad view of the	-	
		.,		5 5
Personal Competence				
Social Competence	Students will be able to discuss problems in	the topic areas of reducing impacts and changin	g the climate with	n each other.
A	Chudanta will be able to independently any		ha la shuna ƙasura	and the analytic of a
Autonomy		ess sources and acquire knowledge based on t		-
	Furthermore, students will be able to resear	ch further climate change mitigation technologie	s and climate con	iditions on their o
Workload in Hours	Independent Study Time 96, Study Time in I	Lecture 84		
Credit points	6			
Course achievement	None			
Examination	Written exam			
Examination duration and	120 min			
scale				
Assignment for the	General Engineering Science (German prog	ram, 7 semester): Specialisation Green Technolog	jies, Focus Renew	able Energy: Elec
Following Curricula	Compulsory			

	ate change and its effects
31	
Hrs/wk	
CP	
	Independent Study Time 32, Study Time in Lecture 28
	Prof. Dr. Jana Sillmann
Language	
Cycle	SoSe Course Content:
	This course provides a comprehensive introduction to the fundamentals of human-induced climate change. Important concept such as the Earth's radiation budget, the greenhouse effect, and the various Earth system components (e.g., atmosphere hydrosphere, cryosphere, biosphere) related to climate change are explained. Fundamentals of climate modeling and climate scenarios are explained. Findings from the Intergovernmental Panel on Climate Change's Assessment Reports are provided ir relation to observed and model-based physical climate changes and their impacts on various Earth system components Furthermore, the impacts of global and regional climate change on society (e.g. agriculture, infrastructure, energy) will be highlighted and especially the changes and impacts of weather and climate extremes will be discussed. In the last part of th lecture, current global and national climate change targets will be explained and discussed in the context of possible scenarios options and challenges to reduce global warming. Concepts such as "net-zero" emissions and negative emissions will be addresse with important implications for the development of new technologies. Learning Objective: Basic knowledge of human-induced climate change, and how to model climate change, and its impacts on different sectors of the environment and society, and the options and consequences for different sectors to achieve the targeted climate goals (reduction of global warming). Structure:
	Introduction Climate Change/Climate Change Reports.
	The climate system
	Observed climate change
	Climate variability
	Climate models
I	

	Ser General Engineering Science (German program, 7 Seriester)
	Climate scenarios
	Physical climate changes under different scenarios
	Impacts of climate change on different regions and sectors
	Weather and climate extremes
	Climate risk and adaptation
	Scenarios, options and challenges to reduce global warming
	Climate Engineering
	Sustainability and climate change
	Climate quiz and discussion
	Course Content:
	This course provides a comprehensive introduction to the fundamentals of human-induced climate change. Important concepts such as the Earth's radiation budget, the greenhouse effect, and the various Earth system components (e.g., atmosphere hydrosphere, cryosphere, biosphere) related to climate change are explained. Fundamentals of climate modeling and climate scenarios are explained. Findings from the Intergovernmental Panel on Climate Change's Assessment Reports are provided in relation to observed and model-based physical climate change on society (e.g. agriculture, infrastructure, energy) will be highlighted and especially the changes and impacts of weather and climate extremes will be discussed. In the last part of the lecture, current global and national climate change targets will be explained and discussed in the context of possible scenarios options and challenges to reduce global warming. Concepts such as "net-zero" emissions and negative emissions will be addressed with important implications for the development of new technologies.
	Learning Objective:
	Basic knowledge of human-induced climate change, and how to model climate change, and its impacts on different sectors of the environment and society, and the options and consequences for different sectors to achieve the targeted climate goals (reduction of global warming).
	Structure:
	Introduction Climate Change/Climate Change Reports.
	The climate system
	Observed climate change
	Climate variability
	Climate models
	Climate scenarios
	Physical climate changes under different scenarios
	Impacts of climate change on different regions and sectors
	Weather and climate extremes
	Climate risk and adaptation
	Scenarios, options and challenges to reduce global warming
	Climate Engineering
	Sustainability and climate change
	Climate quiz and discussion
Literatur	e Vorlesungsunterlagen

Course L2747: Technical mea	sures to mitigate greenhouse gas emissions
Тур	Lecture
Hrs/wk	2
СР	2
	Independent Study Time 32, Study Time in Lecture 28
	Prof. Alexander Penn
Language	
Cycle Content	Lecturers: MK, Dr. Ben Norden (GFZ), Dr. Conny Schmidt-Hattenberger (GFZ)
	Lecture Content:
	The goal of this lecture is to address and present technical measures to mitigate climate change. This primarily includes the immediate means by which climate gas emissions can be reduced when they have already occurred. Specifically, the lecture includes the following content:
	- Overview of the main greenhouse gases emitted, including their global warming potential and the average lifetime of the molecules in the atmosphere.
	- Avoidance Methane (CH ₄) (point sources).
	o Emission sources: Methane slip, methane emission from combustion, etc.
	o Reduction methane slip (including gas extraction, biogas plants, waste management).
	o Reduction of methane from combustion (e.g. power plants, ship engines, car engines, CHP engines, etc.)
	o Reduction of other sources if necessary
	- Avoidance Nitrous oxide (N ₂ O) (point sources).
	o Emission sources: Combustion processes, production processes, biological nitrogen oxidation, etc.
	o Reduction of combustion processes
	o Reduction of production processes
	o Reduction of biological nitrogen oxidation o Reduction of further sources, if necessary
	- Avoidance of other greenhouse gases (including F-gases) (point sources)
	- Avoidance of carbon dioxide from fossil carbon (point sources)
	o Emission sources: Combustion processes, production processes
	o Capture technologies from exhaust gases
	- Capture carbon dioxide from diffuse sources (ambient air)
	- Temporary storage and transport of carbon dioxide
	- Final storage of carbon dioxide
	o Geological framework and storage options, infrastructure (assessment)
	o Surface installations / modes of operation / conditioning of CO $_{ m 2}$ (phase behavior) etc.
	o Thermodynamic framework and interactions
	o Tightness of the storage complex (geomechanics) and long-term behavior (modeling), saltwater displacement and upwelling?
	o Monitoring concepts (monitoring methods from geophysics, geochemistry, microbiology, applied on different spatial and temporal scales) and assessment of storage safety
	o Modeling (static, dynamic, chemical, scale-dependent - borehole, reservoir, energy system modeling).
	o Retrievability (interim storage) and after-use concepts (synthetic fuels)?, backfilling (cements, etc.).
	o Examples
Literature	Vorlesungsunterlagen

Herwise 2 Ore /2 2 Workload in Hours Independent Study Time 32, Study Time in Lecture 28 Lecture Prof. Alexander Penn Softe - Softe Content - Overview of the main greenhouse gases emitted, including their global warming potential and the average lifetime of malecules in the atmosphere. Avoidance Methane (CH4) (point sources). 0 Enission sources: Methane sile, including gas extraction, biogas plants, waste management). O Reduction of methane from combustion (e.g. power plants, ship engines, car engines, CHP engines, etc.) 0 Reduction of other sources in fracessary - Avoidance Nitrus oxide (N20) (point sources). 0 Enission sources: Combustion processes, production processes, biological nitrogen oxidation, etc. 0 Reduction of other sources if necessary - Avoidance Nitrus oxide (N20) (point sources). 0 Reduction of production processes 0 Reduction of further sources, if necessary - Avoidance of other greenhouse gases (including F.gases) (point sources) 0 Enission sources: Combustion processes. 0 Reduction of further sources, if necessary - Avoidance of cathon dioxide from diffuse sources (ambient air) - Temporary storage and transport of carbon dioxide - Final storage of carbon dioxide 0 Emission sources: Combution processes, production processes	Тур	Recitation Section (small)
Workload in Hours Independent Study Time 32, Study Time in Lecture 28 Lecture Port Aesander Penn Language DE Cycle SoSe Content Overview of the main greenhouse gases emitted, including their global warming potential and the average lifetime of molecules in the atmosphere. - Avoidance Methane (CH4) (point sources). 0 Emission sources: Methane slip, methane emission from combustion, etc. 0 Reduction of methane from combustion (e.g. power plants, ship engines, car engines, CHP engines, etc.) 0 Reduction of other sources if necessary - Avoidance Nitrous oxide (N2O) (point sources). 0 Emission sources: Combustion processes 0 Reduction of combustion processes 0 Reduction of production processes 0 Reduction of production processes 0 Reduction of ford sources, if necessary - Avoidance of ther greenhouse gases (including F-gases) (point sources) 0 Reduction of forduction processes 0 Reduction of forduction processes 0 Reduction of divide from fossil carbon (point sources) - Avoidance of achon dioxide from fossil carbon (point sources) - Avoidance of carbon dioxide from fossil carbon (point sources) - Capture technologies from exhaust gases - Capture carb	Hrs/wk	2
Lecture Prof. Alexander Penn Language DE Overles Overview of the main greenhouse gases emitted, including their global warming potential and the average lifetime of molecules in the atmosphere. - Avoidance Methane (CH4) (point sources). • Emission sources: Methane slip, methane emission from combustion, etc. • Reduction methane slip (including gas extraction, biogas plants, waste management). • Reduction of methane from combustion (e.g. power plants, ship engines, car engines, CHP engines, etc.) • Reduction of other sources if necessary • Avoidance Nitrous oxide (N2O) (point sources). • Emission sources: Combustion processes • Reduction of combustion processes • Reduction of orobustion processes • Reduction of biological nitrogen oxidation • Reduction of further sources, if necessary • Avoidance of other greenhouse gases (including F-gases) (point sources) • Avoidance of carbon dioxide from fossil carbon (point sources) • Avoidance of carbon dioxide from fossil carbon (point sources) • Emission sources: Combustion processes • Capture technologies from exhaust gases • Capture technologies from exhaust gases • Capture technologies from exhaust gases • Capture carbon dioxide from dioxide • Final storage of carbon dioxide • Final storage of carbon dioxide • Geneogical frannework and storage operation	СР	2
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o Retrievability (interim storage) and after-use concepts (synthetic fuels)?, backfilling (cements, etc.).		
		o Modeling (static, dynamic, chemical, scale-dependent - borehole, reservoir, energy system modeling).
o Examples		o Retrievability (interim storage) and after-use concepts (synthetic fuels)?, backfilling (cements, etc.).
		o Examples

Courses				
		Tura	Line (mile	CD
Title Phase Equilibria Thermodynamics (0114)	Typ Lecture	Hrs/wk	CP 2
Phase Equilibria Thermodynamics (Phase Equilibria Thermodynamics (Recitation Section (small)	1	2
Phase Equilibria Thermodynamics (Recitation Section (Iarge)	1	2
Module Responsible			_	_
Admission Requirements	None			
		adverse and the set of the		
Kecommended Previous Knowledge	Mathematics, Physical Chemistry, Thermo	Daynamics I and II		
Knowledge				
Educational Objectives	After taking part successfully, students ha	ave reached the following learning results		
Professional Competence				
Knowledge	equilibria.They learn how state variables and these properties.Moreover, the students learn how different phases (vapor, liquid, soli	hermodynamics, the students learn the mathemat e influenced by the mixing of compounds and lea phase equilibria can be described mathematically d) coexist in equilibrium. Furthermore the fundame veral examples relevant for different kinds of pro eting the equilibria are taught.	m concepts to qu v and which pher ntals of reaction e	uantitatively descr nomena may occu equilibria are taug
Skills	 state and know how to simplify the The students know models which are able to solve the resulting math For specific applications, they are model parameters in literature sou Beside pure compound properties The students know how to visualize 	can be used to determine the properties of the systematical relations. able to self-reliantly find necessary physico-chemic rces. the students are capable of describing the propertie e phase equilibria graphically and they know how to students are able to understand fundamental co	tem in the equili al properties of c s of mixtures. interpret the occ	brium state and the ompounds as well curring phenomena
Personal Competence Social Competence	The students are able to work in small g	roups, to solve the corresponding problems and to	present them or	raly to the tutors a
	The students are able to work in small groups, to solve the corresponding problems and to present them oraly to the tutors a other students			
Autonomy		ssary information self-reliantly in literature sources is are able to check their learning progress cont their learning process.		
Workload in Hours	Independent Study Time 124, Study Time	e in Lecture 56		
Credit points	6			
Course achievement	None			
Examination	Written exam			
	120 minutes; theoretical questions and ca	alculations		
scale		-		
	General Engineering Science (German pro	ogram, 7 semester): Specialisation Green Technolog	lies Focus Repen	able Energy: Elec
Following Curricula	Compulsory		,.es, i ocus nellew	casic Energy. Elec
. Showing curriculd		ogram, 7 semester): Specialisation Chemical and Bi	pengineering: Cor	mpulsory
	Bioprocess Engineering: Core Qualificatio		gcer.nig. coi	
	Chemical and Bioprocess Engineering: Co			
		ate: Specialisation Biotechnologies: Elective Compu	lsory	
	Green Technologies: Energy Water Clim	ate: Specialisation Energy Systems / Renewable Ene	raies: Flective C	ompulsory

Course L0114: Phase Equilibria Thermodynamics				
Тур	Lecture			
Hrs/wk	2			
CP	2			
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28			
Lecturer	Prof. Irina Smirnova			
Language	DE			
Cycle	SoSe			
Content				
	 Introduction: Applications of thermodynamics of mixtures Thermodynamic equations in multi-component systems: Fundamental equations, chemical potential, fugacity Phase equilibria of pure substances: thermodynamic equilibrium, vapor pressure, Gibbs' phase rule Equations of state: virial equations, van-der-Waals equation, generalized equations of state Mixing properties: ideal and real mixtures, excess properties, partial molar properties Vapor-liquid-equilibria: binary systems, azeotropes, equilibrium condition Gas-liquid-equilibria: equilibrium condition, Henry-coefficient G^E-Models: Hildebrand-model, Flory-Huggins-model, Wilson-model, UNIQUAC, UNIFAC Liquid-liquid-equilibria: equilibrium condition, phase equilibria in binary and ternary systems Solid-liquid-equilibria: equilibrium condition, binary systems Chemical reactions: reaction coordinate, mass action law, influence of pressure and temperature Osmotic pressure 			
Literature	 Jürgen Gmehling, Bärbel Kolbe: Thermodynamik. VCH 1992 J.M. Prausnitz, R.N. Lichtenthaler, E.G. de Azevedo: Molecular Thermodynamics of Fluid-Phase Equilibria, 3rd ed. Prentice Hall, 1999. J.W. Tester, M. Modell: Thermodynamics and its Applications. 3 rd ed. Prentice Hall, 1997, J.P. O'Connell, J.M. Haile: Thermodynamics. Cambridge University Press, 2005. 			

Course L0140: Phase Equilibria Thermodynamics			
Тур	Recitation Section (small)		
Hrs/wk	1		
CP	2		
Workload in Hours	Independent Study Time 46, Study Time in Lecture 14		
Lecturer	Prof. Irina Smirnova		
Language	DE		
Cycle	SoSe		
Content	 Introduction: Applications of thermodynamics of mixtures Thermodynamic equations in multi-component systems: Fundamental equations, chemical potential, fugacity Phase equilibria of pure substances: thermodynamic equilibrium, vapor pressure, Gibbs' phase rule Equations of state: virial equations, van-der-Waals equation, generalized equations of state Mixing properties: ideal and real mixtures, excess properties, partial molar properties Vapor-liquid-equilibria: binary systems, azeotropes, equilibrium condition Gas-liquid-equilibria: equilibrium condition, Henry-coefficient G^E-Models: Hildebrand-model, Flory-Huggins-model, Wilson-model, UNIQUAC, UNIFAC Liquid-liquid-equilibria: equilibrium condition, phase equilibria in binary and ternary systems Solid-liquid-equilibria: reaction coordinate, mass action law, influence of pressure and temperature Osmotic pressure The students work on tasks in small groups and present their results in front of all students. 		
Literature	 Jürgen Gmehling, Bärbel Kolbe: Thermodynamik. VCH 1992 J.M. Prausnitz, R.N. Lichtenthaler, E.G. de Azevedo: Molecular Thermodynamics of Fluid-Phase Equilibria, 3rd ed. Prentice Hall, 1999. J.W. Tester, M. Modell: Thermodynamics and its Applications. 3rd ed. Prentice Hall, 1997.J.P. O'Connell, J.M. Haile: Thermodynamics. Cambridge University Press, 2005. 		

Course L0142: Phase Equilibri	Course L0142: Phase Equilibria Thermodynamics			
Тур	Recitation Section (large)			
Hrs/wk	1			
CP	2			
Workload in Hours	Independent Study Time 46, Study Time in Lecture 14			
Lecturer	Prof. Irina Smirnova			
Language	DE			
Cycle	SoSe			
Content	 Introduction: Applications of thermodynamics of mixtures Thermodynamic equations in multi-component systems: Fundamental equations, chemical potential, fugacity Phase equilibria of pure substances: thermodynamic equilibrium, vapor pressure, Gibbs' phase rule Equations of state: virial equations, van-der-Waals equation, generalized equations of state Mixing properties: ideal and real mixtures, excess properties, partial molar properties Vapor-liquid-equilibria: binary systems, azeotropes, equilibrium condition Gas-liquid-equilibria: equilibrium condition, Henry-coefficient G^E-Models: Hildebrand-model, Flory-Huggins-model, Wilson-model, UNIQUAC, UNIFAC Liquid-liquid-equilibria: equilibrium condition, phase equilibria in binary and ternary systems Solid-liquid-equilibria: eaction coordinate, mass action law, influence of pressure and temperature Osmotic pressure 			
Literature	 Jürgen Gmehling, Bärbel Kolbe: Thermodynamik. VCH 1992 J.M. Prausnitz, R.N. Lichtenthaler, E.G. de Azevedo: Molecular Thermodynamics of Fluid-Phase Equilibria, 3rd ed. Prentice Hall, 1999. J.W. Tester, M. Modell: Thermodynamics and its Applications. 3rd ed. Prentice Hall, 1997.J.P. O'Connell, J.M. Haile: Thermodynamics. Cambridge University Press, 2005. 			

Focus Water and Environmental Engineering

Module M1627: Wate	r and Enviro	nment				
Courses						
Title				Тур	Hrs/wk	СР
Project on Water, Environment, Tra	ffic (L2462)			Project-/problem-based Learning	2	3
Water in the Environment (L2461)				Lecture	2	3
Module Responsible		st				
Admission Requirements	None					
Recommended Previous	Basic knowledge	of chemistry				
Knowledge						
Educational Objectives	After taking part	successfully, students ha	ve reached the followir	ng learning results		
Professional Competence						
Knowledge	Students can def	Students can define generic material interactions between the environmental media. The can demonstrate their knowledge about				
	natural as well	natural as well as anthropogenic materials. They are capable of explaining the natural condition of waters and other				
	environmental media.					
Skills	Students are able to research environment-specific aspects of civil engineering independent. They can present their findings					
	using accredited	using accredited academic media (e.g. posters) and can give a short summary including scientific references.				
Personal Competence						
•	Students can fulfil a complex environment-related assignment in the field of civil engineering by working in a team.					
Social competence	success can rain a complex environmenterelated assignment in the new of this engineering by working in a team.					
Autonomy						
Workload in Hours	Independent Stu	dy Time 124, Study Time	in Lecture 56			
Credit points	6					
Course achievement	Compulsory Bonus	Form	Description			
	Yes None	Presentation	Team-Projekt	arbeit mit Präsentation		
Examination	Written exam					
Examination duration and	60 min					
scale						
Assignment for the	General Enginee	ring Science (German pro	ogram, 7 semester): Sp	ecialisation Green Technologies	, Focus Water	and Environmental
Following Curricula	5 5	, ,				
		mental Engineering: Core				
	Green Technolog	ies: Energy, Water, Clima	te: Specialisation Wate	er: Elective Compulsory		

Course L2462: Project on Water, Environment, Traffic			
Тур	Project-/problem-based Learning		
Hrs/wk	2		
CP	3		
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28		
Lecturer	Dozenten des SD B		
Language	DE		
Cycle	SoSe		
Content	Lecturers of Civicl Engineering provide duties on environmentally relevant fields of civil engineering for smal student groups (max. 4 students).		
Literature	aufgabenspeziifisch / according to corresponding tasks		

Course L2461: Water in the E	ourse L2461: Water in the Environment				
Тур	Lecture				
Hrs/wk	2				
CP	3				
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28				
Lecturer	Prof. Mathias Ernst, Dozenten des SD B				
Language	DE				
Cycle	SoSe				
Content	 Basics of global/regional Water Cycle quality of water natural/anthropogenic water ingredients Basics water science water legislation (EU/D) 				
Literature	Schwoerbel, J. 2005: Einführung in die Limnologie. Heidelberg: Elsevier Grohmann, A. u. a. 2011: Wasser. Berlin: de Gruyter Kluth, W. & Schmeddinck, U. 2013: Umweltrecht: Ein Lehrbuch. Wiesbaden: Springer				

Recommended Previous Recommended Previous Knowledge A Educational Objectives A Professional Competence Competence Knowledge T Skills P Personal Competence P		reached the following learning results eearch topics relevant to water and environ level). Data analysis, curation and presen I be improved in this module. How to p	tation will be other s repare and deliver a	skills discussed in th
Accessarch Methods (L2756) Admission Requirements M Admission Requirements M Recommended Previous E Knowledge Educational Objectives A Professional Competence Knowledge Skills S Personal Competence	rof. Nima Shokri lone asic knowledge in water and environmental- after taking part successfully, students have r the students will be introduced to current res of microplastics in environment (introductory nodule. itudents' research and academics skills wil	Lecture Seminar related research reached the following learning results earch topics relevant to water and environ level). Data analysis, curation and presen I be improved in this module. How to p	1 2 ment with a particula tation will be other s repare and deliver a	2 2 ar focus on the effect skills discussed in th
Module Responsible P Admission Requirements N Admission Requirements N Recommended Previous E Knowledge N Professional Competence N Knowledge N Skills S Personal Competence P	lone lasic knowledge in water and environmental- fter taking part successfully, students have r he students will be introduced to current res f microplastics in environment (introductory nodule. itudents' research and academics skills wil	Seminar related research reached the following learning results rearch topics relevant to water and environ r level). Data analysis, curation and presen I be improved in this module. How to p	2 ment with a particula itation will be other s	2 ar focus on the effect skills discussed in th
Module Responsible P Admission Requirements N Recommended Previous E Knowledge A Professional Objectives A Nowledge N Skill/s S Personal Competence P	lone lasic knowledge in water and environmental- fter taking part successfully, students have r he students will be introduced to current res f microplastics in environment (introductory nodule. itudents' research and academics skills wil	related research reached the following learning results eearch topics relevant to water and environ r level). Data analysis, curation and presen I be improved in this module. How to p	ment with a particula tation will be other s repare and deliver a	ar focus on the effec skills discussed in th
Admission Requirements N Recommended Previous E Knowledge Knowledge Educational Objectives A Professional Competence Knowledge Knowledge T Skills S Personal Competence P	lone lasic knowledge in water and environmental- fter taking part successfully, students have r he students will be introduced to current res f microplastics in environment (introductory nodule. itudents' research and academics skills wil	reached the following learning results eearch topics relevant to water and environ level). Data analysis, curation and presen I be improved in this module. How to p	tation will be other s repare and deliver a	kills discussed in th
Recommended Previous E Knowledge A Educational Objectives A Professional Competence Knowledge Knowledge T Skills S Personal Competence P	asic knowledge in water and environmental- after taking part successfully, students have r he students will be introduced to current res f microplastics in environment (introductory nodule. tudents' research and academics skills wil	reached the following learning results eearch topics relevant to water and environ level). Data analysis, curation and presen I be improved in this module. How to p	tation will be other s repare and deliver a	kills discussed in th
Knowledge A Educational Objectives A Professional Competence Knowledge Knowledge n Skill/s S Personal Competence P	After taking part successfully, students have not introduced to current rest for microplastics in environment (introductory nodule.	reached the following learning results eearch topics relevant to water and environ level). Data analysis, curation and presen I be improved in this module. How to p	tation will be other s repare and deliver a	kills discussed in th
Educational Objectives A Professional Competence Knowledge n Skills S P Personal Competence	'he students will be introduced to current res f microplastics in environment (introductory nodule. itudents' research and academics skills wil	earch topics relevant to water and environ level). Data analysis, curation and presen I be improved in this module. How to p	tation will be other s repare and deliver a	kills discussed in th
Professional Competence Knowledge n Skills S Personal Competence	'he students will be introduced to current res f microplastics in environment (introductory nodule. itudents' research and academics skills wil	earch topics relevant to water and environ level). Data analysis, curation and presen I be improved in this module. How to p	tation will be other s repare and deliver a	kills discussed in th
Knowledge r skills Personal Competence	f microplastics in environment (introductory nodule. itudents' research and academics skills wil	level). Data analysis, curation and presen	tation will be other s repare and deliver a	kills discussed in th
o n Skills S P Personal Competence	f microplastics in environment (introductory nodule. itudents' research and academics skills wil	level). Data analysis, curation and presen	tation will be other s repare and deliver a	kills discussed in t
n <i>Skills</i> S P ersonal Competence	nodule. tudents' research and academics skills wil	l be improved in this module. How to p	repare and deliver a	
<i>Skills</i> S P Personal Competence	tudents' research and academics skills wil			an effective resear
۵ Personal Competence				an effective resear
۵ Personal Competence				
Personal Competence		- F.F F.F F		
Social Competence				
	Developing teamwork and problem solving sk	ills through Research-Based Teaching appr	oaches will be at the	core of this module
<i>Autonomv</i> T	The students will be involved in writing individual project reports and giving research presentation. This will contribute to the			
	students' ability and willingness to work independently and responsibly.			
Workload in Hours	ndependent Study Time 110, Study Time in L	lecture 70		
Credit points 6				
Course achievement	lone			
Examination S	ubject theoretical and practical work			
Examination duration and R	eport and Presentation			
scale				
Assignment for the	General Engineering Science (German progra	m, 7 semester): Specialisation Green Tech	nologies, Focus Wate	er and Environment
Following Curricula	ngineering: Elective Compulsory			
C	Civil- and Environmental Engineering: Special	isation Water and Environment: Elective Co	ompulsory	
G	Green Technologies: Energy, Water, Climate:	Specialisation Water Technologies: Elective	e Compulsory	
Course L2755: Introduction to	Microplastics in Environment			
	ntegrated Lecture			
Hrs/wk 2				
CP 2				
Workload in Hours	ndependent Study Time 32, Study Time in Le	cture 28		
Lecturer P	rof. Nima Shokri			
Language E	N			
Cycle V	Viso			

Lecturer	Prof. Nima Shokri			
Language	EN			
Cycle	WiSe			
Content	Introduction - course objectives, expectations and format;			
	Source of microplastics in environment;			
	Microplastics sampling; Characterization of microplastics;			
	Fate and distribution of microplastics in terrestrial environments;			
	cts of microplastics on terrestrial environments;			
	Health risks of microplastics in environments			
Literature	1- Characterization and Analysis of Microplastics, Volume 75 1st Edition			
	Series Volume Editors: Teresa Rocha-Santos Armando Duarte			
	Elsevier, published in 2017			
	2- Microplastic Pollutants 1st Edition			
	Authors: Christopher Blair Crawford, Brian Quinn			
	Elsevier Science, published in 2016			
	3- Microplastics in Terrestrial Environments			
	Authors: Defu He and Yongming Luo			
	Springer, published in 2020, DOI https://doi.org/10.1007/978-3-030-56271-7			

Course L2756: Research Met	Course L2756: Research Methods				
Тур	Lecture				
Hrs/wk	1				
CP	2				
Workload in Hours	Independent Study Time 46, Study Time in Lecture 14				
Lecturer	Prof. Nima Shokri				
Language	EN				
Cycle	WiSe				
Content	Introduction - course objectives, expectations and format				
	Analyzing the Audience, purpose and occasion				
	Constructing and delivering effective technical presentations				
	How to write an abstract				
	How to create a scientific poster				
	How to write a scientific paper				
	Individual project on water and environmental research				
	Presentation on water and environmental research				
Literature	The Craft of Scientific Writing Fourth edition				
	Author: Michael Alley				
	Springer-Verlag New York, Copyright 2018, DOI 10.1007/978-1-4419-8288-9				
	Supplemental materials and web links which will be available to registered students.				

Course L2757: Research Tren	lds		
Тур	Seminar		
Hrs/wk	2		
СР	2		
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28		
Lecturer	Dr. Salome Shokri-Kuehni		
Language	EN CONTRACTOR OF CONTRACTOR		
Cycle	WiSe		
Content	Introduction - course objectives, expectations and format		
	Analyzing the Audience, purpose and occasion		
	Constructing and delivering effective technical presentations		
	How to write an abstract		
	How to write a scientific paper		
	Developing competitive and persuasive research proposals		
	Databases and resources available for water and environmental research		
	Individual proposal on water and environmental research		
	ndividual project on water and environmental research		
	Group projects and presentation on water and environmental research		
Literature	The Craft of Scientific Writing Fourth edition		
	Author: Michael Alley		
	Springer-Verlag New York, Copyright 2018, DOI 10.1007/978-1-4419-8288-9		
	Supplemental materials and web links which will be available to registered students.		

Courses				
		-	11 (l-	<u></u>
Title Study Work Green Technologies (L2	2766)	Typ Project Seminar	Hrs/wk 2	CP 4
Scientific Work and Writing (L2765)		Seminar	2	2
	Dozenten des Studiengangs			
Admission Requirements	None			
Recommended Previous	keine			
Knowledge				
Educational Objectives	After taking part successfully, students have rea	ched the following learning results		
Professional Competence				
Knowledge	The students, based on a literature survey, learn deliver afterwards a summary presentation to a preferred, when selecting the thematic area of the overview over the subject and practice technic specialised subject matter.	specialised audience. Environmental iss nese studies. Through their own written	ues and their multidisc contribution the stude	ciplinary linkages a ents communicate
Skills	The students can, when working on a technical topic not familiar to them: conduct a literature survey choose the relevant information for their presentation prepare a written summary present results in front of peers and staff correctly cite and reference sources. 			
Personal Competence				
	The students practice a critical assessment of the their own technical sub-topic tailored to their pu students can formulate questions to other speak The fulfilment of the tasks combines independent	ublic and discuss with the audience. W ers and participate in the ensuing discu	nen attending technic	
Autonomy	The students can, guided by instructors, critically	reflect on their learning and work state	is, and write a scientif	ic report.
Workload in Hours	Independent Study Time 124, Study Time in Lect	cure 56		
Credit points	6			
Course achievement	None			
Examination	Study work			
Examination duration and	?			
scale				
Assignment for the	General Engineering Science (German program,	7 semester): Specialisation Green Tech	ologies, Focus Renew	able Energy: Elect
Following Curricula	Compulsory	-		
	General Engineering Science (German program, Engineering: Elective Compulsory Green Technologies: Energy, Water, Climate: Spe Green Technologies: Energy, Water, Climate: Spe Green Technologies: Energy, Water, Climate: Spe	ecialisation Energy Technology: Elective ecialisation Water Technologies: Elective	Compulsory Compulsory	
	Green Technologies: Energy, Water, Climate: Spe Green Technologies: Energy, Water, Climate: Spe			mpulsory

Course L2766: Study Work G	reen Technologies
Тур	Project Seminar
Hrs/wk	2
СР	4
Workload in Hours	Independent Study Time 92, Study Time in Lecture 28
Lecturer	Dozenten des Studiengangs
Language	DE
Cycle	WiSe
Content	Students carry out a research project in a scientific field under the guidance of an academic staff member. For this purpose, the student can approach the staff of the respective institute and discuss a topic. The topic is then worked on within 4 weeks and regular consultations are held with the supervisor. The student research project should be the size of a scientific article.
Literature	

Тур	Seminar
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
	Dozenten des Studiengangs, Dr. Detlev Bieler, Florian Hagen
Language	
Cycle	
-	The seminar offers an introduction into the diverse aspects of academic research and writing: Finding the topic, finding speci- information, knowledge organisation, writing, presenting and publishing. Suggestions for reflecting own processes of lea- informing and writing - in addition to practical recommendations and tips - facilitate the start and the creation of bachel- master theses, works, which bring thoroughly self-fulfillment and make fun.
	 Topics of the seminar will be in particular Scientific scholarship and academic research methods: Introduction, organization, attributes of science: How is scientific knowledge created? Work scheduling, finding topics, time management, specialities of academic research in engineering
	 Finding specialized information: Full texts and library resources, databases http://www.tub.tuhh.de/en/suinformation/informing-points-to-survive/ Reference management: http://www.tub.tuhh.de/en/publishing/reference-management/ Knowledge organisation and creating publications with Citavi Citing correctly and avoiding plagiarism Preparing and doing presentations
	 Semesterapparat "Wissenschaftliches Arbeiten" in der TU-Bibliothek: http://tinyurl.com/Semesterapparat-Wiss-Arbeite Weblog Wissenschaftliches Arbeiten der TU-Bibliothek: https://www.tub.tuhh.de/wissenschaftliches-arbeiten/ Online-Tutorial VISION der TU-Bibliothek zum wissenschaftlichen Arbeiten: https://www.vision.tuhh.de (funktioniert n installiertem Flash) Andreas Hirsch-Weber, Stefan Scherer: Wissenschaftliches Arbeiten und Abschlussarbeit in Natur- Ingenieurwissenschaften : Grundlagen, Praxisbeispiele, Übungen. Stuttgart: Ulmer, 2016. Werner Sesink: Einführung in das wissenschaftliche Arbeiten : inklusive E-Learning, Web-Recherche, digitale Präser u.a. 9., aktualisierte Aufl. München : Oldenbourg, 2012. Judith Theuerkauf: Schreiben im Ingenieurstudium : effektiv und effizient zur Bachelor-, Master- und Doktor Paderborn : Schöningh, 2012. Wolfsberger, Judith: Frei geschrieben : Mut, Freiheit & Strategie für wissenschaftliche Abschlussarbeiten. Wien: Böhlau Biedermann, Wieland u.a.: Forschungsmethodik in den Ingenieurwissenschaften : Skript vom Lehrst Produktentwicklung, Prof. DrIng. Udo Lindemann, Technische Universität München (TUM), https://www.mw.tum.de/fileadmin/w00btx/lpl/Documents/Forschungsmethodik_Skript.pdf Wissenschaftliches Arbeiten - HOOU Angebot der HCU Hamburg: https://blogs.hoou.de/wissarbeiten/ Course Reserves Collection "Scholarly Research Methods" in the TUHH library: http://tinyurl.com/Semesterapparal Arbeiten Scholarly research methods via TUHH library Website: https://www.tub.tuhh.de/en/scholarly-research-methods/ VISION - Online-Tutorial on research methods by the TUHH library: http://www.vision.tuhh.de (Flash has to be installed Scientific papers and presentations / Martha Davis. 3. ed. Amsterdam: Elsevier / Academic Press, http://www.sciencedirect.com/science/book/9780123847270 Writing for science and engineering : p
	 How to research / Loraine Blaxter, Christina Hughes and Malcolm Tight. Maidenhead : Open Univ. Press, 2010. Managing information for research : practical help in researching, writing and designing dissertations / Elizabeth Orn Graham Stevens. Maidenhead : Open University Press McGraw-Hill, 2009. Writing scientific research articles : strategy and steps / Margaret Cargill and Patrick O'Connor. Chichester : Wiley-Blac 2009.

Module M0869: Hydra	ulic Engineering					
····,	jj					
Courses						
Title				Тур	Hrs/wk	СР
Hydraulics (L0957)				Lecture	1	1
Hydraulics (L0958)				Project-/problem-based Learning	1	1
Hydraulic Engineering (L0959)				Lecture	2	2
Hydraulic Engineering (L0960)				Project-/problem-based Learning	1	2
Module Responsible	Prof. Peter Fröhle					
Admission Requirements	None					
Recommended Previous	Hydraulic Mechanics and	d Hydrology				
Knowledge						
Educational Objectives	After taking part succes	sfully, students have r	eached the followir	ng learning results		
Professional Competence						
Knowledge	Students are able to de	fine the basic terms of	of hydraulic engine	ering and hydraulics. They are	able to expla	in the application o
	basic hydrodynamic for	mulations (conservation	on laws) to practica	al hydraulic engineering probler	ms. Besides th	nis, the students car
	illustrate important task	s of hydraulic engine	ering and give an o	overview over river engineering	, flood protect	tion, hydraulic powe
	engineering and waterways engineering.					
Skills			-	nd approaches to basic practic		÷ .
		-	-	e and apply established approa	-	
				s, etc.) on channel flows as well	as flow condi	tions of pipe system
	Furthermore, they are a	ble to run, explain and	document basic h	ydraulic experiments.		
Personal Competence						
Social Competence	The students are able t	o deploy their gained	knowledge in appl	ied problems. Additionaly, they	will be able t	to work in team wit
, · · · · ·				manner. They can explain thei		
	approaches.	.,				p
Autopomy		e to independently ext	end their knowled	ge and apply it to new problems	Furthermore	they are canable o
, according				of experiments and to present		
Workload in Hours	Independent Study Time			or experiments and to present	alselpline spec	ine knowledge.
Credit points	1	. 110, Study Time in E				
Course achievement		orm	Description			
course acmevement		Subject theoretical	andDurchführung	, Dokumentation und Präs	sentation zu	einem Versuch
	ŗ	practical work	Hydromechar	nik oder Hydraulik		
Examination	Written exam					
Examination duration and	The duration of the exa	mination is 2.5 hours	. The examination	includes tasks with respect to	the general i	understanding of the
scale	lecture contents and cal			man respect to		on g or th
Assignment for the			m 7 semester): Sr	pecialisation Green Technologies	Focus Wate	r and Environmenta
Following Curricula	Engineering: Elective Co		in, , semester). Sp	sectandation oreen rechnologies	, i ocus vale	
Following curricula	Civil- and Environmenta		alification. Comput	conv		
				-	loon	
	Green rechnologies: En	argy, water, climate: S	specialisation Wate	er Technologies: Elective Compu	isory	

Course L0957: Hydraulics	
Тур	Lecture
Hrs/wk	1
CP	1
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14
Lecturer	Prof. Peter Fröhle
Language	DE
Cycle	WiSe/SoSe
Content	Flow of incompressible fluids in pipes and open channels
	Pumps in hydraulic systems
	Open channel flow
	Regulative construction in open channel flow
	• Weirs
	Sliding panels
	Cross-section reduction by constructions
Literature	Zanke, Ulrich C. , Hydraulik für den WasserbauUrsprünglich erschienen unter: Schröder/Zanke "Technische Hydraulik", Springer-
	Verlag, 2003
	Naudascher, E.: Hydraulik der Gerinne und Gerinnebauwerke, Springer, 1992

Course L0958: Hydraulics				
Тур	Project-/problem-based Learning			
Hrs/wk	1			
CP	1			
Workload in Hours	ndent Study Time 16, Study Time in Lecture 14			
Lecturer	Peter Fröhle			
Language	DE			
Cycle	WiSe/SoSe			
Content	See interlocking course			
Literature	See interlocking course			

Course L0959: Hydraulic Eng	ineering			
Тур	Lecture			
Hrs/wk	2			
CP	2			
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28			
Lecturer	Prof. Peter Fröhle			
Language				
Cycle	WiSe/SoSe			
Content	Fundamentals of hydraulic engineering			
	 Introduction and hydrological cycle River engineering Regime theory of natural rivers Sediment transport Regulation of rivers Bank protection / protection of river bed Tidal rivers Flood protection Dikes Flood contraol basins Hydraulic power Inland waterways engineering waterways Locks and ship lifts Fish passages Nature-oriented hydraulic engineering 			
Literature	Strobl, T. & Zunic, F: Wasserbau, Springer 2006			
	Patt, H. & Gonsowski, P: Wasserbau, Springer 2011			

Course L0960: Hydraulic Eng	ourse L0960: Hydraulic Engineering			
Тур	ect-/problem-based Learning			
Hrs/wk	1			
CP	2			
Workload in Hours	ependent Study Time 46, Study Time in Lecture 14			
Lecturer	f. Peter Fröhle			
Language	DE			
Cycle	WiSe/SoSe			
Content	See interlocking course			
Literature	See interlocking course			

C								
Courses								
Title		Тур		Hrs/wk	СР			
Nature-oriented Hydraulic Engineer Numerical modelling of soil water d	-		em-based Learning em-based Learning	2	2			
Numerical modelling of soil water d		Lecture	em-based Learning	2	2			
Module Responsible								
Admission Requirements	None							
Recommended Previous								
Knowledge	 Basic knowledge of analysis and difference 	ential equations						
	 hydromechanical and hydraulic engine 	eering principles						
Educational Objectives	After taking part successfully, students have	reached the following learning re	sults					
Professional Competence								
Knowledge	Students are able to define the basic tasks	and terms of nature-oriented hyd	Iraulic engineering	und groundwa	ater hydrology. The			
-	cam describe the basics concepts, the bas	sic approaches and methods of	nature-oriented hy	draulic engin	eering, groundwat			
	hydrology and groundwater modelling and a	re able to apply these to practical	problems.					
Skills	The students are able to apply the meth		-		-			
	hydrology to practical problems. They can demonstrate to transfer and apply these to simple hydraulic engineering system							
	addition, they are able to apply the approaches commonly used in groundwater hydrology. They can exemplarily explain an reason how to apply them as a basis for geo-hydrological questions. In addition, students can apply basic groundwater modelling							
	methods to simple problems of groundwater movement and groundwater recharge.							
Personal Competence								
Social Competence	Students are able to help each other solving case studies. The students are able to deploy their gained knowledge in applie							
	problems of the practical nature-based hydraulic engineering. Additionaly, they will be able to demonstrate to work cooperatively							
	in teams consisting of engineers from different subject areas.							
Autonomy	The students will be able to independently e	xtend their knowledge and apply	it to new problems.					
Workload in Hours	Independent Study Time 96, Study Time in L	ecture 84						
Credit points	6							
Course achievement	None							
Examination	Subject theoretical and practical work							
Examination duration and	Written-theoretical part and modeling							
scale								
Assignment for the	General Engineering Science (German progr	am, 7 semester): Specialisation	Green Technologies	, Focus Water	and Environment			
Following Curricula	Engineering: Elective Compulsory							
	Civil- and Environmental Engineering: Specia	lisation Civil Engineering: Elective	e Compulsory					
	Civil- and Environmental Engineering: Specia	lisation Traffic and Mobility: Elect	ive Compulsory					
	Civil- and Environmental Engineering: Specialisation Water and Environment: Elective Compulsory							

Course L2472: Nature-orient	Course L2472: Nature-oriented Hydraulic Engineering				
Тур	Project-/problem-based Learning				
Hrs/wk					
CP	2				
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28				
Lecturer	Prof. Peter Fröhle				
Language	DE				
Cycle	SoSe				
Content	 Regime-theory and application for the development of environmental guiding priciples of rivers Engineering-biological measures for the stabilization of rivers design techniques for water engineering hydraulic dimensioning of river bed and bank protection design principles and design techniques for fish passages (fish ladder, ramps etc.) 				
Literature					

Course L2471: Numerical mo	ourse L2471: Numerical modelling of soil water dynamics			
Тур	iect-/problem-based Learning			
Hrs/wk				
CP	2			
Workload in Hours	ependent Study Time 32, Study Time in Lecture 28			
Lecturer	nes Nevermann			
Language	EN			
Cycle	SoSe			
Content	e interlocking course			
Literature	See interlocking course			

Course L2470: Numerical mo	delling of soil water dynamics
Тур	Lecture
Hrs/wk	2
СР	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Dr. Milad Aminzadeh
Language	EN
Cycle	SoSe
Content	 Hydrologic water bilance aquifertyps groundwater velocities Darcy law groundwater contour lines storage capacity flow equation pumping tests method of Beyer solute transport in groundwater Basics and theoretical background of simulation methods for the analysis of water movement in vadose zone groundwater recharge
Literature	Todd, K. (2005): Groundwater Hydrology Fetter, C. W. (2001): Applied Hydrogeology Hölting, B. & Coldewey, W. (2005): Hydrogeologie Charbeneau, R. J. (2000): Groundwater Hydraulics and pollutant Transport

Courses						
Title			Т	ур	Hrs/wk	СР
Particle Technology I (L0434)			Le	ecture	2	3
Particle Technology I (L0435)			Re	ecitation Section (small)	1	1
Particle Technology I (L0440)			Pr	actical Course	2	2
Module Responsible	Prof. Stefan Heinrich					
Admission Requirements	None					
Recommended Previous	keine					
Knowledge						
Educational Objectives	After taking part succ	essfully, students have r	eached the following	learning results		
Professional Competence						
Knowledge	After successful comp	letion of the module stud	dents are able to			
		ain processes and unit-o				
	 characterize pa 	articles, particle distributi	ions and to discuss th	eir bulk properties		
Skills	Students are able to					
	choose and design apparatuses and processes for solids processing according to the desired solids properties of the product					
	 asses solids with respect to their behavior in solids processing steps 					
	document their work scientifically.					
Personal Competence	The shudents are abl					
Social Competence			opics orally with othe	er students or scientific p	ersonal and to d	evelop solutions t
Automore	technical-scientific iss		ne recording colid pr	uticles independently		
Autonomy	Students are able to a	analyze and solve question	ons regarding solid pa	articles independently.		
Workload in Hours	Independent Study Ti	me 110, Study Time in L	ecture 70			
Credit points	6					
Course achievement	Compulsory Bonus	Form	Description			
	Yes None	Written elaboration	sechs Berichte ((pro Versuch ein Bericht) à	5-10 Seiten	
Examination	Written exam					
Examination duration and	90 minutes					
scale						
Assignment for the	General Engineering	Science (German progra	m, 7 semester): Spec	cialisation Green Technolog	gies, Focus Wate	r and Environment
Following Curricula	Engineering: Elective					
	General Engineering S	Science (German prograr	n, 7 semester): Speci	alisation Chemical and Bio	engineering: Cor	npulsory
	Bioprocess Engineering: Core Qualification: Compulsory					
	Chemical and Bioprocess Engineering: Core Qualification: Compulsory					
	Green Technologies: Energy, Water, Climate: Specialisation Water Technologies: Elective Compulsory					
	Process Engineering:	Core Qualification: Comp	ulsory			

Course L0434: Particle Technology I			
Тур	Lecture		
Hrs/wk	2		
CP	3		
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28		
Lecturer	Prof. Stefan Heinrich		
Language	DE		
Cycle	SoSe		
Content	 Description of particles and particle distributions Description of a separation process Description of a particle mixture Particle size reduction Agglomeration, particle size enlargement Storage and flow of bulk solids Basics of fluid/particle flows classifying processes Separation of particles from fluids Basic fluid mechanics of fluidized beds Pneumatic and hydraulic transport 		
Literature	Schubert, H.; Heidenreich, E.; Liepe, F.; Neeße, T.: Mechanische Verfahrenstechnik. Deutscher Verlag für die Grundstoffindustrie, Leipzig, 1990. Stieß, M.: Mechanische Verfahrenstechnik I und II. Springer Verlag, Berlin, 1992.		

ourse L0435: Particle Technology I				
Тур	itation Section (small)			
Hrs/wk	1			
СР	1			
Workload in Hours	pendent Study Time 16, Study Time in Lecture 14			
Lecturer	Prof. Stefan Heinrich			
Language	DE			
Cycle	SoSe			
Content	See interlocking course			
Literature	See interlocking course			

ourse L0440: Particle Tech	nology I				
Тур	Practical Course				
Hrs/wk	2				
СР					
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28				
Lecturer	Prof. Stefan Heinrich				
Language	DE/EN				
Cycle	SoSe				
Content	 Sieving Bulk properties Size reduction Mixing Gas cyclone Blaine-test, filtration Sedimentation 				
Literature	Schubert, H.; Heidenreich, E.; Liepe, F.; Neeße, T.: Mechanische Verfahrenstechnik. Deutscher Verlag für die Grundstoffindustrie Leipzig, 1990. Stieß, M.: Mechanische Verfahrenstechnik I und II. Springer Verlag, Berlin, 1992.				

Module M1630: Sanit	ary Engineering II					
Courses						
Title		Тур	Hrs/wk	СР		
Management of Wastewater Infras	ructure (L2467)	Seminar	2	3		
Drinking Water Treatment (L2466)		Seminar	2	3		
Module Responsible	Prof. Mathias Ernst					
Admission Requirements	None					
Recommended Previous	Basic knowledge in the field of drinking	water supply and waste water disposal.				
Knowledge						
Educational Objectives	After taking part successfully, students	have reached the following learning results				
Professional Competence						
Knowledge	The students can examplify their expe	rt knowledge on drinking water, waste water t	reatment and the asso	ciated infrastructur		
-	systems. They are capable of reproduci	ing the relevant empiricals assumptions and sci	entific simplifcations in	detail. The student		
		cally. They can also assess existing problems ir				
		socio-political context. Furthermore, they know				
		such as high- and low-pressure membrane filtra				
Skills	The students are able to apply the rele	evant standards and guidelines for the design a	gn and operation of urban water infrastructures			
	independently. Their expertise comprises expert skills to design drinking water supply and urban drainage system					
	associated treatment facilities. Besides the acquirement of technical skills the students are able to address and					
	problems in the filed of drinking water and wastewater treatment. The students are also able to develop ideas of their ow					
	improve the existing water related infrastructures, systems and concepts.					
_						
Personal Competence						
Social Competence	The students are able to develop a specific topic in a team and to work out milestones according to a given plan.					
Autonomy	Students are in a position to work on	a subject and to organize their work flow ind	ependently They can	also present on thi		
7.4201101119	Students are in a position to work on a subject and to organize their work flow independently. They can also present on th subject.					
	,					
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56					
Credit points	6					
Course achievement	None					
Examination	Subject theoretical and practical work					
Examination duration and	Written-theoretical part and modelling					
scale						
Assignment for the	General Engineering Science (German	program, 7 semester): Specialisation Green Tec	hnologies. Focus Water	r and Environmenta		
-	Engineering: Elective Compulsory					
i onothing curricula		pecialisation Water and Environment: Compulso	17.7			
			-			
	Civil- and Environmental Engineering: Specialisation Civil Engineering: Elective Compulsory Civil- and Environmental Engineering: Specialisation Traffic and Mobility: Elective Compulsory					
		mate: Specialisation Water Technologies: Elective				
	Green rechnologies. Energy, Water, Clir	mate. Specialisation water recinologies: Electiv	e compuisory			

Course L2467: Management	of Wastewater Infrastructure
Тур	Seminar
Hrs/wk	2
СР	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Prof. Ralf Otterpohl
Language	DE
Cycle	SoSe
Content	The seminar ""Infrastructure Management Wastewater"" develops the understanding of infrastructure systems in relation to wastewater systems, but also addresses other infrastructure systems.
	Initially, an overview of the entire system is given, including water catchment areas, water distribution, the origin of wastewater in households and industry, stormwater runoff management, and the treatment and reuse of water (constituents). Thereby the design tools especially of digital modelling are understood by practical application. Energetic considerations as well as planning and restoration of pipeline systems are covered.
	For wastewater treatment, the basis developed in Sanitary Engineering I will be deepened and significantly expanded, especially the resource recovery of nutrients and water. Sanitary solutions for different socio-economic and climatic conditions are understood and calculated.
Literature	Gujer, W. (2007): Siedlungswasserwirtschaft, Springer, Berlin Heidelberg
	Metcalf and Eddy (2003): Wastewater Engineering : Treatment and Reuse, Boston, McGraw-Hill
	Henze, M. (1997): Wastewater Treatment : Biological and Chemical Processes, Berlin, Springer
	Stein D., Stein R. (2014): Instandhaltung von Kanalisationen, Verlag Prof. DrIng. Stein & Partner GmbH
	Wossog, G. (2016): Handbuch für den Rohrleitungsbau Band 1 und 2
	Deutsche Vereinigung für Wasserwirtschaft, Abwasser und Abfall (2009): Abwasserableitung : Bemessungsgrundlagen, Regenwasserbewirtschaftung, Fremdwasser, Netzsanierung, Grundstücksentwässerung, Weimar, UnivVerl.
	DWA Arbeitsblätter

Course L2466: Drinking Wate	er Treatment
Тур	Seminar
Hrs/wk	2
CP	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Prof. Mathias Ernst, Dr. Klaus Johannsen
Language	DE
Cycle	SoSe
Content	The seminar deepens and expands the knowledge of the processes of drinking water treatment. The seminar deals with ion exchange, oxidation, disinfection, gas exchange and hybrid treatment processes. Further topics include pH adjustment and energy efficiency in water supply. Within the scope of the course, the students work out a seminar performance (presentation, design, modelling) on the basis of a task.
Literature	Worch, E. (2019): Drinking Water Treatment, De Gruyter-Verlag Worch, E. (2015): Hydrochemistry, De Gruyter-Verlag Jekel, M., Czekalla, C. (2016): Wasseraufbereitung - Grundlagen und Verfahren (DVGW Lehr- und Handbuch Wasserversorgung, Band 6), DIV Deutscher Industrieverlag

Specialization Computer Science

The specialization in "Computer Science" allows the graduates to work in the IT sector and to enter Master studies. The Graduates are able to cooperate with Computer Scientists for the design and realization of complex IT tasks. The Graduates should be in the position to adapt to new developments. They should be able to become professionals in almost all branches.

The specialization in "Computer Science" consists of core courses in fundamentals of mathematics and computer science, and specialized courses in software or hardware.

Courses				
Title		Тур	Hrs/wk	СР
Discrete Algebraic Structures (L0164)		Lecture	2	3
Discrete Algebraic Structures (L016	65)	Recitation Section (small)	2	3
Module Responsible	Prof. Karl-Heinz Zimmermann			
Admission Requirements	None			
Recommended Previous	Mathematics from High School.			
Knowledge				
Educational Objectives	After taking part successfully, students have r	eached the following learning results		
Professional Competence				
Knowledge	The students know the important basics of discrete algebraic structures including elementary combinatorial structures, monoid groups, rings, fields, finite fields, and vector spaces. They also know specific structures like sub sum-, and quotient structures ar homomorphisms.			
Skills	Students are able to formalize and analyze basic discrete algebraic structures.			
Personal Competence				
Social Competence	Students are able to solve specific problems a	lone or in a group and to present the results	accordingly.	
Autonomy	Students are able to acquire new knowledge from specific standard books and to associate the acquired knowledge to oth classes.			
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	120 min			
scale				
Assignment for the	General Engineering Science (German program	m, 7 semester): Specialisation Computer Sci	ence: Compulsory	
Following Curricula	Computer Science: Core Qualification: Compu	lsory		
	Data Science: Core Qualification: Compulsory			
	Computer Science in Engineering: Core Qualif	ication: Compulsory		
	Orientation Studies: Core Qualification: Electiv	e Compulsory		

Course L0164: Discrete Alge	Course L0164: Discrete Algebraic Structures	
Тур	Lecture	
Hrs/wk	2	
СР	3	
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28	
Lecturer	Prof. Karl-Heinz Zimmermann	
Language	DE/EN	
Cycle	WiSe	
Content		
Literature		

Course L0165: Discrete Alge	ourse L0165: Discrete Algebraic Structures		
Тур	Recitation Section (small)		
Hrs/wk	2		
CP	3		
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28		
Lecturer	Prof. Karl-Heinz Zimmermann		
Language	DE/EN		
Cycle	WiSe		
Content	See interlocking course		
Literature	See interlocking course		

Courses					
Title		Тур	Hrs/wk	СР	
Computer Engineering (L0321)		Lecture	3	4	
Computer Engineering (L0324)		Recitation Section (small)	1	2	
Module Responsible	Prof. Heiko Falk				
Admission Requirements	None				
Recommended Previous	Basic knowledge in electrical engineering				
Knowledge					
Educational Objectives	After taking part successfully, students have reached t	ne following learning results	-		
Professional Competence					
Knowledge	This module deals with the foundations of the functionality of computing systems. It covers the layers from the assembly				
	programming down to gates. The module includes the	onowing topics.			
	Introduction				
	Combinational logic: Gates, Boolean algebra, Bo	blean functions, hardware synthesis, c	ombinational net	works	
	 Sequential logic: Flip-flops, automata, systemati 	c hardware design			
	Technological foundations				
	Computer arithmetic: Integer addition, subtracti		a la sila la s		
	Basics of computer architecture: Programming r Momoria: Momony biographics SPAM_DRAM_cs		pipelining		
	 Memories: Memory hierarchies, SRAM, DRAM, ca Input/output: I/O from the perspective of the CPU 		oint connections	hussos	
	• Input/output. 1/0 from the perspective of the Cro	, principles of passing data, point-to-p	onic connections	, busses	
Skills	The students perceive computer systems from the arcl	itect's perspective, i.e., they identify	he internal struc:	ture and the physi	
	composition of computer systems. The students can ar	alyze, how highly specific and individe	ual computers ca	n be built based o	
	collection of few and simple components. They are at		ain the different	abstraction layers	
	today's computing systems - from gates and circuits up	to complete processors.			
	After successful completion of the module, the stude	nts are able to judge the interdepend	lencies between	a physical compu	
	system and the software executed on it. In particular, they shall understand the consequences that the execution of software on the hardware-centric abstraction layers from the assembly language down to gates. This way, they will be enabled to eval the impact that these low abstraction levels have on an entire system's performance and to propose feasible options.				
Personal Competence					
	Students are able to solve similar problems alone or in	a group and to present the results acc	ordinaly		
boolar competence			or an igry i		
Autonomy	Students are able to acquire new knowledge from spec	ific literature and to associate this kno	wledge with othe	er classes.	
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56				
Credit points	6				
Course achievement		ription			
course demeterment	Yes 10 % Excercises				
Examination	Written exam				
Examination duration and	90 minutes, contents of course and labs				
scale					
Assignment for the	General Engineering Science (German program, 7 sem	ester): Specialisation Computer Scienc	e: Compulsory		
Following Curricula	General Engineering Science (German program, 7	semester): Specialisation Mechanica	al Engineering,	Focus Mechatron	
	Compulsory				
	General Engineering Science (German program, 7 s	emester): Specialisation Mechanical	Engineering, Foo	cus Aircraft Syste	
	Engineering: Compulsory				
	General Engineering Science (German program, 7 sem	ester): Specialisation Mechanical Engi	neering, Focus Th	neoretical Mechani	
	Engineering: Compulsory	competer). Enocialization Mart-	al Engineeria	Focus Matarial-	
	General Engineering Science (German program, 7 Engineering Sciences: Compulsory	semester): specialisation Mechanic	.ai Erigineering,	rocus materials	
	General Engineering Science (German program, 7 sen	ester): Specialisation Mechanical Eng	ineering Focus (Product Developm	
	and Production: Compulsory	isster). Specialisation mechanical Eng	incernig, rocus i		
	General Engineering Science (German program, 7 s	emester): Specialisation Mechanical	Engineering, Foc	us Energy Syster	
	Compulsory		,	3, -,	
	General Engineering Science (German program, 7	semester): Specialisation Mechanica	I Engineering, I	Focus Biomechan	
	Compulsory				
	General Engineering Science (German program, 7 sem	ester): Specialisation Electrical Engine	ering: Compulsor	У	
	General Engineering Science (German program, 7 sem	ester): Specialisation Green Technolog	ies, Focus Renew	able Energy: Elect	
	Compulsory				
	Computer Science: Core Qualification: Compulsory				
	Data Science: Core Qualification: Elective Compulsory				
	Data Science: Specialisation I. Mathematics/Computer	Science: Elective Compulsory			
	Electrical Engineering: Core Qualification: Compulsory				
	Computer Science in Engineering: Core Qualification: C				
	Integrated Building Technology: Core Qualification: Ele Technomathematics: Specialisation II. Informatics: Elec				

Course L0321: Computer Eng	gineering
Тур	Lecture
Hrs/wk	3
СР	4
Workload in Hours	Independent Study Time 78, Study Time in Lecture 42
Lecturer	Prof. Heiko Falk
Language	DE/EN
Cycle	WiSe
Content	 Introduction Combinational Logic Sequential Logic Technological Foundations Representations of Numbers, Computer Arithmetics Foundations of Computer Architecture Memories Input/Output
Literature	 A. Clements. The Principles of Computer Hardware. 3. Auflage, Oxford University Press, 2000. A. Tanenbaum, J. Goodman. Computerarchitektur. Pearson, 2001. D. Patterson, J. Hennessy. Rechnerorganisation und -entwurf. Elsevier, 2005.

Course L0324: Computer Eng	Irse L0324: Computer Engineering		
Тур	Recitation Section (small)		
Hrs/wk	1		
CP	2		
Workload in Hours	Independent Study Time 46, Study Time in Lecture 14		
Lecturer	Prof. Heiko Falk		
Language	DE/EN		
Cycle	WiSe		
Content	See interlocking course		
Literature	See interlocking course		

Courses				
Title		Тур	Hrs/wk	СР
Graph Theory and Optimization (L1		Lecture	2	3
Graph Theory and Optimization (L1		Recitation Section (small)	2	3
Module Responsible	Prof. Anusch Taraz			
Admission Requirements	None			
Recommended Previous	Discrete Algebraic Structures			
Knowledge	Mathematics I			
Educational Objectives	After taking part successfully, students have reach	ed the following learning results		
Professional Competence				
Knowledge	• Students can name the basic concepts in G	ranh Theory and Ontimization. They are a	hle to explain the	m using appropria
	examples.		bie to explain the	
	 Students can discuss logical connections be 	etween these concepts. They are capable	of illustrating the	ese connections wi
	the help of examples.		5	
	 They know proof strategies and can reprodu 	ice them.		
Skills	Students can model problems in Graph The second secon	neory and Optimization with the help of	the concepts stu	idied in this cours
	Moreover, they are capable of solving them			
	 Students are able to discover and verify furt 	ther logical connections between the conce	pts studied in the	course.
	• For a given problem, the students can dev			
	results.			
Personal Competence				
Social Competence				
	Students are able to work together in teams			
	 In doing so, they can communicate new cor design examples to shock and deepen the up 		perating partners.	Moreover, they ca
	design examples to check and deepen the u	inderstanding of their peers.		
Autonomy				
Autonomy	 Students are capable of checking their und 	erstanding of complex concepts on their of	own. They can sp	ecify open question
	precisely and know where to get help in solv	ving them.		
	Students have developed sufficient persister	ence to be able to work for longer period	ls in a goal-orient	ted manner on ha
	problems.			
Workload in Hours	Independent Study Time 124, Study Time in Lectur	re 56		
Credit points	6			
Course achievement	None			
Examination	Written exam			
Examination duration and	120 min			
scale				
Andunussites	Conoral Engineering Colones (Comments and T	competer), Specialization Computer C	o. Computer	
Assignment for the	General Engineering Science (German program, 7 Computer Science: Core Qualification: Compulsory		e. compulsory	
Following Curricula				
	Data Science: Core Qualification: Compulsory Logistics and Mobility: Specialisation Engineering S	cience: Elective Compulsory		
	Logistics and Mobility: Specialisation Engineering S			
	Logistics and Mobility: Specialisation Information T			
	Technomathematics: Specialisation I. Mathematics			
	Engineering and Management - Major in Logistics a		and Systems: Fle	ective Compulsory
	Engineering and Management - Major in Logistics a			

urse L1046: Graph Theory	
	Lecture
Hrs/wk	
CP	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Prof. Anusch Taraz
Language	DE/EN
Cycle	SoSe
Content	 Graphs, search algorithms for graphs, trees planar graphs shortest paths minimum spanning trees maximum flow and minimum cut theorems of Menger, König-Egervary, Hall NP-complete problems backtracking and heuristics linear programming duality integer linear programming
Literature	 M. Aigner: Diskrete Mathematik, Vieweg, 2004 T. Cormen, Ch. Leiserson, R. Rivest, C. Stein: Algorithmen - Eine Einführung, Oldenbourg, 2013 J. Matousek und J. Nesetril: Diskrete Mathematik, Springer, 2007 A. Steger: Diskrete Strukturen (Band 1), Springer, 2001 A. Taraz: Diskrete Mathematik, Birkhäuser, 2012 V. Turau: Algorithmische Graphentheorie, Oldenbourg, 2009 KH. Zimmermann: Diskrete Mathematik, BoD, 2006

Course L1047: Graph Theory	ourse L1047: Graph Theory and Optimization		
Тур	Recitation Section (small)		
Hrs/wk	2		
СР	3		
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28		
Lecturer	Prof. Anusch Taraz		
Language	DE/EN		
Cycle	SoSe		
Content	See interlocking course		
Literature	See interlocking course		

Courses					
Title		Turn	Hre /wk	СР	
Stochastics (L0777)		Typ Lecture	Hrs/wk 2	4	
Stochastics (L0778)		Recitation Section (small)	2	2	
Module Responsible	Prof. Matthias Schulte				
Admission Requirements	None				
Recommended Previous					
Knowledge	Calculus				
	Discrete algebraic structures (combinatorics)				
	Propositional logic				
Educational Objectives	After taking part successfully, students have reached	the following learning results			
Professional Competence					
Knowledge					
	Students can name the basic concepts in Stoc	hastics. They are able to explain them us	sing appropriate e	examples.	
	 Students can discuss logical connections betw 	veen these concepts. They are capable	of illustrating th	ese connections w	
	the help of examples.				
	 They know proof strategies and can reproduce 	them.			
Skills					
	Students can model problems from stochasti		ed in this course	. Moreover, they a	
	capable of solving them by applying establishe				
	• Students are able to discover and verify further logical connections between the concepts studied in the course.				
	 For a given problem, the students can devel results. 	op and execute a suitable approach, a	nd are able to c	ritically evaluate t	
	Tesuits.				
Personal Competence					
Social Competence	Churchenster and a blacker words to worth an (a. e. an bl				
	 Students are able to work together (e.g. on the different study programs and background know 				
	different study programs and background knoIn doing so, they can communicate new conce				
	design examples to check and deepen the und		perating partners	. Moreover, they c	
		terstanding of their peers.			
Autonomy	Students are capable of checking their under	standing of complex concepts on their (wn They can sn	ecify open questio	
	precisely and know where to get help in solvin		with they can sp	celly open questio	
	 Students can put their knowledge in relation to the contents of other lectures. Students have developed sufficient persistence to be able to work for longer periods in a goal-oriented man 				
	problems.		5		
Workload in Hours	Independent Study Time 124, Study Time in Lecture	56			
Credit points	6				
Course achievement	None				
Examination	Written exam				
Examination duration and	120 min				
scale					
-	General Engineering Science (German program, 7 se				
Following Curricula	General Engineering Science (German program, 7 se	mester): Specialisation Advanced Materi	als: Elective Com	pulsory	
	Computer Science: Core Qualification: Compulsory				
	Data Science: Core Qualification: Compulsory	als, Elective Compulser			
	Engineering Science: Specialisation Advanced Materi				
	Engineering Science: Specialisation Electrical Engine Computer Science in Engineering: Core Qualification:				
	Logistics and Mobility: Specialisation Engineering Sci				
	Logistics and Mobility: Specialisation Engineering Sci Logistics and Mobility: Specialisation Information Tec	1 2			
	Orientation Studies: Core Qualification: Elective Com				
	Theoretical Mechanical Engineering: Core Qualificatio				
	5				

Course L0777: Stochastics			
Тур	Lecture		
Hrs/wk	2		
CP	4		
Workload in Hours	Independent Study Time 92, Study Time in Lecture 28		
Lecturer	Prof. Matthias Schulte		
Language	DE/EN		
Cycle	SoSe		
Content	 Definitions of probability, conditional probability Random variables Independence Distributions and density functions Characteristics: expectation, variance, standard deviation, moments Multivariate distributions Law of large numbers and central limit theorem Basic notions of stochastic processes Basic concepts of statistics (point estimators, confidence intervals, hypothesis testing) 		
Literature	 L. Dümbgen (2003): Stochastik für Informatiker, Springer. HO. Georgii (2012): Stochastics: Introduction to Probability and Statistics, 2nd edition, De Gruyter. N. Henze (2018): Stochastik für Einsteiger, 12th edition, Springer. A. Klenke (2014): Probability Theory: A Comprehensive Course, 2nd edition, Springer. U. Krengel (2005): Einführung in die Wahrscheinlichkeitstheorie und Statistik, 8th edition, Vieweg. A.N. Shiryaev (2012): Problems in probability, Springer. 		

Course L0778: Stochastics		
Тур	Recitation Section (small)	
Hrs/wk	2	
CP	2	
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28	
Lecturer	Prof. Matthias Schulte	
Language	DE/EN	
Cycle	SoSe	
Content	See interlocking course	
Literature	See interlocking course	

Courses				
		-	there for the	<u></u>
Title	12005 (10222)	Typ Lecture	Hrs/wk	CP 4
Automata Theory and Formal Langı Automata Theory and Formal Langı		Recitation Section (small)	2	2
Module Responsible		Reclation Section (Shair)	L	L
Admission Requirements				
Recommended Previous	Participating students should be able to			
Knowledge	- specify algorithms for simple data structures	(such as, e.g., arrays) to solve computational p	problems	
	 apply propositional logic and predicate logic 	for specifying and understanding mathematica	l proofs	
	- apply the knowledge and skills taught in the	module Discrete Algebraic Structures		
		-		
Educational Objectives	After taking part successfully, students have r	eached the following learning results		
Professional Competence				
Knowledge	Students can explain syntax, semantics, and	decision problems of propositional logic, and	I they are able t	o give algorithms
	solving decision problems. Students can sho	ow correspondences to Boolean algebra. Stud	dents can descri	be which applica
	problems are hard to represent with propos	itional logic, and therefore, the students can	motivate predic	ate logic, and de
	syntax, semantics, and decision problems for	r this representation formalism. Students can	explain unificati	on and resolutior
	solving the predicate logic SAT decision proble	em. Students can also describe syntax, semant	ics, and decision	problems for var
		pplication areas. The participants of the cour		
		logic and formal grammars. The spectrum th		
		tomata and pushdown automata to Turing r		
		e expressive than determinism. They are also		
		addition, students can transform decision problements of the state of		
		stand that some formalisms easily induce algor		
		tudents can describe the relationships betwee	n formalisms suc	h as logic, autom
	or grammars.			
Skills	Students can apply propositional logic as well	as predicate logic resolution to a given set of f	ormulas. Student	ts analyze applica
	problems in order to derive propositional logic, predicate logic, or temporal logic formulas to represent them. They can evaluat			
	which formalism is best suited for a particula	ar application problem, and they can demonst	rate the applicat	tion of algorithms
		nts can also transform nondeterministic autom		
		hey can show how parsers work, and they ca		
	emptiness problem in case of infinite words.	· · · · · · · · · · · · · · · · · · ·		
Personal Competence				
Social Competence				
		eams. They are capable to use mathematics as		
		v concepts according to the needs of their coo	perating partners	s. Moreover, they
	design examples to check and deepen t	the understanding of their peers.		
Autonomy				
, aconomy		understanding of complex concepts on their of	own. They can sp	pecify open quest
	precisely and know where to get help ir	n solving them.		
	 Students have developed sufficient per 	rsistence to be able to work for longer period	ds in a goal-orier	nted manner on I
	problems.			
Workload in Hours	Independent Study Time 124, Study Time in L	ecture 56		
Credit points				
Course achievement				
Examination				
Examination duration and	90 min			
scale				
A. 1	General Engineering Science (German program	n, 7 semester): Specialisation Computer Scienc	e: Compulsory	
Assignment for the	Computer Science: Core Qualification: Compul	lsory		
Assignment for the Following Curricula				
	Data Science: Core Qualification: Compulsory			
	Data Science: Core Qualification: Compulsory Engineering Science: Specialisation Mechatror	nics: Elective Compulsory		
	Engineering Science: Specialisation Mechatron			
	Engineering Science: Specialisation Mechatror Engineering Science: Specialisation Mechatror	nics: Elective Compulsory	ctive Compulsory	/
	Engineering Science: Specialisation Mechatror Engineering Science: Specialisation Mechatror General Engineering Science (English program	nics: Elective Compulsory n, 7 semester): Specialisation Mechatronics: Ele	ctive Compulsory	/
	Engineering Science: Specialisation Mechatror Engineering Science: Specialisation Mechatror	nics: Elective Compulsory n, 7 semester): Specialisation Mechatronics: Ele ication: Compulsory	ctive Compulsory	/

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	Lecture			
Hrs/wk	2			
CP	4			
Workload in Hours	Independent Study Time 92, Study Time in Lecture 28			
Lecturer	Prof. Matthias Mnich			
Language	EN			
Cycle	SoSe			
Content				
	1. Propositional logic, Boolean algebra, propositional resolution, SAT-2KNF			
	2. Predicate logic, unification, predicate logic resolution			
	3. Temporal Logics (LTL, CTL)			
	4. Deterministic finite automata, definition and construction			
	5. Regular languages, closure properties, word problem, string matching			
	6. Nondeterministic automata:			
	Rabin-Scott transformation of nondeterministic into deterministic automata			
	7. Epsilon automata, minimization of automata,			
	elimination of e-edges, uniqueness of the minimal automaton (modulo renaming of states)			
	8. Myhill-Nerode Theorem:			
	Correctness of the minimization procedure, equivalence classes of strings induced by automata			
	9. Pumping Lemma for regular languages:			
	provision of a tool which, in some cases, can be used to show that a finite automaton principally cannot be expressi			
	enough to solve a word problem for some given language			
	10. Regular expressions vs. finite automata:			
	Equivalence of formalisms, systematic transformation of representations, reductions			
	11. Pushdown automata and context-free grammars:			
	Definition of pushdown automata, definition of context-free grammars, derivations, parse trees, ambiguities, pumpi			
	lemma for context-free grammars, transformation of formalisms (from pushdown automata to context-free grammars a			
	back)			
	12. Chomsky normal form			
	 CYK algorithm for deciding the word problem for context-free grammrs Deterministic pushdown subsects 			
	14. Deterministic pushdown automata			
	15. Deterministic vs. nondeterministic pushdown automata:			
	Application for parsing, LL(k) or LR(k) grammars and parsers vs. deterministic pushdown automata, compiler compiler			
	 Regular grammars Outlook Turing machines and linear bounded automata us general and sentext sensitive grammars 			
	 Outlook: Turing machines and linear bounded automata vs general and context-sensitive grammars Chomsky hierarchy 			
	19. Mealy- and Moore automata:			
	Automata with output (w/o accepting states), infinite state sequences, automata networks			
	 Omega automata: Automata for infinite input words, Büchi automata, representation of state transition systems, verificati 			
	w.r.t. temporal logic specifications (in particular LTL)			
	21. LTL safety conditions and model checking with Büchi automata, relationships between automata and logic			
	22. Fixed points, propositional mu-calculus			
	23. Characterization of regular languages by monadic second-order logic (MSO)			
Literature	1. Levil für lefensetillen Des Celäring, Carlinger, 5. Aufl			
	1. Logik für Informatiker Uwe Schöning, Spektrum, 5. Aufl.			
	2. Logik für Informatiker Martin Kreuzer, Stefan Kühling, Pearson Studium, 2006			
	3. Grundkurs Theoretische Informatik, Gottfried Vossen, Kurt-Ulrich Witt, Vieweg-Verlag, 2010.			
	4. Principles of Model Checking, Christel Baier, Joost-Pieter Katoen, The MIT Press, 2007			

ourse L0507: Automata Theory and Formal Languages		
Тур	Recitation Section (small)	
Hrs/wk	2	
CP	2	
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28	
Lecturer	Prof. Matthias Mnich	
Language	EN	
Cycle	SoSe	
Content	See interlocking course	
Literature	See interlocking course	

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Students are able to acquire new knowledge from specific literature and to associate this knowledge with other classes.			

Lecturer	Prof. Heiko Falk		
Language	EN		
Cycle	SoSe		
Content	 Introduction Specifications and Modeling Embedded/Cyber-Physical Systems Hardware System Software Evaluation and Validation Mapping of Applications to Execution Platforms Optimization 		
Literature	 Peter Marwedel. Embedded System Design - Embedded Systems Foundations of Cyber-Physical Systems. 2 nd Edition, Springer, 2012., Springer, 2012. 		

Course L2938: Embedded Sy	stems
Тур	Project-/problem-based Learning
Hrs/wk	1
CP	1
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14
Lecturer	Prof. Heiko Falk
Language	EN
Cycle	SoSe
Content	 Introduction Specifications and Modeling Embedded/Cyber-Physical Systems Hardware System Software Evaluation and Validation Mapping of Applications to Execution Platforms Optimization
Literature	 Peter Marwedel. Embedded System Design - Embedded Systems Foundations of Cyber-Physical Systems. 2 nd Edition, Springer, 2012., Springer, 2012.

Course L0806: Embedded Sy	urse L0806: Embedded Systems		
Тур	Recitation Section (small)		
Hrs/wk	1		
CP	2		
Workload in Hours	Independent Study Time 46, Study Time in Lecture 14		
Lecturer	Prof. Heiko Falk		
Language	EN		
Cycle	SoSe		
Content	See interlocking course		
Literature	See interlocking course		

Module M0731: Funct	ional Programming					
Courses						
Title			Тур	Hrs/wk	СР	
Functional Programming (L0624)			Lecture	2	2	
Functional Programming (L0625)			Recitation Section (large)	2	2	
Functional Programming (L0626)			Recitation Section (small)	2	2	
Module Responsible	Prof. Sibylle Schupp					
Admission Requirements	None					
Recommended Previous	Discrete mathematics at high-	school level				
Knowledge						
Educational Objectives	After taking part successfully,	students have reache	d the following learning results			
Professional Competence						
Knowledge	Students apply the principles,	constructs, and simple	e design techniques of functional progra	amming. They dem	nonstrate their abili	
	to read Haskell programs and	to explain Haskell syr	ntax as well as Haskell's read-eval-print	loop. They interpr	et warnings and fir	
	errors in programs. They app	y the fundamental da	ata structures, data types, and type co	onstructors. They e	employ strategies f	
			or partial and total correctness. They di			
	strategies.			5		
Skills	Students break a natural-lang	lage description down	n in parts amenable to a formal specific	ation and develop	a functional progra	
	in a structured way. They	assess different lan	guage constructs, make conscious	selections both a	t specification ar	
	implementations level, and ju	stify their choice. The	y analyze given programs and rewrite	them in a controll	ed way. They desig	
	and implement unit tests and	an assess the quality	of their tests. They argue for the correct	tness of their prog	ıram.	
Demonstration of the second						
Personal Competence					-	
Social Competence	Students practice peer programming with varying peers. They explain problems and solutions to their peer. They defend their					
	programs orally. They commu	licate in English.				
Autonomy	In programming labs, studen	s learn under superv	vision (a.k.a. "Betreutes Programmiere	n") the mechanics	of programming.	
	11 In programming labs, students learn under supervision (a.k.a. "Betreutes Programmieren") the mechanics of programmine exercises, they develop solutions individually and independently, and receive feedback.			p g		
Workload in Hours	Independent Study Time 96, S	tudy Time in Lecture 8	34			
Credit points	6					
Course achievement	Compulsory Bonus Form		Description			
	Yes 15 % Excerc	ses				
	Written exam					
Examination duration and	90 min					
scale						
Assignment for the	General Engineering Science (German program, 7 se	emester): Specialisation Computer Scier	nce: Elective Comp	ulsory	
Following Curricula	Computer Science: Core Quali	ication: Compulsory				
	Data Science: Core Qualificati	n: Elective Compulsor	ry			
	Data Science: Specialisation I.	Mathematics/Compute	er Science: Elective Compulsory			
	Engineering Science: Specialis	ation Mechatronics: El	ective Compulsory			
			mester): Specialisation Mechatronics: El	ective Compulsorv		
			omputer Science: Elective Compulsory			
	Technomathematics: Specialis					
	recinomacientatics, specialis	acion n. informatics: E				

Course L0624: Functional Programming			
Тур	Lecture		
Hrs/wk	2		
CP			
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28		
Lecturer	Prof. Sibylle Schupp		
Language	EN		
Cycle	WiSe		
Content	 Functions, Currying, Recursive Functions, Polymorphic Functions, Higher-Order Functions Conditional Expressions, Guarded Expressions, Pattern Matching, Lambda Expressions Types (simple, composite), Type Classes, Recursive Types, Algebraic Data Type Type Constructors: Tuples, Lists, Trees, Associative Lists (Dictionaries, Maps) Modules Interactive Programming Lazy Evaluation, Call-by-Value, Strictness Design Recipes Testing (axiom-based, invariant-based, against reference implementation) Reasoning about Programs (equation-based, inductive) Idioms of Functional Programming Haskell Syntax and Semantics 		
Literature	Graham Hutton, Programming in Haskell, Cambridge University Press 2007.		

Course L0625: Functional Programming		
Тур	Recitation Section (large)	
Hrs/wk	2	
СР	2	
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28	
Lecturer	Prof. Sibylle Schupp	
Language	EN	
Cycle	WiSe	
Content	 Functions, Currying, Recursive Functions, Polymorphic Functions, Higher-Order Functions Conditional Expressions, Guarded Expressions, Pattern Matching, Lambda Expressions Types (simple, composite), Type Classes, Recursive Types, Algebraic Data Type Type Constructors: Tuples, Lists, Trees, Associative Lists (Dictionaries, Maps) Modules Interactive Programming Lazy Evaluation, Call-by-Value, Strictness Design Recipes Testing (axiom-based, invariant-based, against reference implementation) Reasoning about Programming Idioms of Functional Programming Haskell Syntax and Semantics 	
Literature	Graham Hutton, Programming in Haskell, Cambridge University Press 2007.	

Course L0626: Functional Pr	ogramming
Тур	Recitation Section (small)
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Prof. Sibylle Schupp
Language	EN
Cycle	WiSe
Content	 Functions, Currying, Recursive Functions, Polymorphic Functions, Higher-Order Functions Conditional Expressions, Guarded Expressions, Pattern Matching, Lambda Expressions Types (simple, composite), Type Classes, Recursive Types, Algebraic Data Type Type Constructors: Tuples, Lists, Trees, Associative Lists (Dictionaries, Maps) Modules Interactive Programming Lazy Evaluation, Call-by-Value, Strictness Design Recipes Testing (axiom-based, invariant-based, against reference implementation) Reasoning about Programming Haskell Syntax and Semantics
Literature	Graham Hutton, Programming in Haskell, Cambridge University Press 2007.

Courses			
Fitle		Тур	Hrs/wk CP
ntroductory Seminar Computer Sc	ence I (I 2362)	Seminar	2 3
ntroductory Seminar Computer Sc		Seminar	2 3
Module Responsible	Dozenten des SD E		
Admission Requirements			
Recommended Previous		and Mathematics at the Bachelor's level.	
Knowledge			
-	After taking part successfully, students	have reached the following learning results	
Professional Competence	······ , ····· , ···· , ···· , ···· , ···· , ···· , ···· , ···· , ···· , ···· , ···· , ···· , ···· , ···· , ···	······································	
•	The students are able to		
	 explicate a specific topic in the f 	ield of Computer Science,	
	 describe complex issues, 		
	 present different views and eval 	uate in a critical way.	
Skills	The students are able to		
	 familiarize in a specific topic of 0 		
		e specific topic and cite in a correct way,	
		ve a lecture to a selected audience,	
	• sum up the presentation in 10-1		
	 answer questions in the final dis 	cussion.	
Personal Competence			
Social Competence	The students are able to		
	elaborate and introduce a topic		
		ructure of the presentation with the instructor,	
	discuss certain aspects with the		
	 as the lecturer listen and respon 	id to questions from the audience.	
Autonomy	The students are able to		
	define the task in question in an		
	develop the necessary knowledge		
	 use appropriate work equipment guided by an instructor critically 		
	• guided by an instructor critically	check the working status.	
Workload in Hours	Independent Study Time 124, Study Tim	me in Lecture 56	
Credit points	6		
Course achievement	None		
Examination	Presentation		
Examination duration and	x		
scale			
Assignment for the	General Engineering Science (German	program, 7 semester): Specialisation Computer S	Science: Elective Compulsory
Following Curricula	General Engineering Science (German	program, 7 semester): Specialisation Data Scien	ce: Elective Compulsory
	Computer Science: Core Qualification:	Compulsory	
	Data Science: Core Qualification: Comp	bulsory	
	Data Science: Core Qualification: Comp	bulsory	
	Engineering Science: Specialisation Da	ta Science: Elective Compulsory	
	Computer Science in Engineering: Core	e Qualification: Compulsory	

Course L2362: Introductory Seminar Computer Science I	
Тур	Seminar
Hrs/wk	2
CP	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Dozenten des SD E
Language	DE/EN
Cycle	WiSe/SoSe
Content	
Literature	

ourse L2361: Introductory Seminar Computer Science II	
Тур	Seminar
Hrs/wk	2
CP	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Dozenten des SD E
Language	DE/EN
Cycle	WiSe/SoSe
Content	
Literature	

Courses				
Title		Тур	Hrs/wk	СР
Numerical Mathematics I (L0417)		Lecture	2	3
Numerical Mathematics I (L0418)		Recitation Section (small)	2	3
Module Responsible	Prof. Sabine Le Borne			
Admission Requirements	None			
Recommended Previous	Mathematik I + II for Engineering Students (german	or english) or Analysis & Linear Al	nebra I + II for Te	chnomathematic
Knowledge	basic MATLAB/Python knowledge		gebruit i nier re	
Educational Objectives	After taking part successfully, students have reached the f	ollowing learning results		
Professional Competence				
Knowledge	Students are able to			
	 name numerical methods for interpolation integrat 	ion loast squares problems eigen	value problems r	onlinger root fin
	 name numerical methods for interpolation, integrat 	ion, least squares problems, eigen	alue problems, i	Ioniniear root ning
	problems and to explain their core ideas,	othoda		
	 repeat convergence statements for the numerical m explain aspects for the practical execution of numer 		utational and sto	rado comploxity
	explain aspects for the practical execution of numer	ical methods with respect to comp		rage complexity.
CI ///				
SKIIIS	Students are able to			
	 implement, apply and compare numerical methods 	using MATLAB/Python,		
	 justify the convergence behaviour of numerical met 	hods with respect to the problem a	nd solution algori	ithm,
	select and execute a suitable solution approach for	a given problem.		
Personal Competence				
Social Competence	Students are able to			
	 work together in heterogeneously composed teams 	(i.e., teams from different study p	rograms and bac	karound knowled
	explain theoretical foundations and support each ot			
Autonomy	Students are capable			
	 to assess whether the supporting theoretical and pro- 	actical excercises are better solved	l individually or in	a team
	 to assess their individual progess and, if necessary, 		individually of it	la cean,
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 minutes			
scale				
Assignment for the	General Engineering Science (German program, 7 semeste	r): Specialisation Computer Science	e: Compulsory	
	General Engineering Science (German program, 7 semeste			ory
3	General Engineering Science (German program, 7 ser			-
	Compulsory		, .	
	General Engineering Science (German program, 7 semeste	er): Specialisation Mechanical Engir	neering, Focus Th	eoretical Mechar
	Engineering: Compulsory		-	
	General Engineering Science (German program, 7 sem	ester): Specialisation Mechanical	Engineering, Foo	us Aircraft Syste
	Engineering: Elective Compulsory			
	General Engineering Science (German program, 7 semest	er): Specialisation Mechanical Engi	neering, Focus M	echatronics: Elec
	Compulsory			
	General Engineering Science (German program, 7 seme	ester): Specialisation Mechanical I	Engineering, Foc	us Energy Syste
	Elective Compulsory			
	General Engineering Science (German program, 7 semeste	r): Specialisation Advanced Materia	als: Compulsory	
	General Engineering Science (German program, 7 semeste	er): Specialisation Data Science: Co	mpulsory	
	Bioprocess Engineering: Specialisation A - General Bioproc	ess Engineering: Elective Compulso	ory	
	Data Science: Core Qualification: Compulsory			
	Electrical Engineering: Core Qualification: Elective Compute	sory		
	Engineering Science: Core Qualification: Compulsory			
	Green Technologies: Energy, Water, Climate: Specialisation	n Energy Technology: Elective Com	pulsory	
	Computer Science in Engineering: Core Qualification: Com	oulsory		
	Mechanical Engineering: Specialisation Theoretical Mechar	lical Lingineering. Compulsory		
	Mechanical Engineering: Specialisation Theoretical Mechan Mechanical Engineering: Specialisation Energy Systems: El			
		ective Compulsory	Compulsory	

Course L0417: Numerical Ma	thematics I		
Тур	Lecture		
Hrs/wk			
CP	3		
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28		
Lecturer	Prof. Sabine Le Borne		
Language	EN		
Cycle	WiSe		
Content	 Finite precision arithmetic, error analysis, conditioning and stability Linear systems of equations: LU and Cholesky factorization, condition Interpolation: polynomial, spline and trigonometric interpolation Nonlinear equations: fixed point iteration, root finding algorithms, Newton's method Linear and nonlinear least squares problems: normal equations, Gram Schmidt and Householder orthogonalization, singular value decomposition, regularizatio, Gauss-Newton and Levenberg-Marquardt methods Eigenvalue problems: power iteration, inverse iteration, QR algorithm Numerical differentiation Numerical integration: Newton-Cotes rules, error estimates, Gauss quadrature, adaptive quadrature 		
Literature	 Gander/Gander/Kwok: Scientific Computing: An introduction using Maple and MATLAB, Springer (2014) Stoer/Bulirsch: Numerische Mathematik 1, Springer Dahmen, Reusken: Numerik f ür Ingenieure und Naturwissenschaftler, Springer 		

Course L0418: Numerical Mathematics I	
Тур	Recitation Section (small)
Hrs/wk	2
CP	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Prof. Sabine Le Borne, Dr. Jens-Peter Zemke
Language	EN
Cycle	WiSe
Content	See interlocking course
Literature	See interlocking course

Courses				
Title		Тур	Hrs/wk	СР
Computer Networks and Internet S	ecurity (L1098)	Lecture	3	5
Computer Networks and Internet S	ecurity (L1099)	Recitation Section (small)	1	1
Module Responsible	Prof. Andreas Timm-Giel			
Admission Requirements	None			
Recommended Previous	Basics of Computer Science			
Knowledge				
Educational Objectives	After taking part successfully, students	have reached the following learning results		
Professional Competence				
	Students are able to explain important	and common Internet protocols in detail and class	ify them, in order t	to be able to anal
5	and develop networked systems in furth			
Skills	Students are able to analyse common Ir	nternet protocols and evaluate the use of them in di	fferent domains.	
Personal Competence				
Social Competence				
Autonomy	Students can select relevant parts out o	of high amount of professional knowledge and can ir	dependently learn	and understand it
Workload in Hours	Independent Study Time 124, Study Tin	ne in Lecture 56		
Credit points				
Course achievement				
	Written exam			
Examination duration and	120 min			
scale				
Assignment for the	General Engineering Science (German r	program, 7 semester): Specialisation Computer Scien	nce: Elective Comp	ulsorv
	Computer Science: Core Qualification: C			
0		tics/Computer Science: Elective Compulsory		
	Data Science: Core Qualification: Electiv			
	Electrical Engineering: Core Qualificatio	n: Elective Compulsory		
	Engineering Science: Specialisation Med	hatronics: Elective Compulsory		
	Engineering Science: Specialisation Elec	trical Engineering: Elective Compulsory		
	General Engineering Science (English pi	rogram, 7 semester): Specialisation Mechatronics: E	lective Compulsory	/
	General Engineering Science (English pr Computer Science in Engineering: Core	-	lective Compulsory	

Тур	Lecture
Hrs/wk	
CP	5
Workload in Hours	Independent Study Time 108, Study Time in Lecture 42
Lecturer	DrIng. Koojana Kuladinithi, Prof. Sibylle Fröschle
Language	EN
Cycle	WiSe
-	In this class an introduction to computer networks with focus on the Internet and its security is given. Basic functionality complex protocols are introduced. Students learn to understand these and identify common principles. In the exercises these bas principles and an introduction to performance modelling are addressed using computing tasks and physical labs. In the second part of the lecture an introduction to Internet security is given. This class comprises: Introduction to the Internet (TCP/IP model) Application layer protocols (HTTP, SMTP, DNS) Transport layer protocols (TCP, UDP) Network Layer (Internet Protocol IPv4 & IPv6, routing in the Internet) Data link layer with media access at the example of WLAN Introduction to Internet Security Security Aspects of Address Resolution (DNS/DNSSEC, ARP/SEND Communication Security (IPSec) - From Address Resolution to Routing (Securing BGP) Botnets + Firewalls
Literature	 Kurose, Ross, Computer Networking - A Top-Down Approach, 8th Edition, Addison-Wesley Kurose, Ross, Computernetzwerke - Der Top-Down-Ansatz, Pearson Studium; Auflage: 8. Auflage W. Stallings: Cryptography and Network Security: Principles and Practice, 6th edition
	Further literature is announced at the beginning of the lecture.

Course L1099: Computer Networks and Internet Security	
Тур	Recitation Section (small)
Hrs/wk	1
CP	1
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14
Lecturer	DrIng. Koojana Kuladinithi, Prof. Sibylle Fröschle
Language	EN
Cycle	WiSe
Content	See interlocking course
Literature	See interlocking course

Courses				
Title		Тур	Hrs/wk	СР
Computer Architecture (L0793)		Lecture	2	3
Computer Architecture (L0794)		Project-/problem-based Learning	2	2
Computer Architecture (L1864)		Recitation Section (small)	1	1
Module Responsible	Prof. Heiko Falk			
Admission Requirements	None			
Recommended Previous	Module "Computer Engineering"			
Knowledge				
Educational Objectives	After taking part successfully, students have r	eached the following learning results		
Professional Competence				
Knowledge	This module presents advanced concepts fro	m the discipline of computer architecture. In the	beginning, a k	proad overview o
	various programming models is given, both	n for general-purpose computers and for specia	il-purpose ma	chines (e.g., sig
	processors). Next, foundational aspects of the	micro-architecture of processors are covered. Here	e, the focus pa	articularly lies on
	so-called pipelining and the methods used fo	r the acceleration of instruction execution used in	this context.	The students get
		anch prediction, superscalar execution of machi		-
	hierarchies.			
	incruirences.			
Skills	The students are able to describe the organiza	tion of processors. They know the different archite	ctural principl	es and programm
	models. The students examine various structu	res of pipelined processor architectures and are ab	le to explain t	heir concepts and
	analyze them w.r.t. criteria like, e.g., performa	ance or energy efficiency. They evaluate different s	tructures of n	nemory hierarchie
		able to distinguish between instruction- and data-le		-
			purunensi	
Personal Competence				
Social Competence	Students are able to solve similar problems al	one or in a group and to present the results accord	ngly.	
Autonomy	Students are able to acquire new knowledge f	rom specific literature and to associate this knowle	dge with other	classes.
Workload in Hours	Independent Study Time 110, Study Time in L	ecture 70		
Credit points	6			
Course achievement	Compulsory Bonus Form	Description		
	No 15 % Subject theoretical	and		
	practical work			
Examination	Written exam			
Examination duration and	90 minutes, contents of course and 4 attestati	ons from the PBL "Computer architecture"		
scale				
Assignment for the	General Engineering Science (German prograr	n, 7 semester): Specialisation Computer Science: E	lective Compu	ilsory
Following Curricula	Computer Science: Specialisation I. Computer	and Software Engineering: Elective Compulsory		
	Aircraft Systems Engineering: Core Qualification	on: Elective Compulsory		
	Computer Science in Engineering: Specialisati			
	Aeronautics: Core Qualification: Elective Comp			

Course L0793: Computer Arc	hitecture
Тур	Lecture
Hrs/wk	2
CP	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Prof. Heiko Falk
Language	DE/EN
Cycle	WiSe
Content	 Introduction VHDL Basics Programming Models Realization of Elementary Data Types Dynamic Scheduling Branch Prediction Superscalar Machines Memory Hierarchies The theoretical tutorials amplify the lecture's content by solving and discussing exercise sheets and thus serve as exam preparation. Practical aspects of computer architecture are taught in the FPGA-based PBL on computer architecture whose attendance is mandatory.
Literature	 D. Patterson, J. Hennessy. Rechnerorganisation und -entwurf. Elsevier, 2005. A. Tanenbaum, J. Goodman. Computerarchitektur. Pearson, 2001.

Course L0794: Computer Architecture		
Тур	Project-/problem-based Learning	
Hrs/wk	2	
CP	2	
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28	
Lecturer	Prof. Heiko Falk	
Language	DE/EN	
Cycle	WiSe	
Content	See interlocking course	
Literature	See interlocking course	

Course L1864: Computer Architecture		
Тур	Recitation Section (small)	
Hrs/wk	1	
CP	1	
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14	
Lecturer	Prof. Heiko Falk	
Language	DE/EN	
Cycle	WiSe	
Content	See interlocking course	
Literature	See interlocking course	

Courses					
Title			Тур	Hrs/wk	СР
ntroduction to Quantum Computin	g (L3109)		Lecture	2	3
Introduction to Quantum Computin	g (L3110)		Recitation Section (large)) 2	3
Module Responsible	Prof. Martin Kliesch				
Admission Requirements	None				
Recommended Previous					
Knowledge	5	and very good mather	iter science or quantum mechanics is helpful	but not required	
	 Phor knowledge 	je in theoretical compu	ter science of quantum mechanics is helpful	but not required	
Educational Objectives	After taking part suc	cessfully, students have	e reached the following learning results		
Professional Competence					
Knowledge	- Information th				
			of quantum mechanics		
	 The quantum Basic quantum 	teleportation protocol			
	Grover's search	-			
		-	Shor's algorithm for integer factoring		
			computation (qubits, quantum gates and rea	adout) and the comp	lexity class BOP
Skills	 Rigorous understanding of how quantum algorithms work and the ability to analyze them Connection of concepts in quantum mechanics and computer science Basic knowledge required to start programming a quantum computer Ability to solve exercises related to quantum algorithms 				
Devenuel Commetence	• Ability to solve	exercises related to q			
Personal Competence	After completing thi		a superior to be able to work on subject.	anasifis taska alana	an in a group and
Social Competence	After completing this module, students are expected to be able to work on subject-specific tasks alone or in a group and present the results appropriately. Moreover, students will be trained to identify and defuse misleading statements related quantum computing, which can often be found in popular media.				
Autonomy	After completion of this module, students are able to work out sub-areas of the subject independently using textbooks and oth literature, to summarize and present the acquired knowledge and to link it to the contents of other courses.				
Workload in Hours	Independent Study T	ime 124, Study Time ir	n Lecture 56		
Credit points	6				
Course achievement	CompulsoryBonusYes20 %	Form Excercises	Description		
Examination	Written exam				
Examination duration and scale	90 min				
Assignment for the	General Engineering	Science (German prog	ram, 7 semester): Specialisation Computer So	cience: Elective Com	oulsory
Following Curricula			natics and Engineering Science: Elective Com		
5			ation I. Computer Science: Elective Compulso		
			natics: Elective Compulsory		

Course L3109: Introduction to Quantum Computing			
Тур	Lecture		
Hrs/wk	2		
CP	3		
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28		
Lecturer	Prof. Martin Kliesch		
Language	DE/EN		
Cycle	WiSe		
Content	Quantum computing is among the most exciting applications of quantum mechanics. Quantum algorithms can solve computational problems efficiently that have a prohibitive runtime on traditional computers. Such problems include, for instance, factoring of integer numbers or energy estimation problems from quantum chemistry and material science. This course provides an introduction to the topic. An emphasize will be put on conceptual and mathematical aspects.		
Literature	 Course specific lecture notes will be provided Nielsen and Chuang, Quantum Computation and Quantum Information Sevag Gharibian's lecture notes 		

ourse L3110: Introduction to Quantum Computing		
Тур	Recitation Section (large)	
Hrs/wk	2	
CP	3	
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28	
Lecturer	Prof. Martin Kliesch	
Language	DE/EN	
Cycle	WiSe	
Content	See interlocking course	
Literature	See interlocking course	

	Тур	Hrs/wk	СР	
			4	
	Recitation Section (small)	1	2	
Stochastics (or a comparable class)				
After taking part successfully, students have rea	ached the following learning results			
 Students can name the basic concepts in 	Statistics They are able to explain them usin	a appropriate ex	amples	
			-	
Students can model statistical problems	with the help of the concents studied in this	sourse Maroover	thoy are capable	
			, they are capable	
			o courco	
	develop and execute a suitable approach, a		inclany evaluate	
. Chudanta ang akla ta wanit ta sati an (a s	an their menutes being could in between a			
		usly composed t	eams and to pres	
their results appropriately (e.g. during exercise class).In doing so, they can communicate new concepts according to the needs of their cooperating partners. More				
		wn. They can sp	ecify open questic	
precisely and know where to get help in solving them.Students can put their knowledge in relation to the contents of other lectures.				
problems.				
Independent Study Time 124, Study Time in Lea	cture 56			
6				
90 min				
Constal Engineering Science (Corman program	7 competer), Specialization Advanced Materi	als, Elective Com	pulcon	
	•			
	laterials: Elective Compulsory			
		Compulsory		
	 Students can name the basic concepts in Students can discuss logical connections the help of examples. Students can model statistical problems solving them by applying established me Students are able to discover and verify f For a given problem, the students can results. Students are able to work together (e.g. their results appropriately (e.g. during examples to check and deepen the students can precisely and know where to get help in s Students have developed sufficient pers problems. Independent Study Time 124, Study Time in Lee 6 None Written exam 90 min General Engineering Science (German program, General Engineering Science (German program, Computer Science: Specialisation II. Mathematic Data Science: Core Qualification: Compulsory Engineering Science: Specialisation II. Mathematic Technomathematics: Specialisation I. Mathematic Theoretical Mechanical Engineering: Specialisation I. Mathematic Theoretical Mechanical Engineering: Specialisation I. Mathematic Theoretical Mechanical Engineering: Specialisation I. Mathematic Specia	Lecture Recitation Section (small) Prof. Matthias Schulte None Stochastics (or a comparable class) After taking part successfully, students have reached the following learning results • Students can name the basic concepts in Statistics. They are able to explain them usin • Students can discuss logical connections between these concepts. They are capable the help of examples. • Students can model statistical problems with the help of the concepts studied in this of solving them by applying established methods. They are able to use the statistical soft • Students are able to discover and verify further logical connections between the conce • For a given problem, the students can develop and execute a suitable approach, a results. • Students are able to work together (e.g. on their regular home work) in heterogeneo their results appropriately (e.g. during exercise class). • In doing so, they can communicate new concepts according to the needs of their coor design examples to check and deepen the understanding of complex concepts on their or precisely and know where to get help in solving them. • Students ane quable of checking their understanding of towrk for longer period problems. Independent Study Time 124, Study Time in Lecture 56 6 6 7 8 90 min General Engineering Science (German program, 7 semester): Specialisation Advanced Materid General Engineering Science (German program, 7 semester): Specialisation Data Science: Co Computer Science: Specialisation Da	Lecture 3 Recitation Section (small) 1 Prof. Matthias Schulte 1 None 5 Stochastics (or a comparable class) 4 After taking part successfully, students have reached the following learning results 5 • Students can name the basic concepts in Statistics. They are able to explain them using appropriate excession of the samples. 5 • Students can ondel statistical problems with the help of the concepts studied in this course. Moreover solving them by applying established methods. They are able to use the statistical software R. 5 • Students are able to discover and verify further logical connections between the concepts studied in this course. Moreover solving them by applying established methods. They are able to use the statistical software R. 5 • Students are able to discover and verify further logical connections between the concepts studied in this course. Moreover solving them by appropriately (e.g. during exercise class). • • Students are able to work together (e.g. on their regular home work) in heterogeneously composed to their results appropriately (e.g. during exercise class). • • In doing so, they can communicate new concepts according to the needs of their cooperating partners design examples to check and deepen the understanding of complex concepts on their own. They can sp precisely and know where to get help in solving them. • Students have developed sufficient persistence	

Course L2430: Statistics	
Тур	Lecture
Hrs/wk	3
CP	4
Workload in Hours	Independent Study Time 78, Study Time in Lecture 42
Lecturer	Prof. Matthias Schulte
Language	DE/EN
Cycle	WiSe
Content	 Multivariate distributions and stochastic convergence Point estimators Confidence intervals Hypothesis testing Nonparametric statistics Linear Regression Time series analysis Statistical software (R)
Literature	 L. Dümbgen (2016): Einführung in die Statistik, Birkhäuser. L. Dümbgen (2003): Stochastik für Informatiker, Springer. HO. Georgii (2012): Stochastics: Introduction to Probability and Statistics, 2nd edition, De Gruyter. N. Henze (2018): Stochastik für Einsteiger, 12th edition, Springer. A. Klenke (2014): Probability Theory: A Comprehensive Course, 2nd edition, Springer. U. Krengel (2005): Einführung in die Wahrscheinlichkeitstheorie und Statistik, 8th edition, Vieweg.

Course L2431: Statistics	ourse L2431: Statistics		
Тур	Recitation Section (small)		
Hrs/wk	1		
CP	2		
Workload in Hours	ependent Study Time 46, Study Time in Lecture 14		
Lecturer	Matthias Schulte		
Language	N		
Cycle	ViSe		
Content	e interlocking course		
Literature	See interlocking course		

Module M0562: Comp	utability and Complexity Theory			
Courses				
Title		Тур	Hrs/wk	СР
Computability and Complexity Theory (L0166)		Lecture	2	3
Computability and Complexity Theo	ory (L0167)	Recitation Section (small)	2	3
Module Responsible	Prof. Martin Kliesch			
Admission Requirements	None			
Recommended Previous	Discrete Algebraic Structures, Automata Theory	, Logic, and Formal Language Theory		
Knowledge				
Educational Objectives	After taking part successfully, students have rea	ached the following learning results		
Professional Competence				
Knowledge				
	Basic models of computation (finite state	machines, Turing machines)		
	Decision problems and formal languages Citate purchasing of account time			
	Gödel numbering of computations			
	Universal computability			
	Decidable and undecidable problems			
	Reductions, diagonalization, Rice's theore Time and anose complexity			
	Time and space complexity The complexity classes B and NB			
	The complexity classes P and NP			
	Hierarchy theorems Belynamial time reductions NB complete			
	 Polynomial time reductions, NP-complete Cook-Levin theorem 	ness		
	Uniform circuit families			
Skills	After completing this module, students are able	to		
	 reproduce the knowledge taught in the comparison 	ourse.		
	 reproduce the knowledge targin in the course, reproduce simpler proofs of the course and reproduce the ideas of the more complicated ones, establish connections between the concepts taught, and apply the learned knowledge to concrete problems. 			
Personal Competence				
Social Competence	After completing this module, students are able to work on subject-specific tasks alone or in a group and to present the result			
	appropriately.			
Autopomy	After completion of this module, students are	able to work out sub-areas of the subject	area independe	ntly on the basis o
Autonomy	textbooks and other literature, to summarize an			
		a present the dequired knowledge and to mik	te to the content	s of other courses.
Workload in Hours	Independent Study Time 124, Study Time in Leo	ture 56		
Credit points	6			
Course achievement	Compulsory Bonus Form	Description		
	Yes 15 % Excercises			
Examination	Written exam			
Examination duration and	90 min			
scale				
Assignment for the	General Engineering Science (German program,	7 semester): Specialisation Computer Science	e: Elective Comp	ulsony
Following Curricula	General Engineering Science (German program, General Engineering Science (German program,			-
i onowing curricula	Computer Science: Core Qualification: Compulse		cente compuisor	J
	Data Science: Core Qualification: Elective Comp			
	Data Science: Specialisation I. Mathematics/Con	-		
	Computer Science in Engineering: Specialisation			
	Technomathematics: Specialisation II. Information			
Course L0166: Computability	and Complexity Theory			

Course L0100: Computability	and complexity meory	
Тур	Lecture	
Hrs/wk	2	
CP	3	
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28	
Lecturer	rtin Kliesch	
Language		
Cycle	SoSe	
Content		
Literature		

Course L0167: Computability	urse L0167: Computability and Complexity Theory		
Тур	Recitation Section (small)		
Hrs/wk	2		
CP	3		
Workload in Hours	pendent Study Time 62, Study Time in Lecture 28		
Lecturer	Martin Kliesch		
Language	DE/EN		
Cycle	SoSe		
Content	e interlocking course		
Literature	See interlocking course		

Module M0732: Softw	are Engineerin	g			
Courses					
Title			Tree	Line (usis	СР
Software Engineering (L0627)			Typ Lecture	Hrs/wk 2	3
Software Engineering (L0628)			Recitation Section (sm		3
Module Responsible	Prof. Sibvlle Schupp		· · · · · · · · · · · · · · · · · · ·		-
Admission Requirements					
Recommended Previous					
Knowledge	 Automata theorem 	ry and formal language	es		
2	 Procedural prog 	gramming or Functiona	al programming		
	 Object-oriented 	l programming, algorit	hms, and data structures		
Educational Objectives	After taking part succ	essfully, students have	e reached the following learning results		
Professional Competence					
Knowledge	Students explain the	phases of the soft	ware life cycle, describe the fundamen	tal terminology and	concepts of softw
	engineering, and para	phrase the principles	of structured software development. They	give examples of softw	vare-engineering ta
	of existing large-scal	e systems. They writ	e test cases for different test strategies	and devise specificat	ions or models us
	different notations, and critique both. They explain simple design patterns and the major activities in requirements an maintenance, and project planning.				equirements analy
CI-111-	For a since book in th				
SKIIIS	-	-	students identify the corresponding pha		
	choose the proper approach for quality assurance. They design tests for realistic systems, assess the quality of the tests, and f errors at different levels. They apply and modify non-executable artifacts. They integrate components based on interfa specifications.				
	specifications.				
Personal Competence					
Social Competence	Students practice peer programming. They explain problems and solutions to their peer. They communicate in English.				
Autonomy	Using on-line quizzes	and accompanying m	naterial for self study, students can asses	s their level of knowle	dae continuously :
hatehenny			problems, they receive additional feedbac		age continuouoly (
	Independent Study Tir	me 124, Study Time in	Lecture 56		
Credit points		Form	Description		
Course achievement	Compulsory Bonus Yes 15 %	Excercises	Description		
Examination	Written exam	Excercises			
Examination duration and					
scale	50 mm				
Assignment for the	General Engineering S	Science (German progr	am, 7 semester): Specialisation Computer	Science: Elective Com	pulsory
Following Curricula	Computer Science: Co	ore Qualification: Comp	oulsory		
-			Computer Science: Elective Compulsory		
			ation I. Computer Science: Elective Compul	sory	
	Technomathematics:			-	

	Lecture			
Hrs/wk				
СР				
Workload in Hours	pendent Study Time 62, Study Time in Lecture 28			
Lecturer	Prof. Sibylle Schupp			
Language	EN			
Cycle	SoSe			
Content				
	Model-based software engineering			
	 Information modeling (use case diagrams) 			
	 Behavioral modeling (finite state machines, Petri Nets, behavioral UML diagrams) 			
	 Structural modeling (OOA, UML class diagrams, OCL) 			
	 Model-based testing 			
	Engineering software products			
	Agile processes			
	• Architecture			
	Code-based testing			
	System-level testing			
	Software management			
	Maintenance			
	Project management			
	Software processes			
Literature	Ian Sommerville, Engineering Software Products: An Introduction to Modern Software Engineering, Pearson 2020.			
	Kassem A. Saleh, Software Engineering, J. Ross Publishing 2009.			

Course L0628: Software Eng	urse L0628: Software Engineering		
Тур	Recitation Section (small)		
Hrs/wk	2		
CP	3		
Workload in Hours	ependent Study Time 62, Study Time in Lecture 28		
Lecturer	Sibylle Schupp		
Language			
Cycle	SoSe		
Content	e interlocking course		
Literature	See interlocking course		

Courses			
Fitle _ab Cyber-Physical Systems (L1740	Typ Hrs/wk CP 0) Project-/problem-based Learning 4 6		
Module Responsible			
Admission Requirements	None		
Recommended Previous			
Knowledge			
Educational Objectives	After taking part successfully, students have reached the following learning results		
Professional Competence			
Knowledge	e Cyber-Physical Systems (CPS) are tightly integrated with their surrounding environment, via sensors, A/D and D/A converters, ar actors. Due to their particular application areas, highly specialized sensors, processors and actors are common. Accordingly, the is a large variety of different specification approaches for CPS - in contrast to classical software engineering approaches.		
	Based on practical experiments using robot kits and computers, the basics of specification and modelling of CPS are taught. T lab introduces into the area (basic notions, characteristical properties) and their specification techniques (models of computatic hierarchical automata, data flow models, petri nets, imperative approaches). Since CPS frequently perform control tasks, the la experiments will base on simple control applications. The experiments will use state-of-the-art industrial specification to (MATLAB/Simulink, LabVIEW, NXC) in order to model cyber-physical models that interact with the environment via sensors an actors.		
Skills	After successful attendance of the lab, students are able to develop simple CPS. They understand the interdependencies betwee CPS and its surrounding processes which stem from the fact that a CPS interacts with the environment via sensors, A/D converted digital processors, D/A converters and actors. The lab enables students to compare modelling approaches, to evaluate th advantages and limitations, and to decide which technique to use for a concrete task. They will be able to apply these technique to practical problems. They obtain first experiences in hardware-related software development, in industry-relevant specificati tools and in the area of simple control applications.		
Personal Competence			
Social Competence	Students are able to solve similar problems alone or in a group and to present the results accordingly.		
Autonomy	Students are able to acquire new knowledge from specific literature and to associate this knowledge with other classes.		
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56		
Credit points	6		
Course achievement	None		
Examination	Written elaboration		
Examination duration and	Execution and documentation of all lab experiments		
scale			
Assignment for the	General Engineering Science (German program, 7 semester): Specialisation Computer Science: Elective Compulsory		
Following Curricula	Computer Science: Specialisation II. Mathematics and Engineering Science: Elective Compulsory		
	Computer Science in Engineering: Specialisation II. Mathematics & Engineering Science: Elective Compulsory		
	Mechatronics: Core Qualification: Elective Compulsory		

Course L1740: Lab Cyber-Ph	ysical Systems
Тур	Project-/problem-based Learning
Hrs/wk	4
СР	6
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56
Lecturer	Prof. Heiko Falk
Language	DE/EN
Cycle	SoSe
Content	 Experiment 1: Programming in NXC Experiment 2: Programming the Robot in Matlab/Simulink Experiment 3: Programming the Robot in LabVIEW
Literature	 Peter Marwedel. Embedded System Design - Embedded System Foundations of Cyber-Physical Systems. 2 nd Edition, Springer, 2012. Begleitende Foliensätze

Courses				
Title		Тур	Hrs/wk	СР
Fundamentals of Operating Systems (L3148)		Lecture	2	3
Fundamentals of Operating System		Recitation Section (small)	2	3
Module Responsible	Prof. Christian Dietrich			
Admission Requirements	None			
Recommended Previous Knowledge		ell as associated tools (editor, linker, compiler) re		
Educational Objectives	After taking part successfully, students have	ve reached the following learning results		
Professional Competence				
Skills	strategies for process scheduling, latency minimization through buffering, and main and background memory manageme Furthermore, they know the topics of security in the operating system context and aspects of system-oriented softw development in C. In the lecture-accompanying exercises, they deepened material practically on the basis programming tasks i from the range of the UNIX system programming. The students are familiar with the operating system functions for sing processor systems. They have become familiar with special issues relating to multiprocessor systems (based on shared memory in passing and in relation to functions for coordinating concurrent programs. Similarly, they know the topic of real-time process to some extent only in relation to process scheduling. Students will be able to use the POSIX system interface to access the various resources of the computing system. They are able grasp technical documentation in order to implement complex interaction protocols. They are able to recognize concurre problems and avoid them with blocking synchronization primitives.			
Personal Competence				
Social Competence	Students are able to discuss and collaboratively present a problem in small groups with reference to operating systems a systems software.			
Autonomy	Students are able to independently prepare and review the lecture content.			
Workload in Hours	Independent Study Time 124, Study Time i	in Lecture 56		
Credit points	6			
Course achievement	None			
Examination	Written exam			
Examination duration and	90 min			
scale				
Assignment for the	General Engineering Science (German prog	gram, 7 semester): Specialisation Computer Scie	nce: Elective Comp	oulsory
Following Curricula	Computer Science: Specialisation I. Compu	ter and Software Engineering: Elective Compulse	ory	
	Computer Science in Engineering: Specialis	sation I. Computer Science: Elective Compulsory		

Course L3148: Fundamentals	s of Operating Systems
Тур	Lecture
Hrs/wk	2
CP	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Prof. Christian Dietrich
Language	DE/EN
Cycle	SoSe
Content	 Basic OS concepts System-oriented software development in C Files and file systems Processes and threads Interrupts, system calls and signals Process scheduling Memory based interaction Resource management, synchronization and jamming Inter-process communication Memory organization Storage virtualization System security and access protection
Literature	 Operating Systems. Internals and Design Principles; William Stallings; Prentice Hall 2008; ISBN: 978-0136006329. Operating System Concepts; Abraham Silberschatz, Greg Gagne, Peter Bear Galvin; John Wiley & Sons, Inc.; 2005 ISBN: 0-471-69466-5. Modern Operating Systems; Andrew S. Tanenbaum; Prentice Hall 2007 ISBN: 978-0136006633 Structured Computer Organization; Andrew S. Tanenbaum; Prentice Hall 2006 ISBN: 978-0131485211.

Course L3149: Fundamentals of Operating Systems		
Тур	Recitation Section (small)	
Hrs/wk	2	
CP	3	
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28	
Lecturer	Prof. Christian Dietrich	
Language	DE/EN	
Cycle	SoSe	
Content	See interlocking course	
Literature	See interlocking course	

Specialization Mechanical Engineering

The educational goal of this Bachelor's program is to develop the skills to select and link fundamental methods and procedures in order to solve technical problems in the field of General Engineering science, especially in the selected subject area of specialisation. Graduates have:

1) Sound knowledge in the subject areas mathematics, thermodynamics, mechanics, electrical Engineering and computer science.

2) A basic knowledge in the field of measurement and control engineering, fluid mechanics and materials science.

3) In-depth knowledge in Engineering applications, especially in the selected subject area of specialisation (product development and manufacturing, material science, aircrafts, energy Engineering, mechatronics, medical engineering, theoretical mechanical engineering). They have in particular the necessary methodological knowledge and its application to engineering problems, taking into account technical specifications and economic and social parameters.

4) The ability to work scientifically and to expand their specialized knowledge independently.

Graduates are able to work responsibly and competently as mechanical engineers, especially in occupations related to the selected subject area of specialisation.

Module M0598: Mechanical Engineering: Design

C							
Courses							
Title					Гур	Hrs/wk	СР
Embodiment Design and 3D-CAD Ir		ractical Training (L0	268)		ecture	2	1
Mechanical Design Project I (L0695					Project-/problem-based Learning	3 3	2
Mechanical Design Project II (L0592 Team Project Design Methodology					Project-/problem-based Learning Project-/problem-based Learning	3	2
					roject-problem-based Learning	L	Ŧ
Module Responsible		luse					
Admission Requirements Recommended Previous	None						
Keconnended Previous	Fundame	entals of Mechanic	al Engineering D	Design			
Kilowieuge	 Mechani 	cs					
	Fundame	entals of Materials	Science				
	 Productiv 	on Engineering					
Educational Objectives	After taking na	rt successfully stu	Idents have read	ched the following			
Professional Competence	Arter taking pa	resuccessiony, see	idents have read		g learning results		
-	After passing t	ne module, studen	its are able to:				
Kilowicage	Arter pussing t	ie module, studen					
	 explain d 	design guidelines f	for machinery pa	arts e.g. consideri	ng load situation, materials ar	nd manufactur	ing requirement
		basics of 3D CAD					
	 explain b 	pasics methods of	engineering des	signing.			
Skills	After passing t	ne module, studen	its are able to:				
	in days and						
	-				umentations e.g. using 3D CAI),	
	_	omponents based on (calculate) used		ennes autonomou	siy,		
				ring docign tacks	systamtically and solution-orie	ntod	
		eativity technique			systamlically and solution-one	niceu,	
	- upply cit	cutivity teeninque.	5 m ceams.				
Personal Competence							
Social Competence	After passing the	ne module, studen	its are able to:				
	 develop and evaluate solutions in groups including making and documenting decisions, 						
		 moderate the use of scientific methods, 					
	 present and discuss solutions and technical drawings within groups, 						
	 reflect the own results in the work groups of the course. 						
Autonomy	Students are al	ble					
	• to optim	ato their lovel of l		a activating math	ade within the lactures (a.g. w	ith clickors)	
		engineering desig			ods within the lectures (e.g. w	itii tiitkeis),	
	• 10 50170	engineering desig	jii tusks systema	adically.			
Workload in Hours	Independent St	udy Time 40, Stud	dy Time in Lectur	ire 140			
Credit points							
Course achievement				Description			
	Yes Nor				onstruktionsmethodik		
	Yes Nor Yes Nor			Konstruktionsp Konstruktionsp	,		
	Yes Nor Yes Nor			3D-CAD-Praktil	-		
Examination	Written exam	ie whiteh er		SE CAD-HUKU			
Examination duration and							
scale	100						
Assignment for the	General Engine	ering Science (Co	rman program	7 semester): Spor	cialisation Mechanical Enginee	ring: Compute	orv
-	-	-			cialisation Mechanical Enginee		-
i onowing curricula	-	-			cialisation Biomedical Engineer		-
	-	ical Engineering: C			Electron biomedicar Engineer		,
	-	ience: Specialisati					
		ience: Specialisati			oulsory		
		ience: Specialisati			-		

Green Technologies: Energy, Water, Climate: Specialisation Energy Technology: Elective Compulsory Mechanical Engineering: Core Qualification: Compulsory Mechatronics: Core Qualification: Compulsory Naval Architecture: Core Qualification: Compulsory

Тур
Hrs/wk
СР
Workload in Hours
Lecturer
Language
Cycle
Content
Literature

Course L0695: Mechanical D	esign Project I
Тур	Project-/problem-based Learning
Hrs/wk	3
CP	2
Workload in Hours	Independent Study Time 18, Study Time in Lecture 42
Lecturer	Prof. Thorsten Schüppstuhl
Language	DE
Cycle	WiSe
Content	 Create a technical documentation of an existing mechanical model Consolidation of the following aspects of technical drawings: Presentation of technical objects and standardized parts (bearings, seals, shaft-hub joints, detachable connections, springs, axes and shafts) Sectional views Dimensioning Tolerances and surface specifications Creating a tally sheet
Literature	 Hoischen, H.; Hesser, W.: Technisches Zeichnen. Grundlagen, Normen, Beispiele, darstellende Geometrie, 33. Auflage. Berlin 2011. Labisch, S.; Weber, C.: Technisches Zeichnen. Selbstständig lernen und effektiv üben, 4. Auflage. Wiesbaden 2008. Fischer, U.: Tabellenbuch Metall, 43. Auflage. Haan-Gruiten 2005.

Course L0592: Mechanical D	esign Project II
Тур	Project-/problem-based Learning
Hrs/wk	3
CP	2
Workload in Hours	Independent Study Time 18, Study Time in Lecture 42
Lecturer	Prof. Wolfgang Hintze
Language	DE
Cycle	SoSe
Content	 Generation of sketches for functions and sub-functions Approximately calculation of shafts Dimension of bearings, screw connections and weld Generation of engineering drawings (assembly drawings, manufacturing drawing)
Literature	 Dubbel, Taschenbuch für Maschinenbau, Beitz, W., Küttner, KH, Springer-Verlag. Maschinenelemente, Band I - III, Niemann, G., Springer-Verlag. Maschinen- und Konstruktionselemente, Steinhilper, W., Röper, R., Springer-Verlag. Einführung in die DIN-Normen, Klein, M., Teubner-Verlag. Konstruktionslehre, Pahl, G., Beitz, W., Springer-Verlag.

Course L0267: Team Project	Design Methodology
Тур	Project-/problem-based Learning
Hrs/wk	2
CP	1
Workload in Hours	Independent Study Time 2, Study Time in Lecture 28
Lecturer	Prof. Dieter Krause
Language	DE
Cycle	SoSe
Content	 Introduction to engineering designing methodology Team Project Design Methodology Creating requirement lists Problem formulation Creating functional structures Finding solutions Evaluation of the found concepts Documentation of the taken methodological steps and the concepts using presentation slides
Literature	 Dubbel, Taschenbuch für den Maschinenbau; Grote, KH., Feldhusen, J.(Hrsg.); Springer-Verlag, aktuelle Auflage. Maschinenelemente, Band I-III; Niemann, G., Springer-Verlag, aktuelle Auflage. Maschinen- und Konstruktionselemente; Steinhilper, W., Röper, R., Springer Verlag, aktuelle Auflage. Einführung in die DIN-Normen; Klein, M., Teubner-Verlag. Konstruktionslehre, Pahl, G.; Beitz, W., Springer-Verlag, aktuelle Auflage. Maschinenelemente 1-2; Schlecht, B., Pearson Verlag, aktuelle Auflage. Maschinenelemente - Gestaltung, Berechnung, Anwendung; Haberhauer, H., Bodenstein, F., Springer-Verlag, aktuelle Auflage. Roloff/Matek Maschinenelemente; Wittel, H., Muhs, D., Jannasch, D., Voßiek, J., Springer Vieweg, aktuelle Auflage. Sowie weitere Bücher zu speziellen Themen

Courses				
Title		Тур	Hrs/wk	СР
Advanced Mechanical Engineering	Design II (10264)	Lecture	2	2
Advanced Mechanical Engineering		Recitation Section (large)	2	1
Advanced Mechanical Engineering		Lecture	2	2
Advanced Mechanical Engineering	Design I (L0263)	Recitation Section (large)	2	1
Module Responsible	Prof. Dieter Krause			
Admission Requirements	None			
Recommended Previous				
Knowledge	 Fundamentals of Mechanical Engine 	eering Design		
	Mechanics			
	Fundamentals of Materials Science			
	Production Engineering			
Educational Objectives	After taking part successfully, students ha	ave reached the following learning results		
Professional Competence				
Knowledge	After passing the module, students are at	ble to:		
	evolain complex working principles	and functions of machine elements and of basic e	elements of fluidics	
		teria, application scenarios and practical examples		
	 indicate the background of dimens 		s of complex mach	ine elements,
	· indicate the background of amens			
Skills	After passing the module, students are at	ble to:		
	 accomplish dimensioning calculation 	ons of covered machine elements.		
		module to new requirements and tasks (problem s	olvina skills).	
	 recognize the content of technical 		5 , ,	
	 evaluate complex designs, technica 	5		
Personal Competence				
Social Competence	Students are able to discuss techni	cal information in the lecture supported by actival	ing methods.	
Autonomy				
		deepen their acquired knowledge in exercises.		
		ional knowledge and to recapitulate poorly unde	rstood content e.o	g. by using the vid
	recordings of the lectures.			
Workload in Hours	Independent Study Time 68, Study Time i	n Lecture 112		
Credit points	6			
Course achievement	None			
Examination	Written exam			
Examination duration and	120			
scale				
		ogram, 7 semester): Specialisation Mechanical Eng	ineering: Compuls	ory
Following Curricula	Energy and Environmental Engineering: C			
		ry Course Core Studies: Elective Compulsory		
	Engineering Science: Specialisation Mecha	anical Engineering: Compulsory		
	General Engineering Science (English pro	gram, 7 semester): Specialisation Mechanical Engi	neering: Compulso	ory
	Mechanical Engineering: Core Qualificatio	n: Compulsory		
	Naval Architecture: Core Qualification: Co	mpulsory		

Course L0264: Advanced Med	chanical Engineering Design II
	Lecture
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Prof. Dieter Krause, Prof. Dr. Nikola Bursac
Language	DE
Cycle	SoSe
Content	Advanced Mechanical Engineering Design I & II
	Lecture
	Fundamentals of the following machine elements:
	Linear rolling bearings
	• Axes & shafts
	Seals
	Clutches & brakes
	• Belt & chain drives
	Gear drives
	Epicyclic gears
	Crank drives
	Sliding bearings
	Elements of fluidics
	Exercise
	Calculation methods of the following machine elements:
	Linear rolling bearings
	• Axes & shafts
	Clutches & brakes
	• Belt & chain drives
	Gear drives
	• Epicyclic gears
	Crank gears
	 Sliding bearings Calculations of hydrostatic systems (fluidics)
Literature	. Dubbal Tarahashash ("adas Marshingkas, Casha K.U. Faldhuara I.(Usar). Casiana Madas alturlla Adlasa
	 Dubbel, Taschenbuch f ür den Maschinenbau; Grote, KH., Feldhusen, J.(Hrsg.); Springer-Verlag, aktuelle Auflage. Maschinenelemente, Band I-III; Niemann, G., Springer-Verlag, aktuelle Auflage.
	 Maschinen- und Konstruktionselemente; Steinhilper, W., Röper, R., Springer Verlag, aktuelle Auflage.
	 Einführung in die DIN-Normen; Klein, M., Teubner-Verlag.
	 Konstruktionslehre, Pahl, G.; Beitz, W., Springer-Verlag, aktuelle Auflage.
	 Maschinenelemente 1-2; Schlecht, B., Pearson Verlag, aktuelle Auflage.
	 Maschinenelemente - Gestaltung, Berechnung, Anwendung; Haberhauer, H., Bodenstein, F., Springer-Verlag, aktuelle
	Auflage.
	Roloff/Matek Maschinenelemente; Wittel, H., Muhs, D., Jannasch, D., Voßiek, J., Springer Vieweg, aktuelle Auflage.
	Sowie weitere Bücher zu speziellen Themen

Course L0265: Advanced Mechanical Engineering Design II		
Тур	Recitation Section (large)	
Hrs/wk	2	
CP	1	
Workload in Hours	Independent Study Time 2, Study Time in Lecture 28	
Lecturer	Prof. Dieter Krause, Prof. Dr. Nikola Bursac	
Language	DE	
Cycle	SoSe	
Content	See interlocking course	
Literature	See interlocking course	

Course L0262: Advanced Me	chanical Engineering Design I
Тур	Lecture
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Prof. Dieter Krause, Prof. Otto von Estorff
Language	DE
Cycle	WiSe
Content	Advanced Mechanical Engineering Design I & II
	Lecture
	Fundamentals of the following machine elements:
	Linear rolling bearings
	• Axes & shafts
	• Seals
	Clutches & brakes
	• Belt & chain drives
	Gear drives
	• Epicyclic gears
	Crank drives
	Sliding bearings
	Elements of fluidics
	Exercise
	Calculation methods of the following machine elements:
	Linear rolling bearings
	• Axes & shafts
	Clutches & brakes
	• Belt & chain drives
	Gear drives
	• Epicyclic gears
	Crank gears
	 Sliding bearings Calculations of hydrostatic systems (fluidics)
	• Calculations of hydrostatic systems (induce)
Literature	
	Dubbel, Taschenbuch für den Maschinenbau; Grote, KH., Feldhusen, J.(Hrsg.); Springer-Verlag, aktuelle Auflage.
	Maschinenelemente, Band I-III; Niemann, G., Springer-Verlag, aktuelle Auflage.
	 Maschinen- und Konstruktionselemente; Steinhilper, W., Röper, R., Springer Verlag, aktuelle Auflage. Einführung in die DIN-Normen; Klein, M., Teubner-Verlag.
	 Konstruktionslehre, Pahl, G.; Beitz, W., Springer-Verlag, aktuelle Auflage.
	 Konstructionsleine, Fain, G., Deitz, W., Springer-Verlag, actuelle Auflage. Maschinenelemente 1-2; Schlecht, B., Pearson Verlag, aktuelle Auflage.
	 Maschinenelemente - Gestaltung, Berechnung, Anwendung; Haberhauer, H., Bodenstein, F., Springer-Verlag, aktuelle
	Auflage.
	Roloff/Matek Maschinenelemente; Wittel, H., Muhs, D., Jannasch, D., Voßiek, J., Springer Vieweg, aktuelle Auflage.
	Sowie weitere Bücher zu speziellen Themen
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Course L0263: Advanced Mechanical Engineering Design I		
Тур	Recitation Section (large)	
Hrs/wk	2	
CP	1	
Workload in Hours	Independent Study Time 2, Study Time in Lecture 28	
Lecturer	Prof. Dieter Krause, Prof. Otto von Estorff	
Language	DE	
Cycle	WiSe	
Content	See interlocking course	
Literature	See interlocking course	

ourses					
itle		Tun	Hrs/wk	СР	
undamentals of Materials Science	1 (11085)	Typ Lecture	2	2	
	II (Advanced Ceramic Materials, Polymers and Composites) (L0506)	Lecture	2	2	
nysical and Chemical Basics of Ma	terials Science (L1095)	Lecture	2	2	
Module Responsible	Prof. Jörg Weißmüller				
Admission Requirements	None				
Recommended Previous	Highschool-level physics, chemistry und mathematics				
Knowledge					
Educational Objectives	After taking part successfully, students have reached the follow	ing learning results			
Professional Competence		5 5			
Knowledge	The students have acquired a fundamental knowledge on r comprehensively. Fundamental knowledge here means specific phase transformations, corrosion and mechanical properties. Th for materials and can identify relevant approaches for cha phenomena back to the underlying physical and chemical laws	ally the issues of ato ne students know abo racterizing specific p	mic structure, microstructu out the key aspects of chara	ire, phase diagrar acterization meth	
Skills	The students are able to trace materials phenomena back t phenomena here refers to mechanical properties such as stree resistance, and to phase transformations such as solidificatio between processing conditions and the materials microstructu material's behavior.	ngth, ductility, and s	tiffness, chemical propertie nelting. The students can	es such as corros explain the relat	
Personal Competence					
Social Competence	-				
Autonomy	-				
Workload in Hours	Independent Study Time 96, Study Time in Lecture 84				
Credit points	6				
Course achievement	None				
Examination	Written exam				
Examination duration and	180 min				
scale					
Assignment for the	General Engineering Science (German program, 7 semester): S	pecialisation Mechan	ical Engineering: Compulso	ry	
	General Engineering Science (German program, 7 semester): S				
	General Engineering Science (German program, 7 semester): S	pecialisation Naval A	rchitecture: Compulsory		
	General Engineering Science (German program, 7 semester): S	pecialisation Advance	ed Materials: Compulsory		
	Data Science: Specialisation II. Application: Elective Compulsory				
	Digital Mechanical Engineering: Core Qualification: Compulsory				
	Green Technologies: Energy, Water, Climate: Specialisation Energy Technology: Elective Compulsory				
	Logistics and Mobility: Specialisation Engineering Science: Elective Compulsory				
	Logistics and Mobility: Specialisation Production Management and Processes: Elective Compulsory				
	Mechanical Engineering: Core Qualification: Compulsory				
	Mechatronics: Core Qualification: Compulsory				
	Naval Architecture: Core Qualification: Compulsory				
	Technomathematics: Specialisation III. Engineering Science: Ele	ective Compulsory			
	Engineering and Management - Major in Logistics and Mobility	ty: Specialisation Pro	duction Management and	Processes: Elect	

course L1005. Fundamentals	
Тур	Lecture
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Prof. Jörg Weißmüller
Language	DE
Cycle	WiSe
Content	
Literature	Vorlesungsskript
	W.D. Callister: Materials Science and Engineering - An Introduction. 5th ed., John Wiley & Sons, Inc., New York, 2000, ISBN 0-471- 32013-7 P. Haasen: Physikalische Metallkunde. Springer 1994

Course L0506: Fundamentals	s of Materials Science II (Advanced Ceramic Materials, Polymers and Composites)
Тур	Lecture
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Prof. Bodo Fiedler, Prof. Gerold Schneider
Language	DE
Cycle	SoSe
Content	Chemische Bindungen und Aufbau von Festkörpern; Kristallaufbau; Werkstoffprüfung; Schweißbarkeit; Herstellung von Keramiken;
	Aufbau und Eigenschaften der Keramik; Herstellung, Aufbau und Eigenschaften von Gläsern; Polymerwerkstoffe,
	Makromolekularer Aufbau; Struktur und Eigenschaften der Polymere; Polymerverarbeitung; Verbundwerkstoffe
Literature	Vorlesungsskript
	W.D. Callister: Materials Science and Engineering -An Introduction-5th ed., John Wiley & Sons, Inc., New York, 2000, ISBN 0-471- 32013-7

Course L1095: Physical and O	Chemical Basics of Materials Science
Тур	Lecture
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Gregor Vonbun-Feldbauer
Language	DE
Cycle	WiSe
Content	 Motivation: "Atoms in Mechanical Engineering?" Basics: Force and Energy The electromagnetic Interaction "Detour": Mathematics (complex e-funktion etc.) The atom: Bohr's model of the atom Chemical bounds The multi part problem: Solutions and strategies Descriptions of using statistical thermodynamics Elastic theory of atoms Consequences of atomar properties on makroskopic Properties: Discussion of examples (metals, semiconductors, hybrid systems)
Literature	 Für den Elektromagnetismus: Bergmann-Schäfer: "Lehrbuch der Experimentalphysik", Band 2: "Elektromagnetismus", de Gruyter Für die Atomphysik: Haken, Wolf: "Atom- und Quantenphysik", Springer Für die Materialphysik und Elastizität: Hornbogen, Warlimont: "Metallkunde", Springer

Module M0680: Fluid	Dynamics			
	-			
Courses				
Title		Тур	Hrs/wk	СР
Fluid Mechanics (L0454)		Lecture	3	4
Fluid Mechanics (L0455)		Recitation Section (large)	2	2
Module Responsible	Prof. Thomas Rung			
Admission Requirements	None			
Recommended Previous	Students should have sound knowledge of engineering mat	hematics, engineering mechanics	and thermodyna	nics.
Knowledge				
Educational Objectives	After taking part successfully, students have reached the fo	llowing learning results		
Professional Competence				
Skills	are familiar with the similarities and differences between fluid mechanics and neighbouring subjects (thermodynamics, structura mechanics). Students can scientifically outline the rationale of flow physics using mathematical models. They are familiar wit most performance analysis methods -in particular their realms and limitations- and the prediction of fluid engineering devices. Students are able to apply fluid-engineering principles and flow-physics models for the analysis of technical systems. They are abl			
Personal Competence	to explain physical relationships used to design fluid engineering devices. The lecture enables the student to carry out a necessary theoretical calculations for the fluid dynamic design of engineering devices on a scientific level.			
Social Competence	The students are able to discuss problems, present the re- address given technical goals.	sults of their own analysis, and jc	intly develop sol	ution strategies th
Autonomy	The students are able to develop solution strategies for co results as well as external data with regards to the plausibil		ney are able to c	ritically analyse ov
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	General Engineering Science (German program, 7 semester): Specialisation Mechanical Engin	eering: Compulso	ory
Following Curricula	General Engineering Science (German program, 7 semester): Specialisation Biomedical Engin	eering: Compulso	ory
	General Engineering Science (German program, 7 semester): Specialisation Naval Architectur	e: Compulsory	
	Mechanical Engineering: Core Qualification: Compulsory			
	Naval Architecture: Core Qualification: Compulsory			
	Technomathematics: Specialisation III. Engineering Science	Elective Compulsory		

Course L0454: Fluid Mechani	ics
Тур	Lecture
Hrs/wk	3
CP	4
Workload in Hours	Independent Study Time 78, Study Time in Lecture 42
Lecturer	Prof. Thomas Rung
Language	DE/EN
Cycle	SoSe
Content	 continuum physics definition of fluids, difference to solids/structures and material properties of fluids dimensional analysis and similitude fluid forces and fluid statics transport and conservation of mass, momentum & energy fluid kinematics technically relevant flow models for incompressible fluids control volume & stream tube analysis vortical flow models potential flows boundary layer flows different types of conservation equations and their realm (Navier-Stokes/Euler/Bernoulli equations) analytical solutions for Navier-Stokes systems Analysis of internal flows (channels, pipes, open channels) and external flows, fundamentals of wing aerodynamics turbulent flows fundamentals of gas dynamics (1D compressible flows)
Literature	 the course primarily refers to / das Modul stütz sich bevorzugt auf : Munson, B.R.; Rothmayer, A.P.; Okiishi, T.H.; Huebsch, W.W.: Fundamentals of Fluid Mechanics, John Wiley & Sons. Spurk, J.; Aksel, N.: Strömungslehre, Springer. Schade, H.; Kunz, E., Kameier, F.; Paschereit, C.O.: Strömungslehere, De Gruyter. Herwig, H.: Strömungsmechanik, Springer. Herwig, H.: Strömungsmechanik von A-Z, Vieweg.

Course L0455: Fluid Mechani	urse L0455: Fluid Mechanics	
Тур	Recitation Section (large)	
Hrs/wk	2	
СР	2	
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28	
Lecturer	Prof. Thomas Rung	
Language	DE/EN	
Cycle	SoSe	
Content	See interlocking course	
Literature	See interlocking course	

Courses					
Title		Тур	Hrs/wk	СР	
Computational Mechanics (Exercise	es) (L1138)	Recitation Section (small)	2	2	
Computational Multibody Dynamics	s (L1137)	Integrated Lecture	2	2	
Computational Stuctural Mechanics	; (L2475)	Integrated Lecture	2	2	
Module Responsible	Prof. Robert Seifried				
Admission Requirements	None				
Recommended Previous	Mathematics I-III and Engineering Mechanics	1-111			
Knowledge					
Educational Objectives	After taking part successfully, students have	reached the following learning results			
Professional Competence					
Knowledge	The students can				
		d in merchanised exchange			
	 describe the axiomatic procedure use explain important steps in model desi 				
	 present technical knowledge. 	yn,			
	• present technical knowledge.				
Skills	The students can				
	- evelope the important planants of methomstical / mechanical applying and model formation, and apply it to the control to				
	 explain the important elements of mathematical / mechanical analysis and model formation, and apply it to the context of their own problems; 				
	 apply basic methods from numerical mechanics to engineering problems; 				
	 apply basic methods from numerical mechanics to engineering problems; estimate the reach and boundaries of the methods and extend them to be applicable to wider problem sets. 				
	• estimate the reach and boundaries of	the methods and extend them to be applicable	to wider problem	5005.	
Personal Competence					
Social Competence	The students can work in groups and suppor	t each other to overcome difficulties.			
Διιτοροπγ	Students are canable of determining their ov	vn strengths and weaknesses and to organize tl	eir time and learn	ing based on those	
Autonomy	Students are capable of acternining their of			ing based on those	
Workload in Hours	Independent Study Time 96, Study Time in L	ecture 84			
Credit points	6				
Course achievement	None				
Examination	Written exam				
Examination duration and	120 min				
scale					
Assignment for the	General Engineering Science (German progr	am, 7 semester): Specialisation Mechanical Eng	ineering: Compuls	ory	
Following Curricula					
	General Engineering Science (German program, 7 semester): Specialisation Naval Architecture: Compulsory				
	Energy Systems: Technical Complementary Course Core Studies: Elective Compulsory				
	Mechanical Engineering: Core Qualification: Compulsory				
	Mechatronics: Core Qualification: Compulsory				
	Naval Architecture: Core Qualification: Comp	ulsory			
	Technomathematics: Specialisation III. Engin	eering Science: Elective Compulsory			
	Theoretical Mechanical Engineering: Technic	al Complementary Course Core Studies: Electiv	e Compulsory		

course L1138. computationa	
Тур	Recitation Section (small)
Hrs/wk	2
СР	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Prof. Robert Seifried, Prof. Christian Cyron
Language	DE
Cycle	SoSe
Content	
Literature	K. Magnus, H.H. Müller-Slany: Grundlagen der Technischen Mechanik. 7. Auflage, Teubner (2009).
	D. Gross, W. Hauger, J. Schröder, W. Wall: Technische Mechanik 1-4. 11. Auflage, Springer (2011).

Course L1137: Computationa	Il Multibody Dynamics
Тур	Integrated Lecture
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Prof. Robert Seifried
Language	DE
Cycle	SoSe
Content	 Linear versus nonlinear vibration Numerical methods for time integration Concepts from analytical mechanics Spatial multibody systems Linearization of multibody systems Vibrations with multiple degrees of freedom: free, damped, forced, modal transformation Impacts Introduction to Matlab
Literature	K. Magnus, H.H. Müller-Slany: Grundlagen der Technischen Mechanik. 7. Auflage, Teubner (2009). D. Gross, W. Hauger, J. Schröder, W. Wall: Technische Mechanik 1-4. 11. Auflage, Springer (2011). W. Schiehlen, P. Eberhard: Technische Dynamik, Springer (2012).

Course L2475: Computationa	Il Stuctural Mechanics			
Тур	Integrated Lecture			
Hrs/wk	2			
CP	2			
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28			
Lecturer	Prof. Christian Cyron			
Language	DE			
Cycle	SoSe			
Content	The lecture Computational Structural Mechanics extends the content of the lecture Engineering Mechanic II. It bridges the gap			
	between the manual calculation of mechanical stress and deformation in systems with a particularly simple geometry and the			
	efficent computer-based computation of general mechanical systems:			
	Basics of linear continuum mechanics			
	Planar structures: plate, membrane, slab			
	Linientragwerke: beam, cable, truss			
	Weak form and Galerkin's method			
	Finite element method: theory and application			
	Principles of mechanics: principle of virtual work, virtual displacements, virtual forces			
Literature	Gross, Hauger, Wriggers, "Technische Mechanik 4", Springer			

Courses					
Title		Тур	Hrs/wk	СР	
Practical Course: Measurement and Control Systems (L1119) Measurement Technology for Mechanical Engineering (L1116)		Practical Course Lecture	2	2 2	
Measurement Technology for Mech		Practical Course	2	2	
		Tractical Course	2	2	
Module Responsible					
Admission Requirements					
Recommended Previous Knowledge	Basic knowledge of physics, chemistry and e	electrical engineering			
	After taking part successfully, students have	weeked the following learning yearst			
Educational Objectives	After taking part successfully, students have	reached the following learning results			
Professional Competence					
Knowledge	Students are able to name the most impor Calibration, Static and Dynamic Properties of		nology (Quantities ar	d Units, Uncertain	
		uring methods for different kinds of quantit	ies to be maesured	(Electrical Quantiti	
	Temperature, mechanical quantities, Flow,	lime, Frequency).			
	They can describe important methods of che	emical Analysis (Gas Sensors, Spectroscopy,	Gas Chromatography	·)	
Skills	Students can select suitable measuring met	hods to given problems and can use refering	measurement device	es in practice.	
	The students are able to orally explain issue	es in the subject area of measurement tech	nology and solution a	annroaches as wel	
	place the issues into the right context and a		nology and solution c	ipprodenes as we	
Personal Competence					
Social Competence	Students can arrive at work results in group	s and document them in a common report.			
Autonomy	Students are able to familiarize themselves	with new measurement technologies.			
,					
Workload in Hours	Independent Study Time 96, Study Time in I	Lecture 84			
Credit points	6				
Course achievement	Compulsory Bonus Form	Description			
	Yes None Subject theoretica	i and			
	practical work				
	Subject theoretical and practical work				
Examination duration and		periments on measurements technology ar	nd sucessfull particip	ation in the practi	
scale		nd Control Systems"			
Assignment for the	General Engineering Science (German progr	am, 7 semester): Specialisation Mechanical I	Engineering: Compuls	sory	
Following Curricula		am, 7 semester): Specialisation Biomedical E			
		am, 7 semester): Specialisation Advanced M	aterials: Elective Com	ipulsory	
	Digital Mechanical Engineering: Core Qualifi	cation: Compulsory			
	Engineering Science: Specialisation Mechatr	onics: Compulsory			
	Engineering Science: Specialisation Mechani	ical Engineering: Compulsory			
	Engineering Science: Specialisation Biomedi	cal Engineering: Elective Compulsory			
	Engineering Science: Specialisation Advance	ed Materials: Elective Compulsory			
	General Engineering Science (English progra	am, 7 semester): Specialisation Mechatronics	: Compulsory		
	General Engineering Science (English program, 7 semester): Specialisation Mechanical Engineering: Compulsory				
	General Engineering Science (English program, 7 semester): Specialisation Biomedical Engineering: Elective Compulsory				
	Logistics and Mobility: Specialisation Production Management and Processes: Elective Compulsory				
	Mechanical Engineering: Core Qualification: Compulsory				
	Mechatronics: Specialisation Naval Engineer				
	Mechatronics: Specialisation Electrical Syste				
	Mechatronics: Specialisation Dynamic Syste				
	Mechatronics: Core Qualification: Compulsor				
	Mechatronics: Specialisation Robot- and Mac				
	Mechatronics: Specialisation Medical Engine				
		ering: Compulsory ogistics and Mobility: Specialisation Product	ion Management an	d Processes: Elect	

Course L1119: Practical Cour	rse: Measurement and Control Systems
Тур	Practical Course
Hrs/wk	2
СР	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Prof. Thorsten Kern
Language	DE
	WiSe/SoSe
	The content of experiment 1:
	Accuracy testing of a delta robot: In the course of the experiment, the accuracy of a delta robot is tested through 3 tasks. The first task focuses on the online/offline programming of the robot. The second task deals with sensor calibration. In the third task, the radius of a sphere is determined using three different measurement methods (manual measurement, manual measurement with a sensor, automatic data acquisition and data processing). The content of experiment 3:
	The aim of the task is to enable the parallel kinematics to find objects, grasp them and place them on a static target position For this purpose, the end effector of the kinematics is equipped with an optical sensor (camera), whose characteristics are to be defined. The measuring range of the sensor is to be identified and, based on this, a movement strategy for finding the objects is to be developed and implemented. Once the objects have been found, they are to be picked up with a magnetic gripper and transported to their destination. The content of experiment 4:
	The aim of the task is to enable the parallel kinematics to find objects, grab them and deposit them on a moving platform. For this purpose, the end effector of the kinematics is equipped with an optical sensor (camera), the properties of which were worked out in experiment 3. Based on this, the parallel kinematics should now be able to follow the moving platform. For this purpose, a position control must be developed and implemented. Once the controller has been appropriately configured, the objects can be placed on the moving platform.
Literature	Versuch 1:
	 1)Weck, Manfred; Brecher, Christian. Maschinenarten und Anwendungsbereiche. Springer (Werkzeugmaschinen, 1, Ed. 6). 2005 2)Weck, Manfred; Brecher, Christian. Automatisierung von Maschinen und Anlagen. Springer (Werkzeugmaschinen, 4, Ed. 6). 2006 3)Siciliano, Bruno; Khatib, Oussama. Springer handbook of robotics. Springer. 2008 4)Schüppstuhl, Thorsten. VL Grundlagen der Handhabungs- und Montagetechnik. 2017
	 Versuch 3: 1)Hompel, Michael, Hubert Büchter, and Ulrich Franzke. Identifikationssysteme und Automatisierung. Springer-Verlag, 2007. ArUco Library Documentation, https://docs.google.com/document/d/1QU9KoBtjSM2kF6ITOjQ76xqL7H0TEtXrjJX5kwi9Kgc/edit Stand 10/21 Demant, Christian, Bernd Streicher-Abel, and Axel Springhoff. Industrielle Bildverarbeitung: wie optische Qualitätskontrolle wirklich funktioniert. Springer-Verlag, 2011.
	Versuch 4:
	 1)Will, Thorsten T. C++ Das umfassende Handbuch, Rheinwerk Computing, 2020 2)Hildebrand, Walter. Grundkurs Regelungstechnik : Grundlagen für Bachelorstudiengänge aller technischen Fachrichtungen und Wirtschaftsingenieure, Springer Vieweg, 2013. 3)Erlenkötter, Helmut. C++: Objektorientiertes Programmieren von Anfang an, rororo, 2016
	Bibliography:
	Experiment 1
	 1)Weck, Manfred; Brecher, Christian. Maschinenarten und Anwendungsbereiche. Springer (Werkzeugmaschinen, 1, Ed. 6). 2005 2)Weck, Manfred; Brecher, Christian. Automatisierung von Maschinen und Anlagen. Springer (Werkzeugmaschinen, 4, Ed. 6). 2006 3)Siciliano, Bruno; Khatib, Oussama. Springer handbook of robotics. Springer. 2008 4)Schüppstuhl, Thorsten. VL Grundlagen der Handhabungs- und Montagetechnik. 2017
	Experiment 3:
	 1)Hompel, Michael, Hubert Büchter, and Ulrich Franzke. Identifikationssysteme und Automatisierung. Springer-Verlag, 2007. ArUco Library Documentation, https://docs.google.com/document/d/1QU9KoBtjSM2kF6ITOjQ76xqL7H0TEtXrJX5kwi9Kgc/edit Stand 10/21 Demant, Christian, Bernd Streicher-Abel, and Axel Springhoff. Industrielle Bildverarbeitung: wie optische Qualitätskontrolle wirklich funktioniert. Springer-Verlag, 2011.
	Experiment 4:
	 1)Will, Thorsten T. C++ Das umfassende Handbuch, Rheinwerk Computing, 2020 2)Hildebrand, Walter. Grundkurs Regelungstechnik : Grundlagen für Bachelorstudiengänge aller technischen Fachrichtungen und Wirtschaftsingenieure, Springer Vieweg, 2013. 3)Erlenkötter, Helmut. C++: Objektorientiertes Programmieren von Anfang an, rororo, 2016

Course L1116: Measurement	Technology for Mechanical Engineering
Тур	Lecture
Hrs/wk	2
СР	2
	Prof. Thorsten Kern, Dennis Kähler
Language	
Cycle	
Content	1 Fundamentals 1.1 Quantities and Units
	1.2 Uncertainty
	1.3 Calibration
	1.4 Static and Dynamic Properties of Sensors and Systems
	2 Measurement of Electrical Quantities
	2.1 Current and Voltage
	2.2 Impedance
	2.3 Amplification
	2.4 Oscilloscope
	2.5 Analog-to-Digital Conversion
	2.6 Data Transmission
	3 Measurement of Nonelectric Quantities
	3.1 Temperature
	3.2 Length, Displacement, Angle
	3.3 Strain, Force, Pressure
	3.4 Flow
	3.5 Time, Frequency
Literature	Lerch, R.: "Elektrische Messtechnik; Analoge, digitale und computergestützte Verfahren", Springer, 2006, ISBN: 978-3-540-34055- 3.
	Profos, P. Pfeifer, T.: "Handbuch der industriellen Messtechnik", Oldenbourg, 2002, ISBN: 978-3486217940.

ourse L1118: Measurement Technology for Mechanical Engineering		
Тур	Practical Course	
Hrs/wk	2	
CP	2	
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28	
Lecturer	Prof. Thorsten Kern	
Language	EN	
Cycle	WiSe/SoSe	
Content	See interlocking course	
Literature	See interlocking course	

Focus Biomechanics

	iomechanics get in addition to their core engineering skills, a basic understanding of the medical field focusing on fra ables them to understand operational planning as well as research and development in this highly interdisciplinary ar		
Module M1277: MED	I: Introduction to Anatomy		
Courses			
Fitle ntroduction to Anatomy (L0384)	TypHrs/wkCPLecture23		
Module Responsible	Prof. Udo Schumacher		
Admission Requirements	None		
Recommended Previous	Students can listen to the lectures without any prior knowledge. Basic school knowledge of biology, chemistry / biochem		
Knowledge	physics and Latin can be useful.		
Educational Objectives	After taking part successfully, students have reached the following learning results		
Professional Competence			
Knowledge	The lectures are about microscopic anatomy, describing the microscopic structure of tissues and organs, and about macroscopic anatomy which is about organs and organ systems. The lectures also contain an introduction to cell biology, human developme and to the central nervous system. The fundamentals of radiologic imaging are described as well, using projectional x-ray a cross-sectional images. The Latin terms are introduced.		
Skills	At the end of the lecture series the students are able to describe the microscopic as well as the macroscopic assembly functions of the human body. The Latin terms are the prerequisite to understand medical literature. This knowledge is need understand und further develop medical devices.		
	These insights in human anatomy are the fundamentals to explain the role of structure and function for the developme common diseases and their impact on the human body.		
Personal Competence			
Social Competence	The students can participate in current discussions in biomedical research and medicine on a professional level. The Latin te		
Autonomy	are prerequisite for communication with physicians on a professional level. The lectures are an introduction to the basics of anatomy and should encourage students to improve their knowledg		
	themselves. Advice is given as to which further literature is suitable for this purpose. Likewise, the lecture series encou students to recognize and think critically about biomedical problems.		
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28		
Credit points	3		
Course achievement	None		
Examination	Written exam		
Examination duration and	90 minutes		
scale			
	General Engineering Science (German program, 7 semester): Specialisation Biomedical Engineering: Compulsory		
Following Curricula	General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Biomecha Compulsory		
	Data Science: Specialisation II. Application: Elective Compulsory		
	Electrical Engineering: Specialisation Medical Technology: Elective Compulsory		
	Engineering Science: Specialisation Biomedical Engineering: Compulsory		
	General Engineering Science (English program, 7 semester): Specialisation Biomedical Engineering: Compulsory		
	Mechanical Engineering: Specialisation Biomechanics: Compulsory		
	Biomedical Engineering: Specialisation Medical Technology and Control Theory: Elective Compulsory		
	Biomedical Engineering: Specialisation Management and Business Administration: Elective Compulsory		
	Biomedical Engineering: Specialisation Artificial Organs and Regenerative Medicine: Elective Compulsory		
	Biomedical Engineering: Specialisation Implants and Endoprostheses: Elective Compulsory		
	Technomathematics: Specialisation III. Engineering Science: Elective Compulsory		

Тур	Lecture	
Hrs/wk	2	
CP	3	
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28	
Lecturer	r Prof. Tobias Lange, PD Thorsten Frenzel	
Language		
	soSe	
Content	t General Anatomy	
	1 st week: The Eucaryote Cell	
	2 nd week: The Tissues	
	3 rd week: Cell Cycle, Basics in Development	
	4 th week: Musculoskeletal System	
	5 th week: Cardiovascular System	
	6 th week: Respiratory System	
	7 th week: Genito-urinary System	
	8 th week: Immune system	
	9 th week: Digestive System I	
	10 th week: Digestive System II	
	11 th week: Endocrine System	
	12 th week: Nervous System	
	13 th week: Exam	
Literature	Adolf Faller/Michael Schünke, Der Körper des Menschen, 17. Auflage, Thieme Verlag Stuttgart, 2016	

Courses				
Title		Тур	Hrs/wk	СР
ntroduction to Radiology and Radi	ation Therapy (L0383)	Lecture	2	3
Module Responsible	Prof. Ulrich Carl			
Admission Requirements	None			
Recommended Previous Knowledge	None			
5	After taking part successfully, students have	reached the following learning results		
Professional Competence		· · · · · · · · · · · · · · · · · · ·		
Knowledge	Therapy			
	The students can distinguish different types of	f currently used equipment with respect	to its use in radiation the	erapy.
	The students can explain treatment plans use	ed in radiation therapy in interdisciplinary	v contexts (e.g. surgery,	internal medicine).
	The students can describe the patients'	passage from their initial admittanc	e through to follow-up	care.
	Diagnostics			
	The students can illustrate the technical bas well as sectional imaging techniques (CT, MR		cluding angiography an	d mammography, a
	The students can explain the diagnostic as w techniques.	ell as therapeutic use of imaging techni	ques, as well as the tech	inical basis for tho
	The students can choose the right treatment	method depending on the patient's clinic	al history and needs.	
	The student can explain the influence of tech	nical errors on the imaging techniques.		
	The student can draw the right conclusions b	ased on the images' diagnostic findings o	or the error protocol	
		ased on the images diagnostic infamgs c	in the error protocol.	
Skills	Therapy The students can distinguish curative and pal	liative situations and motivate why they	came to that conclusion.	
	The students can develop adequate therapy o	concepts and relate it to the radiation bio	logical aspects.	
	The students can use the therapeutic principl	e (effects vs adverse effects)		
	The students can distinguish different kinds tumor) and choose the energy needed in that		depending on the situa	tion (location of t
	The student can assess what an individual groups, self-help groups, social services, psyc		e.g. follow-up treatment	, sports, social he
	Diagnostics			
	The students can suggest solutions for repain	s of imaging instrumentation after having	done error analyses	
	The students can classify results of imaging anatomy, pathology and pathophysiology.	techniques according to different grou	ps of diseases based or	their knowledge
Personal Competence				
Social Competence	The students can assess the special social sit The students are aware of the special, oft measures and can meet them appropriately.			-
Autonomy	The students can apply their new knowledge	and skills to a concrete therapy case		
Autonomy	The students can introduce younger students			
	The students are able to access anatomical l and acquire the relevant knowledge themselv		te competently in conve	rsations on the top
Workload in Hours	Independent Study Time 62, Study Time in Le	ecture 28		
Credit points				
Course achievement				
Examination	Written exam			
Examination duration and	90 minutes			
scale Assignment for the	General Engineering Science (German progra	m 7 semester): Specialisation Biomedica	al Engineering: Compulse	
Following Curricula	General Engineering Science (German progra			
	Compulsory		-	
	Data Science: Specialisation II. Application: El			
	Electrical Engineering: Specialisation Medical Engineering Science: Specialisation Biomedic			
	General Engineering Science (English program		l Engineering: Compulso	У
	Mechanical Engineering: Specialisation Biome			
	Biomedical Engineering: Specialisation Medical			
	Biomedical Engineering: Specialisation Manag Biomedical Engineering: Specialisation Artific			
	Biomedical Engineering: Specialisation Implar			

Technomathematics: Specialisation III. Engineering Science: Elective Compulsory

Course L0383: Introduction t	o Radiology and Radiation Therapy
Тур	Lecture
Hrs/wk	2
	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Prof. Ulrich Carl, Prof. Thomas Vestring
Cycle	
	The students will be given an understanding of the technological possibilities in the field of medical imaging, interventional radiology and radiation therapy/radiation oncology. It is assumed, that students in the beginning of the course have heard the word "X-ray" at best. It will be distinguished between the two arms of diagnostic (Prof. Dr. med. Thomas Vestring) and therapeutic (Prof. Dr. med. Ulrich Carl) use of X-rays. Both arms depend on special big units, which determine a predefined sequence in their respective departments
Literature	• "Technik der medizinischen Radiologie" von T. + J. Laubenberg –
	7. Auflage – Deutscher Ärzteverlag – erschienen 1999
	• "Klinische Strahlenbiologie" von Th. Herrmann, M. Baumann und W. Dörr –
	4. Auflage - Verlag Urban & Fischer – erschienen 02.03.2006
	ISBN: 978-3-437-23960-1
	"Strahlentherapie und Onkologie für MTA-R" von R. Sauer –
	5. Auflage 2003 - Verlag Urban & Schwarzenberg – erschienen 08.12.2009
	ISBN: 978-3-437-47501-6
	"Taschenatlas der Physiologie" von S. Silbernagel und A. Despopoulus-
	8. Auflage – Georg Thieme Verlag - erschienen 19.09.2012
	ISBN: 978-3-13-567708-8
	• "Der Körper des Menschen " von A. Faller u. M. Schünke -
	16. Auflage 2004 – Georg Thieme Verlag – erschienen 18.07.2012
	ISBN: 978-3-13-329716-5
	"Praxismanual Strahlentherapie" von Stöver / Feyer –
	1. Auflage - Springer-Verlag GmbH - erschienen 02.06.2000

Courses				
		T	User tools	67
Title Introduction to Biochemistry and M	olecular Biology (L0386)	Typ Lecture	Hrs/wk	СР 3
		Lecture	2	5
•	Prof. Hans-Jürgen Kreienkamp			
Admission Requirements	None			
	None			
Knowledge				
	After taking part successfully, students	s have reached the following learning results		
Professional Competence	-			
Knowledge	The students can			
	 describe basic biomolecules; 			
	explain how genetic information	n is coded in the DNA;		
	 explain the connection between 	DNA and proteins;		
CI-III-	The should also be as a			
SKIIIS	The students can			
	 recognize the importance of mo 	lecular parameters for the course of a disease;		
	describe selected molecular-dia	gnostic procedures;		
	 explain the relevance of these provide the second se	procedures for some diseases		
D 10 1				
Personal Competence	The shuden he can neght in the institution			
Social Competence	The students can participate in discuss	sions in research and medicine on a technical lev	/el.	
	Students will have an improved under	erstanding of current medical problems (e.g. Co	orona pandemic)and wil	l be able to exp
	these issues to others.			
Autonomy	The students can develop an understa	nding of topics from the course, using technical	literature, by themselves	5.
	Charles to still be better and incertain		- Lucasa - and the star	
	Students will be better equipped to rec	cognize fake news in the media regarding medic	al research topics.	
	Independent Study Time 62, Study Tin	ne in Lecture 28		
•	3			
	None			
	Written exam			
Examination duration and	60 minutes			
scale				
-		program, 7 semester): Specialisation Biomedica		-
Following Curricula		an program, 7 semester): Specialisation Mec	chanical Engineering, F	ocus Biomechan
	Compulsory			
		Aedical Technology: Elective Compulsory		
	Engineering Science: Specialisation Bid		Engineering, Compulsor	
	5 5 . 5	program, 7 semester): Specialisation Biomedical	Engineering: Compulsor	У
	Mechanical Engineering: Specialisation Mechatronics: Specialisation Medical E			
		Management and Business Administration: Elec	tive Compulsory	
		a Artificial Organs and Regenerative Medicine: Elec		
		Medical Technology and Control Theory: Electiv		
		Implants and Endoprostheses: Elective Computer		
	Sisting and Engineering. Specialisation	p.a	<i>j</i>	

Course L0386: Introduction to Biochemistry and Molecular Biology		
Тур	Lecture	
Hrs/wk	2	
CP	3	
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28	
Lecturer	Prof. Hans-Jürgen Kreienkamp	
Language	DE	
Cycle	WiSe	
Content		
Literature	Müller-Esterl, Biochemie, Spektrum Verlag, 2010; 2. Auflage	
	Löffler, Basiswissen Biochemie, 7. Auflage, Springer, 2008	
1		

Courses		
Title	Typ Hrs/wk	СР
Numerical Mathematics I (L0417)		3
Numerical Mathematics I (L0418)		3
Module Responsible	e Prof. Sabine Le Borne	
Admission Requirements		
Recommended Previous		
Knowledge	 Mathematik I + II for Engineering Students (german or english) or Analysis & Linear Algebra I + II for Technological students (german or english) 	chnomathematici
Educational Objectives	After taking part successfully, students have reached the following learning results	
Professional Competence	e	
Knowledge	re Students are able to	
	 name numerical methods for interpolation, integration, least squares problems, eigenvalue problems, no problems and to explain their core ideas, repeat convergence statements for the numerical methods, explain aspects for the practical execution of numerical methods with respect to computational and store 	
Skills	//s Students are able to	
	 implement, apply and compare numerical methods using MATLAB/Python, justify the convergence behaviour of numerical methods with respect to the problem and solution algorit select and execute a suitable solution approach for a given problem. 	hm,
Personal Competence	e	
Social Competence	e Students are able to	
,		
	 work together in heterogeneously composed teams (i.e., teams from different study programs and back explain theoretical foundations and support each other with practical aspects regarding the implementat 	
Autonomy	y Students are capable	
	 to assess whether the supporting theoretical and practical excercises are better solved individually or in to assess their individual progess and, if necessary, to ask questions and seek help. 	a team,
Workload in Hours	rs Independent Study Time 124, Study Time in Lecture 56	
Credit points		
Course achievement		
	n Written exam	
Examination duration and		
scale		
	e General Engineering Science (German program, 7 semester): Specialisation Computer Science: Compulsory	
Following Curricula	a General Engineering Science (German program, 7 semester): Specialisation Biomedical Engineering: Compulso	
	General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Fo	ocus Biomechan
	Compulsory	aratical Machani
	General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus The Engineering: Compulsory	
	General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focu	is Aircraft Syste
	Engineering: Elective Compulsory	as Allerate Syste
	General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Me	
		chatronics: Elect
		echatronics: Elect
	Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focu	
	Compulsory	
	Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focu	
	Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focu Elective Compulsory	
	Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focu Elective Compulsory General Engineering Science (German program, 7 semester): Specialisation Advanced Materials: Compulsory	
	Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focu Elective Compulsory General Engineering Science (German program, 7 semester): Specialisation Advanced Materials: Compulsory General Engineering Science (German program, 7 semester): Specialisation Data Science: Compulsory	
	Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focu Elective Compulsory General Engineering Science (German program, 7 semester): Specialisation Advanced Materials: Compulsory General Engineering Science (German program, 7 semester): Specialisation Data Science: Compulsory Bioprocess Engineering: Specialisation A - General Bioprocess Engineering: Elective Compulsory	
	Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focu Elective Compulsory General Engineering Science (German program, 7 semester): Specialisation Advanced Materials: Compulsory General Engineering Science (German program, 7 semester): Specialisation Data Science: Compulsory Bioprocess Engineering: Specialisation A - General Bioprocess Engineering: Elective Compulsory Data Science: Core Qualification: Compulsory Electrical Engineering: Core Qualification: Elective Compulsory Engineering Science: Core Qualification: Compulsory	
	Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focu Elective Compulsory General Engineering Science (German program, 7 semester): Specialisation Advanced Materials: Compulsory General Engineering Science (German program, 7 semester): Specialisation Data Science: Compulsory Bioprocess Engineering: Specialisation A - General Bioprocess Engineering: Elective Compulsory Data Science: Core Qualification: Compulsory Electrical Engineering: Core Qualification: Elective Compulsory Engineering Science: Core Qualification: Compulsory Green Technologies: Energy, Water, Climate: Specialisation Energy Technology: Elective Compulsory	
	Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focu Elective Compulsory General Engineering Science (German program, 7 semester): Specialisation Advanced Materials: Compulsory General Engineering Science (German program, 7 semester): Specialisation Data Science: Compulsory Bioprocess Engineering: Specialisation A - General Bioprocess Engineering: Elective Compulsory Data Science: Core Qualification: Compulsory Electrical Engineering: Core Qualification: Elective Compulsory Engineering Science: Core Qualification: Compulsory Green Technologies: Energy, Water, Climate: Specialisation Energy Technology: Elective Compulsory Computer Science in Engineering: Core Qualification: Compulsory	
	Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focu Elective Compulsory General Engineering Science (German program, 7 semester): Specialisation Advanced Materials: Compulsory General Engineering Science (German program, 7 semester): Specialisation Data Science: Compulsory Bioprocess Engineering: Specialisation A - General Bioprocess Engineering: Elective Compulsory Data Science: Core Qualification: Compulsory Electrical Engineering: Core Qualification: Elective Compulsory Engineering Science: Core Qualification: Compulsory Green Technologies: Energy, Water, Climate: Specialisation Energy Technology: Elective Compulsory Computer Science in Engineering: Core Qualification: Compulsory Mechanical Engineering: Specialisation Theoretical Mechanical Engineering: Compulsory	
	Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focu Elective Compulsory General Engineering Science (German program, 7 semester): Specialisation Advanced Materials: Compulsory General Engineering Science (German program, 7 semester): Specialisation Data Science: Compulsory Bioprocess Engineering: Specialisation A - General Bioprocess Engineering: Elective Compulsory Data Science: Core Qualification: Compulsory Electrical Engineering: Core Qualification: Elective Compulsory Engineering Science: Core Qualification: Compulsory Green Technologies: Energy, Water, Climate: Specialisation Energy Technology: Elective Compulsory Computer Science in Engineering: Core Qualification: Compulsory	

ourse L0417: Numerical Mathematics I			
Тур	Lecture		
Hrs/wk			
CP	3		
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28		
Lecturer	Prof. Sabine Le Borne		
Language	EN		
Cycle	WiSe		
Content	 Finite precision arithmetic, error analysis, conditioning and stability Linear systems of equations: LU and Cholesky factorization, condition Interpolation: polynomial, spline and trigonometric interpolation Nonlinear equations: fixed point iteration, root finding algorithms, Newton's method Linear and nonlinear least squares problems: normal equations, Gram Schmidt and Householder orthogonalization, singular value decomposition, regularizatio, Gauss-Newton and Levenberg-Marquardt methods Eigenvalue problems: power iteration, inverse iteration, QR algorithm Numerical differentiation Numerical integration: Newton-Cotes rules, error estimates, Gauss quadrature, adaptive quadrature 		
Literature	 Gander/Gander/Kwok: Scientific Computing: An introduction using Maple and MATLAB, Springer (2014) Stoer/Bulirsch: Numerische Mathematik 1, Springer Dahmen, Reusken: Numerik f ür Ingenieure und Naturwissenschaftler, Springer 		

Course L0418: Numerical Mathematics I	
Тур	Recitation Section (small)
Hrs/wk	2
СР	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Prof. Sabine Le Borne, Dr. Jens-Peter Zemke
Language	EN
Cycle	WiSe
Content	See interlocking course
Literature	See interlocking course

Module M1333: BIO I:	Implants and Fracture Healin	g		
	-	-		
Courses				
Title		Тур	Hrs/wk	СР
Implants and Fracture Healing (L03	76)	Lecture	2	3
Module Responsible	Prof. Michael Morlock			
Admission Requirements	None			
Recommended Previous	It is recommended to participate in "Introdu	ction into Anatomie" before attending "Impl	ants and Fracture Heali	ng".
Knowledge				
Educational Objectives	After taking part successfully, students have	e reached the following learning results		
Professional Competence				
Knowledge	The students can describe the different ways how bones heal, and the requirements for their existence.			
	The students can name different treatments	s for the spine and hollow bones under giver	n fracture morphologies	
Skills	The students can determine the forces actir	ng within the human body under quasi-static	situations under specif	ic assumptions.
Personal Competence				
•	The students can in groups, solve basis put	marical modaling tacks for the calculation of	internal forces	
Social Competence	The students can, in groups, solve basic nur	nerical modeling tasks for the calculation of	internal forces.	
Autonomy	The students can, in groups, solve basic nur	merical modeling tasks for the calculation of	internal forces.	
Workload in Hours	Independent Study Time 62, Study Time in	Lecture 28		
Credit points	3			
Course achievement	None			
Examination	Written exam			
Examination duration and	90 min			
scale				
Assignment for the	General Engineering Science (German p	rogram, 7 semester): Specialisation Mech	nanical Engineering, F	ocus Biomechanic
Following Curricula	Compulsory			
	General Engineering Science (German prog	ram, 7 semester): Specialisation Biomedical	Engineering: Compulso	ry
	Engineering Science: Specialisation Biomed	ical Engineering: Compulsory		
	General Engineering Science (English progra	am, 7 semester): Specialisation Biomedical B	Engineering: Compulsor	У
	Mechanical Engineering: Specialisation Bion	nechanics: Compulsory		
	Biomedical Engineering: Specialisation Impl	ants and Endoprostheses: Elective Compulse	ory	
	Biomedical Engineering: Specialisation Artif			
	Biomedical Engineering: Specialisation Mana	agement and Business Administration: Elect	ive Compulsory	
	Biomedical Engineering: Specialisation Medi		Compulsory	
	Orientation Studies: Core Qualification: Elec			
	Technomathematics: Specialisation III. Engin	neering Science: Elective Compulsory		

ourse L0376: Implants and Fracture Healing		
-		
CP		
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28	
Lecturer	Prof. Michael Morlock	
Language	DE	
Cycle	WiSe	
Content	Topics to be covered include:	
	1. Introduction (history, definitions, background importance)	
	2. Bone (anatomy, properties, biology, adaptations in femur, tibia, humerus, radius)	
	3. Spine (anatomy, biomechanics, function, vertebral bodies, intervertebral disc, ligaments)	
	3.1 The spine in its entirety	
	3.2 Cervical spine	
	3.3 Thoracic spine	
	3.4 Lumbar spine	
	3.5 Injuries and diseases	
	4. Pelvis (anatomy, biomechanics, fracture treatment)	
	5 Fracture Healing	
	5.1 Basics and biology of fracture repair	
	5.2 Clinical principals and terminology of fracture treatment	
	5.3 Biomechanics of fracture treatment	
	5.3.1 Screws	
	5.3.2 Plates	
	5.3.3 Nails	
	5.3.4 External fixation devices	
	5.3.5 Spine implants	
	6.0 New Implants	
Literature	Cochran V.B.: Orthopädische Biomechanik	
	Mow V.C., Hayes W.C.: Basic Orthopaedic Biomechanics	
	White A.A., Panjabi M.M.: Clinical biomechanics of the spine	
	Nigg, B.: Biomechanics of the musculo-skeletal system	
	Schiebler T.H., Schmidt W.: Anatomie	
	Platzer: dtv-Atlas der Anatomie, Band 1 Bewegungsapparat	

Courses	
Title	Typ Hrs/wk CP
Introduction to Physiology (L0385)	Lecture 2 3
Module Responsible	Dr. Roger Zimmermann
Admission Requirements	None
Recommended Previous	None
Knowledge	
Educational Objectives	After taking part successfully, students have reached the following learning results
Professional Competence	
Knowledge	The students can
	describe the basics of the energy metabolism;
	 describe the basics of the energy metabolism, describe physiological relations in selected fields of muscle, heart/circulation, neuro- and sensory physiology.
	• describe physiological relations in selected fields of moscie, field circulation, field of and sensory physiology.
Skills	The students can describe the effects of basic bodily functions (sensory, transmission and processing of information, developm
	of forces and vital functions) and relate them to similar technical systems.
Personal Competence	
Social Competence	The students can conduct discussions in research and medicine on a technical level.
	The students can find solutions to problems in the field of physiology, both analytical and metrological.
Autonomy	The students can derive answers to questions arising in the course and other physiological areas, using technical literature,
	themselves.
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Credit points	3
Course achievement	None
Examination	Written exam
Examination duration and	60 minutes
scale	
Assignment for the	General Engineering Science (German program, 7 semester): Specialisation Biomedical Engineering: Compulsory
Following Curricula	General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Biomechan
	Compulsory
	Electrical Engineering: Specialisation Medical Technology: Elective Compulsory
	Engineering Science: Specialisation Biomedical Engineering: Elective Compulsory
	General Engineering Science (English program, 7 semester): Specialisation Biomedical Engineering: Elective Compulsory
	Mechanical Engineering: Specialisation Biomechanics: Compulsory
	Mechatronics: Specialisation Medical Engineering: Compulsory
	Biomedical Engineering: Specialisation Medical Technology and Control Theory: Elective Compulsory Biomedical Engineering: Specialisation Management and Business Administration: Elective Compulsory
	Biomedical Engineering: Specialisation Artificial Organs and Regenerative Medicine: Elective Compulsory
	Biomedical Engineering: Specialisation Artificial organs and Regenerative Medicine. Lective Compulsory Biomedical Engineering: Specialisation Implants and Endoprostheses: Elective Compulsory
	Technomathematics: Specialisation III. Engineering Science: Elective Compulsory

Course L0385: Introduction to Physiology		
Тур	Lecture	
Hrs/wk	2	
CP	3	
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28	
Lecturer	Dr. Gerhard Engler	
Language	DE	
Cycle	SoSe	
Content		
Literature	Taschenatlas der Physiologie, Silbernagl Despopoulos, ISBN 978-3-135-67707-1, Thieme	
	Repetitorium Physiologie, Speckmann, ISBN 978-3-437-42321-5, Elsevier	

Courses	
Title	Typ Hrs/wk CP
Experimental Methods in Biomecha	
Module Responsible	Prof. Michael Morlock
Admission Requirements	None
Recommended Previous	
Knowledge	······································
Educational Objectives	After taking part successfully, students have reached the following learning results
Professional Competence	
Knowledge	The course deals with common experimental methods used in biomechanics. For each topic an overview and some basic pract knowledge is provided.
	1. Tribology
	2. Optical Methods
	3. Motion Analysis
	4. Pressure Distribution
	5. Strain Gauges
	6. Pre-clinical testing
	7. Specimen Preparation and Storage
	The students can describe the different ways how bones heal, and the requirements for their existence.
	The students can name different treatments for the spine and hollow bones under given fracture morphologies.
	The students can describe different measurement techniques for forces and movements, and choose the adequate technique for given task.
Skills	The students can describe the basic handling of several experimental techniques used in biomechanics.
Personal Competence	
Social Competence	Students are able to organize themselves as a group to solve simple experimental tasks together. On the one hand, the division tasks must be organized during the experiment as well as during the short written elaboration, but on the other hand, knowledge acquired must be available to all participants of the group afterwards. The challenge here is that the topics char quickly because fundamentally different measurement principles are taught. In addition, a strict time management is expected.
Autonomy	Students perform simple experimental tasks in small groups or create simple sensors (e.g. strain gauges). The preceding lect serves as a basis for these experiments. As preparation or follow-up, the theoretical knowledge has to be worked up and related the experimental result. In particular, independent transfer performance is necessary to clarify why experimental observations show deviations from the theoretical values and how these deviations can be compensated.
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Credit points	3
Course achievement	None
Examination	Written exam
Examination duration and	90 min
scale	
-	General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Biomechan
Following Curricula	Compulsory
	General Engineering Science (German program, 7 semester): Specialisation Biomedical Engineering: Compulsory
	Engineering Science: Specialisation Biomedical Engineering: Elective Compulsory
	General Engineering Science (English program, 7 semester): Specialisation Biomedical Engineering: Elective Compulsory
	Mechanical Engineering: Specialisation Biomechanics: Compulsory Mechatronics: Specialisation Medical Engineering: Elective Compulsory
	Technomathematics: Specialisation III. Engineering Science: Elective Compulsory

Course L0377: Experimental	Methods in Biomechanics	
Тур	Lecture	
Hrs/wk	2	
CP	3	
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28	
Lecturer	Prof. Michael Morlock, Dr. Gerd Huber	
Language	DE	
Cycle	SoSe	
Content	The course deals with common experimental methods used in biomechanics. For each topic an overview and some basic practical	
	knowledge is provided.	
	1. Tribology	
	2. Optical Methods	
	3. Motion Analysis	
	4. Pressure Distribution	
	5. Strain Gauges	
	6. Pre-clinical testing	
	7. Specimen Preparation and Storage	
Literature	Hoffmann K., Eine Einführung in die Technik des Messens mit Dehnmessstreifen	
	White A.A., Panjabi M.M.: Clinical biomechanics of the spine	
	Nigg, B.: Biomechanics of the musculo-skeletal system	
	Online Hilfe van Mathuusela, https://de.mathuusela.com/hale/mathak/	
	Online Hilfe von Mathworks: https://de.mathworks.com/help/matlab/	

Courses					
Title		Тур	Hrs/wk	СР	
Advanced Materials Characterization	on (L1087)	Lecture	2	2	
Advanced Materials for Sustainabil		Lecture	2	2	
Advanced Materials for Sustainabil	ity (L1092)	Recitation Section (large)	2	2	
Module Responsible	Prof. Patrick Huber				
Admission Requirements	None				
Recommended Previous	Fundamentals of Materials Science (I and	11)			
Knowledge					
Educational Objectives	After taking part successfully, students ha	ve reached the following learning results			
Professional Competence					
Knowledge	The students will be able to explain the p	roperties of advanced materials along with the	ir applications in tec	hnology, in particul	
	metallic, ceramic, polymeric, semiconduct	cor, modern composite materials (biomaterials)	and nanomaterials.		
CI-111-					
Skills	s The students will be able to select material configurations according to the technical needs and, if necessary, to design ne				
	materials considering architectural principles from the micro- to the macroscale. The students will also gain an overview o				
	modern materials science, which enables	them to select optimum materials combinations	s depending on the te	echnical application	
Personal Competence					
Social Competence	The students are able to present solutions	to specialists and to develop ideas further.			
,					
Autonomv	The students are able to				
2					
	 assess their own strengths and weat 	aknesses.			
	 define tasks independently. 				
Workload in Hours	Independent Study Time 96, Study Time in	n Lecture 84			
Credit points	6				
Course achievement	None				
Examination	Written exam				
Examination duration and	90 min				
scale					
Assignment for the	General Engineering Science (German	program, 7 semester): Specialisation Mecha	nical Engineering, I	Focus Biomechani	
Following Curricula		· · ·	2 5.		
-		gram, 7 semester): Specialisation Advanced Ma	terials: Compulsory		
	Engineering Science: Specialisation Mecha				
	Engineering Science: Specialisation Advan				
	Mechanical Engineering: Core Qualification				

Course L1087: Advanced Ma	terials Characterization
Тур	Lecture
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Prof. Patrick Huber
Language	DE
Cycle	SoSe
Content	
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 L1091: Advanced Ma	terials for Sustainability
Тур	Lecture
Hrs/wk	2
СР	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Prof. Patrick Huber, Prof. Bodo Fiedler, Prof. Gerold Schneider, Prof. Jörg Weißmüller, Prof. Kaline Pagnan Furlan, Prof. Patrick
	Huber, Prof. Robert Meißner, Prof. Stefan Fritz Müller
Language	DE/EN
Cycle	SoSe
Content	
Literature	Vorlesungsunterlagen

Course L1092: Advanced Ma	terials for Sustainability
Тур	Recitation Section (large)
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Prof. Bodo Fiedler, Prof. Gerold Schneider, Prof. Jörg Weißmüller, Prof. Patrick Huber, Prof. Stefan Fritz Müller
Language	DE/EN
Cycle	SoSe
Content	See interlocking course
Literature	See interlocking course

Courses				
		_		
Title		Typ Lecture	Hrs/wk	СР
	rogramming Concepts, Data Handling & Communication (L2689) rogramming Concepts, Data Handling & Communication (L2690)	Recitation Section (small)	3 2	3 3
Module Responsible		Rectation Section (Smail)	L	5
	None			
Recommended Previous	None			
Knowledge				
-	After taking part successfully, students have reached the fo	lowing loarning rocults		
Professional Competence	Arter taking part successfully, students have reached the to	lowing learning results		
Knowledge				
Skills				
SKIIIS				
Personal Competence				
Social Competence				
Autonomy				
Workload in Hours	Independent Study Time 110, Study Time in Lecture 70			
Credit points	6			
Course achievement	Compulsory Bonus Form Descriptio			
		inden semesterbegleitend statt.		
Examination				
Examination duration and	120 min			
scale				
-	General Engineering Science (German program, 7 sem	ester): Specialisation Mechanica	I Engineering, F	ocus Biomechani
Following Curricula				
	General Engineering Science (German program, 7 semester			
	General Engineering Science (German program, 7 semester	: Specialisation Green Technolog	les, Focus Renew	able Energy: Elect
	Compulsory General Engineering Science (German program, 7 semes	ter): Specialisation Mechanical	Engineering Foc	us Energy System
	Compulsory	ter). Specialisation mechanical	Lingineering, Toe	us Energy Syster
	General Engineering Science (German program, 7 seme	ster): Specialisation Mechanical	Engineering, Foc	us Aircraft Syste
	Engineering: Compulsory		5,	
	General Engineering Science (German program, 7 sem	ester): Specialisation Mechanica	al Engineering, I	ocus Mechatroni
	Compulsory			
	General Engineering Science (German program, 7 semeste	r): Specialisation Mechanical Eng	ineering, Focus P	roduct Developm
	and Production: Elective Compulsory			
	General Engineering Science (German program, 7 semester): Specialisation Mechanical Engi	neering, Focus Th	eoretical Mechani
	Engineering: Elective Compulsory			
	General Engineering Science (German program, 7 semester	: Specialisation Electrical Engine	ering: Elective Co	mpulsory
	Bioprocess Engineering: Core Qualification: Compulsory			
	Chemical and Bioprocess Engineering: Core Qualification: Co	ompulsory		
	Electrical Engineering: Core Qualification: Compulsory	Eporar Systems / Bonowable Epo	raioci Electivo Co	mpulcony
	Green Technologies: Energy, Water, Climate: Specialisation Logistics and Mobility: Specialisation Information Technolog		ingres. Elective Co	mpuisoi y
	Mechatronics: Specialisation Robot- and Machine-Systems: (
	Mechatronics: Specialisation Medical Engineering: Compulse			
	Mechatronics: Specialisation Dynamic Systems and AI: Com	,		
	Mechatronics: Specialisation Electrical Systems: Elective Co			
	Process Engineering: Core Qualification: Compulsory			
	5 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5			

Course L2689: Computer Sci	ence for Engineers - Programming Concepts, Data Handling & Communication
Тур	Lecture
Hrs/wk	3
CP	3
Workload in Hours	Independent Study Time 48, Study Time in Lecture 42
Lecturer	Prof. Sibylle Fröschle
Language	DE
Cycle	SoSe
Content	
Literature	John V. Guttag: Introduction to Computation and Programming Using Python.
	With Application to Understanding Data. 2nd Edition. The MIT Press, 2016.

Course L2690: Computer Sci	ence for Engineers - Programming Concepts, Data Handling & Communication
Тур	Recitation Section (small)
Hrs/wk	2
CP	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Prof. Sibylle Fröschle
Language	DE
Cycle	SoSe
Content	See interlocking course
Literature	See interlocking course

Focus Energy Systems

The aim of the specialization Energy Systems in the field of study Mechanical Engineering of the course of study General Engineering Science is to familiarize students with different technologies for energy conversion, energy distribution and energy application. Graduates are qualified to analyse, abstract and model processes. They are able to evaluate data and results and to develop strategies for finding innovative, energy efficient solutions. They take the connection of different problems into account. Furthermore the graduates are able to document and to communicate scientific results.

The specialization Energy Systems enables a consecutive study of the Master Energy Systems or an economical oriented master study.

Courses Typ Hrs/wk CP The int motion (LL458) Lacture 3 4 4 4 5 4 4 5 4 4 5 4 4 5 4 4 5 4 4 5 4 <th>Module M0684: Heat</th> <th>Transfer</th> <th></th> <th></th> <th></th>	Module M0684: Heat	Transfer			
Item Termster (JASB) 1 4 Reclation Recipiend Proteins 0: Andreas Moschaltski 2 2 Module Responsible Dr. Andreas Moschaltski 2 2 Admission Requirements None 2 2 Recommended Previous Technical Thermodynamics I. II and Fluid Dynamics 2 2 Recommended Previous Technical Thermodynamics I. II and Fluid Dynamics 2 2 Recommended Previous The students can - - 2 2 Professional Competence Intertacting part successfully, students have reached the following learning results -	Courses				
Instruction Recitation Section (large) 2 2 Module Responsible Or. Address Moschallski Admission Requirements None Recommended Previous Technical Thermodynamics I, II and Pluid Dynamics International Complexity International Complexity Professional Complexence Advantation Response International Complexity International Complexity Skife The students can - captain the technical terms, - classify the various physical processes of heat transfer in terms of conduction-based and radiation-based mechanisms, - simplify and critically analyze complex heat transfer in terms of conduction-based and radiation-based mechanisms, - simplify and critically analyze complex heat transfer in terms of conduction-based and radiation-based mechanisms, - simplify and critically analyze complex heat transfer in terms of conduction-based and radiation-based mechanisms, - simplify mit models, calculate and evaluate complex heat transfer in terms of conduction-based mechanisms, - simplify mit models, calculate and evaluate complex heat transfer, - describe the physics of the different Heat Transfer mechanism, - solve excersises self-consistent and in small groups. - describe the physics of the different state constant, - solve excersises self-consistent and in small groups. - describe their level of knowledge by means of repetition questins an independently develop	ītle		Тур	Hrs/wk	СР
Module Responsible Dr. Andreas Moschaliski Admission Requirements None Recommended Previous Technical Thermodynamics I, II and Fluid Dynamics Knowledge It and Fluid Dynamics Professional Competence Accounted Dynamics I, II and Fluid Dynamics Knowledge It as students can - explain the technical terms, - classify the various physical processes of heat transfer in terms of conduction-based and radiation-based mechanisms, - simplify and critically analyze complex heat transfer in terms of conduction-based and radiation-based mechanisms, - simplify and critically analyze complex heat transfer in terms of conduction-based and radiation-based mechanisms, - simplify with models, calculate and evaluate complex Heat Transfer processes using models, - methodically develop solutions to tasks. Skills - exclusite the physics of the different Heat Transfer mechanism, - simplifywith models, calculate and evaluate complex Heat Transfer processes, - critically question and answer statements on heat transfer, - solve excensises self-consistent and in small groups. Personal Competence In tectures and evarches, the students in the evercises, the students can independently develop further quest work out targeted solutions. Autonomy The stude					
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IMechanical Engineering: Specialisation Theoretical Mechanical Engineering: Elective Compulsory

Course L0458: Heat Transfer	
Тур	Lecture
Hrs/wk	3
CP	4
Workload in Hours	Independent Study Time 78, Study Time in Lecture 42
Lecturer	Dr. Andreas Moschallski
Language	DE
Cycle	WiSe
Content	Dimensional analysis, Heat Conduction (steady and unsteady) , Convective Heat Transfer (natural convection, forced convection), Two-phase Heat Transfer (evaporation, condensation), Thermal Radiation, Heat Transfer on a thermodynamic view, thermotechnical devices, measures of temperature and heat flux
Literature	 Herwig, H.; Moschallski, A.: Wärmeübertragung, 4. Auflage, Springer Vieweg Verlag, Wiesbaden, 2019 Herwig, H.: Wärmeübertragung von A-Z, Springer- Verlag, Berlin, Heidelberg, 2000 Baehr, H.D.; Stephan, K.: Wärme- und Stoffübertragung, 2. Auflage, Springer Verlag, Berlin, Heidelberg, 1996

Course L0459: Heat Transfer	
Тур	Recitation Section (large)
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Dr. Andreas Moschallski
Language	DE
Cycle	WiSe
Content	See interlocking course
Literature	See interlocking course

As a result of the part module "Internal Combustion Engines I", the students are able reflect and utilize the state-regarding efficiency limits. In addition, they are able to utilize their knowledge of design, mechanical and thermu-characteristics and the approach of similarity. They are able to explain, assess and develop engines as well as charging Detailed knowledge is present regarding computer-aided process design. Skills The students are skilled to employ basic and detail knowledge regarding reciprocating machinery, their selection and to They are further able to assess, analyse and solve technical and operational problems and to perform mechar thermodynamic design. Personal Competence The students are able to communicate and cooperate in a professional environment in the field of machinery de application. Autonomy The widespread scope of gained knowledge enables the students to handle situations in their future profession independent confidently. Workload in Hours Independent Study Time 110, Study Time in Lecture 70 Course achievement None Examination Witten exam Examination Witten exam Sciela General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Energy Compulsory	C				
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Social Competence The students are able to communicate and cooperate in a professional environment in the field of machinery de application. Autonomy The widespread scope of gained knowledge enables the students to handle situations in their future profession independ confidently. Workload in Hours Independent Study Time 110, Study Time in Lecture 70 Credit pointa 6 Course achievement None Examination duration and course achievement 120 min Assignment for the Final Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Energy Engry Systems: Technical Complementary Course Core Studies: Elective Compulsory	Skills	's The students are skilled to employ basic and detail knowledge regarding reciprocating machinery, their selection and opera They are further able to assess, analyse and solve technical and operational problems and to perform mechanical		nal problems. the state-of-the-a and thermodynan as charging system ection and operatio	
Autonomy The widespread scope of gained knowledge enables the students to handle situations in their future profession independ confidently. Workload in Hours Independent Study Time 110, Study Time in Lecture 70 Credit point 6 Course achievement None Examination Written exam Examination duration and scale 120 min Assignment for the Following Curricula General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Energy Compulsory Energy Systems: Technical Complementary Course Core Studies: Elective Compulsory			a professional environment in	the field of ma	achinery design a
Credit points 6 Course achievement None Examination Written exam Examination duration and scale 120 min Assignment for the Following Curricula General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Energy Compulsory Energy Systems: Technical Complementary Course Core Studies: Elective Compulsory	Autonomy	The widespread scope of gained knowledge enables the stud	lents to handle situations in thei	r future professic	on independently a
Course achievement None Examination Written exam Examination duration and scale 120 min Assignment for the Following Curricula General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Energy Compulsory Following Curricula Compulsory Energy Systems: Technical Complementary Course Core Studies: Elective Compulsory	Workload in Hours	Independent Study Time 110, Study Time in Lecture 70			
Examination Written exam Examination duration and scale 120 min Assignment for the Following Curricula General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Energy Compulsory Following Curricula Compulsory Energy Systems: Technical Complementary Course Core Studies: Elective Compulsory	Credit points	6			
Examination duration and scale 120 min Assignment for the Following Curricula General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Energy Compulsory Energy Systems: Technical Complementary Course Core Studies: Elective Compulsory	Course achievement	None			
scale Assignment for the General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Energy Following Curricula Compulsory Energy Systems: Technical Complementary Course Core Studies: Elective Compulsory	Examination	Written exam			
Assignment for the General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Energy Following Curricula Compulsory Energy Systems: Technical Complementary Course Core Studies: Elective Compulsory		120 min			
Following Curricula Compulsory Energy Systems: Technical Complementary Course Core Studies: Elective Compulsory		General Engineering Science (German program 7 comost	er): Specialisation Mechanical	Engineering For	us Energy System
Energy Systems: Technical Complementary Course Core Studies: Elective Compulsory	-		any. Specialisation Mechailleal	Lingineering, roo	as Energy System
	i onowing curricula		ties: Elective Compulsory		
Green Technologies: Energy, Water, Climate: Specialisation Energy Technology: Elective Compulsory				pulsory	
Mechanical Engineering: Specialisation Energy Systems: Compulsory				pulsory	

Тур	Lecture
Hrs/wk	1
CP	1
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14
Lecturer	Prof. Christopher Friedrich Wirz
Language	
Cycle	
Content	 Verbrennungsmotoren Historischer Rückblick Einteilung der Verbrennungsmotoren Arbeitsverfahren Vergleichsprozesse Arbeit, Mitteldrücke, Leistungen Arbeitsprozess des wirklichen Motors Wirkungsgrade Gemischbildung und Verbrennung Motorkennfeld und Betriebskennlinien Abgasentgiftung Gaswechsel Aufladung Kühl- und Schmiersystem Kräfte im Triebwerk Kolbenverdichter Thermodynamik des Kolbenverdichters Einteilung und Verwendung
	Prinzip der Kolbenpumpen
	Einteilung und Verwendung
Literature	Einteilung und Verwendung A. Urlaub: Verbrennungsmotoren W. Kalide: Kraft- und Arbeitsmaschinen

ourse L0634: Fundamentals of Reciprocating Engines and Turbomachinery - Part Reciprocating Engines		
Тур	Recitation Section (large)	
Hrs/wk	1	
CP	1	
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14	
Lecturer	Prof. Christopher Friedrich Wirz	
Language	DE	
Cycle	WiSe	
Content	See interlocking course	
Literature	See interlocking course	

Course L0059: Internal Combustion Engines I		
Тур	ture	
Hrs/wk		
CP		
Workload in Hours	dependent Study Time 32, Study Time in Lecture 28	
Lecturer	of. Christopher Severin	
Language	E	
Cycle	SoSe	
Content	 The beginnings of engine development Design of of motors Real process calculation Charging methods Kinematics of the crank mechanism Forces in the engine 	
Literature	 Vorlesungsskript Übungsaufgaben mit Lösungsweg Literaturliste 	

ourse L0639: Internal Combustion Engines I		
Тур	Recitation Section (large)	
Hrs/wk	1	
CP	2	
Workload in Hours	Independent Study Time 46, Study Time in Lecture 14	
Lecturer	Prof. Christopher Severin	
Language	DE	
Cycle	SoSe	
Content	See interlocking course	
Literature	See interlocking course	

Courses			
Title	Typ Hrs/wk CP		
Numerical Mathematics I (L0417)	Lecture 2 3		
Numerical Mathematics I (L0418)	Recitation Section (small) 2 3		
Module Responsible	Prof. Sabine Le Borne		
Recommended Previous			
Knowledge	 Mathematik I + II for Engineering Students (german or english) or Analysis & Linear Algebra I + II for Technomathematicity 		
Educational Objectives	After taking part successfully, students have reached the following learning results		
Professional Competence			
Knowledge	Students are able to		
	 name numerical methods for interpolation, integration, least squares problems, eigenvalue problems, nonlinear root fine problems and to explain their core ideas, repeat convergence statements for the numerical methods, explain aspects for the practical execution of numerical methods with respect to computational and storage complexitx. 		
Skills	Students are able to		
	 implement, apply and compare numerical methods using MATLAB/Python, 		
	 justify the convergence behaviour of numerical methods with respect to the problem and solution algorithm, select and execute a suitable solution approach for a given problem. 		
Personal Competence			
	Students are able to		
Social competence			
	 work together in heterogeneously composed teams (i.e., teams from different study programs and background knowledge explain theoretical foundations and support each other with practical aspects regarding the implementation of algorithms 		
Autonomy	Students are capable		
, aconomy			
	 to assess whether the supporting theoretical and practical excercises are better solved individually or in a team, to assess their individual progess and, if necessary, to ask questions and seek help. 		
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56		
Credit points			
Course achievement			
	Written exam		
scale			
	General Engineering Science (German program, 7 semester): Specialisation Computer Science: Compulsory		
Following Curricula	General Engineering Science (German program, 7 semester): Specialisation Biomedical Engineering: Compulsory		
	General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Biomechani		
	Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Theoretical Mechani		
	Engineering: Compulsory		
	General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Aircraft Syste		
	Engineering: Elective Compulsory		
	General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Mechatronics: Elect		
	Compulsory		
	General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Energy System		
	Elective Compulsory		
	General Engineering Science (German program, 7 semester): Specialisation Advanced Materials: Compulsory		
	General Engineering Science (German program, 7 semester): Specialisation Advanced Materials: Compulsory General Engineering Science (German program, 7 semester): Specialisation Data Science: Compulsory		
	General Engineering Science (German program, 7 semester): Specialisation Data Science: Compulsory Bioprocess Engineering: Specialisation A - General Bioprocess Engineering: Elective Compulsory		
	General Engineering Science (German program, 7 semester): Specialisation Data Science: Compulsory Bioprocess Engineering: Specialisation A - General Bioprocess Engineering: Elective Compulsory Data Science: Core Qualification: Compulsory		
	General Engineering Science (German program, 7 semester): Specialisation Data Science: Compulsory Bioprocess Engineering: Specialisation A - General Bioprocess Engineering: Elective Compulsory Data Science: Core Qualification: Compulsory Electrical Engineering: Core Qualification: Elective Compulsory		
	General Engineering Science (German program, 7 semester): Specialisation Data Science: Compulsory Bioprocess Engineering: Specialisation A - General Bioprocess Engineering: Elective Compulsory Data Science: Core Qualification: Compulsory Electrical Engineering: Core Qualification: Elective Compulsory Engineering Science: Core Qualification: Compulsory		
	General Engineering Science (German program, 7 semester): Specialisation Data Science: Compulsory Bioprocess Engineering: Specialisation A - General Bioprocess Engineering: Elective Compulsory Data Science: Core Qualification: Compulsory Electrical Engineering: Core Qualification: Elective Compulsory Engineering Science: Core Qualification: Compulsory Green Technologies: Energy, Water, Climate: Specialisation Energy Technology: Elective Compulsory		
	General Engineering Science (German program, 7 semester): Specialisation Data Science: Compulsory Bioprocess Engineering: Specialisation A - General Bioprocess Engineering: Elective Compulsory Data Science: Core Qualification: Compulsory Electrical Engineering: Core Qualification: Elective Compulsory Engineering Science: Core Qualification: Compulsory Green Technologies: Energy, Water, Climate: Specialisation Energy Technology: Elective Compulsory Computer Science in Engineering: Core Qualification: Compulsory		
	General Engineering Science (German program, 7 semester): Specialisation Data Science: Compulsory Bioprocess Engineering: Specialisation A - General Bioprocess Engineering: Elective Compulsory Data Science: Core Qualification: Compulsory Electrical Engineering: Core Qualification: Elective Compulsory Engineering Science: Core Qualification: Compulsory Green Technologies: Energy, Water, Climate: Specialisation Energy Technology: Elective Compulsory Computer Science in Engineering: Core Qualification: Compulsory Mechanical Engineering: Specialisation Theoretical Mechanical Engineering: Compulsory		
	General Engineering Science (German program, 7 semester): Specialisation Data Science: Compulsory Bioprocess Engineering: Specialisation A - General Bioprocess Engineering: Elective Compulsory Data Science: Core Qualification: Compulsory Electrical Engineering: Core Qualification: Elective Compulsory Engineering Science: Core Qualification: Compulsory Green Technologies: Energy, Water, Climate: Specialisation Energy Technology: Elective Compulsory Computer Science in Engineering: Core Qualification: Compulsory		

Course L0417: Numerical Ma	thematics I		
Тур	Lecture		
Hrs/wk	2		
CP	3		
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28		
Lecturer	Prof. Sabine Le Borne		
Language	EN		
Cycle	WiSe		
Content	 Finite precision arithmetic, error analysis, conditioning and stability Linear systems of equations: LU and Cholesky factorization, condition Interpolation: polynomial, spline and trigonometric interpolation Nonlinear equations: fixed point iteration, root finding algorithms, Newton's method Linear and nonlinear least squares problems: normal equations, Gram Schmidt and Householder orthogonalization, singular value decomposition, regularizatio, Gauss-Newton and Levenberg-Marquardt methods Eigenvalue problems: power iteration, inverse iteration, QR algorithm Numerical differentiation Numerical integration: Newton-Cotes rules, error estimates, Gauss quadrature, adaptive quadrature 		
Literature	 Gander/Gander/Kwok: Scientific Computing: An introduction using Maple and MATLAB, Springer (2014) Stoer/Bulirsch: Numerische Mathematik 1, Springer Dahmen, Reusken: Numerik f ür Ingenieure und Naturwissenschaftler, Springer 		

Course L0418: Numerical Mathematics I	
Тур	Recitation Section (small)
Hrs/wk	2
CP	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Prof. Sabine Le Borne, Dr. Jens-Peter Zemke
Language	EN
Cycle	WiSe
Content	See interlocking course
Literature	See interlocking course

Courses					
Title		Тур	Hrs/wk	СР	
Computational Fluid Dynamics I (L0	235)	Lecture	2	3	
Computational Fluid Dynamics I (LO	419)	Recitation Section (large)	2	3	
Module Responsible	Prof. Thomas Rung				
Admission Requirements	None				
Recommended Previous	revious Students should have sound knowledge of engineering mathematics (series expansions, internal & vector calculus), a		ulus), and be fami		
Knowledge	ge with the foundations of partial/ordinary differential equations. They should also be familiar with engineering fluid m		fluid mechanics a		
	thermodynamics.				
Educational Objectives	After taking part successfully, students have reached the following learning results				
Professional Competence					
-			to translato gong		
Knowledge	Knowledge Students will have the required combined knowledge of thermo-/fluid dynamics and numerical and		-	-	
	principles of thermo-/fluid engineering into discrete algorithms on the basis of local (finite differences/volumes) and glob (potential theory) ansatz functions. They are familiar with the similarities and differences between different discretisation and				
	approximation concepts for investigating coupled systems of non-linear, convective partial differential equations (PDE), an explain the motivation for applying them. Students have the required background knowledge to develop, code, explain and appl				
	numerical algorithms dedicated to the solution of thermofluid dynamic PDEs. They are familiar with most numerical methods use				
	to predict thermofluid dynamic fields, in particular their realms and limitations.				
Skills	The students are able choose and apply appropr				
	in space and time. They can apply/optimise numerical analysis concepts to/for fluid dynamic applications. They can cod				
	computational algorithms in a structured way, apply these codes for parameter investigations and supplement interfaces to				
	extract simulation data for an engineering analys	SIS.			
Personal Competence					
Social Competence	The students are able to discuss problems, pres	ent the results of their own analysis, and joint	ly develop, imple	ement and report	
	solution strategies that address given technical r	eference problems.			
Autonomy	The students can independently analyse nume	rical methods to solving fluid engineering p	oroblems. They a	are able to critic	
	analyse own results as well as external data with	regards to the plausibility and reliability.			
Workload in Hours	Independent Study Time 124, Study Time in Lect	ture 56			
Credit points	6				
Course achievement	None				
Examination	Written exam				
Examination duration and	2h				
scale					
Assignment for the	General Engineering Science (German program	n, 7 semester): Specialisation Mechanical E	Engineering, Foc	us Aircraft Syste	
	Engineering: Elective Compulsory		5 5.	2	
-	General Engineering Science (German program,	7 semester): Specialisation Naval Architecture	e: Compulsory		
	General Engineering Science (German program			us Energy Syster	
	Elective Compulsory		-		
	Energy Systems: Technical Complementary Cour	se Core Studies: Elective Compulsory			
	Green Technologies: Energy, Water, Climate: Spe	ecialisation Energy Technology: Elective Com	oulsory		
	Green Technologies: Energy, Water, Climate: Spe	ecialisation Maritime Technologies: Elective C	ompulsory		
	Mechanical Engineering: Specialisation Energy S	ystems: Elective Compulsory			
	Naval Architecture: Core Qualification: Compulso	iry			
	Technomathematics: Specialisation III. Engineeri				

Course L0235: Computationa	al Fluid Dynamics I		
Тур	Lecture		
Hrs/wk	2		
CP	3		
Workload in Hours	ndependent Study Time 62, Study Time in Lecture 28		
Lecturer	Prof. Thomas Rung		
Language	DE		
Cycle	WiSe		
Content	Fundamentals of computational modelling of thermofluid dynamic problems. Development of numerical algorithms.		
	 Partial differential equations Foundations of finite numerical approximations Computation of potential flows Introduction of finite-differences Approximation of convective, diffusive and transient transport processes Formulation of boundary conditions and initial conditions Assembly and solution of algebraic equation systems Facets of weighted -residual approaches Finite volume methods Basics of grid generation 		
Literature	Ferziger and Peric: Computational Methods for Fluid Dynamics, Springer		

ourse L0419: Computational Fluid Dynamics I		
Тур	Recitation Section (large)	
Hrs/wk	2	
СР	3	
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28	
Lecturer	Prof. Thomas Rung	
Language	DE	
Cycle	WiSe	
Content	See interlocking course	
Literature	See interlocking course	

Courses				
Title		Тур	Hrs/wk	СР
Electrical Machines and Actuators	,L0293)	Lecture	3	4
Electrical Machines and Actuators	L0294)	Recitation Section (large)	2	2
Module Responsible	Prof. Thorsten Kern			
Admission Requirements	None			
Recommended Previous	Basics of mathematics, in particular complexe numb	ers, integrals, differentials		
Knowledge	Basics of electrical engineering and mechanical engi	neering		
Educational Objections				
Educational Objectives Professional Competence	After taking part successfully, students have reached	a the following learning results		
-	Students can to draw and explain the basic principle	s of electric and magnetic fields		
	They can describe the function of the standard types of electric machines and present the corresponding equations a characteristic curves. For typically used drives they can explain the major parameters of the energy efficiency of the whole syster from the power grid to the driven engine.			
Skills	Students are able to calculate two-dimensional electric they apply the usual methods of the design autor		rromagnetic circu	uits with air gap. F
	They can calulate the operational performance of electric machines from their given characteristic data and selected qu and characteristic curves. They apply the usual equivalent circuits and graphical methods.			
Personal Competence				
Social Competence		a and magnetic fields for applications. Th		aluca independen
Autonomy	Students are able independently to calculate electric the operational performance of electric machines fr and characteristic curves.			
Workload in Hours	Independent Study Time 110, Study Time in Lecture	70		
Credit points				
Course achievement				
Examination				
Examination duration and scale	Design of four machines and actuators, review of dea	sign files		
	General Engineering Science (German program, 7	semester): Specialisation Mechanical	Engineering Foc	us Energy System
Following Curricula		semestery. Specialisation Mechanical	Engineering, roc	us Energy System
· · · · · · · · · · · · · · · · · · ·	General Engineering Science (German program,	7 semester): Specialisation Mechanica	al Engineering, I	Focus Mechatronio
	Compulsory			
	General Engineering Science (German program, 7 se	emester): Specialisation Mechanical Engir	neering, Focus Th	eoretical Mechanio
	Engineering: Elective Compulsory			
	General Engineering Science (German program, 7 se		ering: Elective Co	mpulsory
	General Engineering Science (German program, 7 se	mester): Specialisation Electrical Enginee		
	Digital Mechanical Engineering: Core Qualification: C	Compulsory		
	Digital Mechanical Engineering: Core Qualification: C Electrical Engineering: Core Qualification: Elective Co	ompulsory ompulsory		
	Digital Mechanical Engineering: Core Qualification: C Electrical Engineering: Core Qualification: Elective Co Engineering Science: Specialisation Electrical Engine	ompulsory ompulsory ering: Elective Compulsory		
	Digital Mechanical Engineering: Core Qualification: C Electrical Engineering: Core Qualification: Elective Co Engineering Science: Specialisation Electrical Engine Green Technologies: Energy, Water, Climate: Specia	ompulsory ompulsory ering: Elective Compulsory lisation Energy Technology: Elective Com		
	Digital Mechanical Engineering: Core Qualification: C Electrical Engineering: Core Qualification: Elective Co Engineering Science: Specialisation Electrical Engine Green Technologies: Energy, Water, Climate: Special Green Technologies: Energy, Water, Climate: Special	ompulsory ompulsory ering: Elective Compulsory lisation Energy Technology: Elective Com lisation Maritime Technologies: Elective C	Compulsory	
	Digital Mechanical Engineering: Core Qualification: C Electrical Engineering: Core Qualification: Elective Co Engineering Science: Specialisation Electrical Engine Green Technologies: Energy, Water, Climate: Special Green Technologies: Energy, Water, Climate: Special Computer Science in Engineering: Specialisation II. M	ompulsory ompulsory ering: Elective Compulsory lisation Energy Technology: Elective Com lisation Maritime Technologies: Elective C lathematics & Engineering Science: Elect	Compulsory	
	Digital Mechanical Engineering: Core Qualification: C Electrical Engineering: Core Qualification: Elective Co Engineering Science: Specialisation Electrical Engine Green Technologies: Energy, Water, Climate: Special Green Technologies: Energy, Water, Climate: Special	ompulsory ompulsory ering: Elective Compulsory lisation Energy Technology: Elective Com lisation Maritime Technologies: Elective C fathematics & Engineering Science: Elect and Systems: Elective Compulsory	Compulsory ive Compulsory	
	Digital Mechanical Engineering: Core Qualification: C Electrical Engineering: Core Qualification: Elective C Engineering Science: Specialisation Electrical Engine Green Technologies: Energy, Water, Climate: Special Green Technologies: Energy, Water, Climate: Special Computer Science in Engineering: Specialisation II. M Logistics and Mobility: Specialisation Traffic Planning	ompulsory ompulsory ering: Elective Compulsory lisation Energy Technology: Elective Com lisation Maritime Technologies: Elective C Mathematics & Engineering Science: Elect and Systems: Elective Compulsory agement and Processes: Elective Compu	Compulsory ive Compulsory	
	Digital Mechanical Engineering: Core Qualification: C Electrical Engineering: Core Qualification: Elective C Engineering Science: Specialisation Electrical Engine Green Technologies: Energy, Water, Climate: Special Green Technologies: Energy, Water, Climate: Special Computer Science in Engineering: Specialisation II. M Logistics and Mobility: Specialisation Traffic Planning Logistics and Mobility: Specialisation Production Man	ompulsory ompulsory ering: Elective Compulsory lisation Energy Technology: Elective Com lisation Maritime Technologies: Elective C Mathematics & Engineering Science: Elect and Systems: Elective Compulsory agement and Processes: Elective Compu Compulsory	Compulsory ive Compulsory	
	Digital Mechanical Engineering: Core Qualification: C Electrical Engineering: Core Qualification: Elective C Engineering Science: Specialisation Electrical Engine Green Technologies: Energy, Water, Climate: Special Green Technologies: Energy, Water, Climate: Special Computer Science in Engineering: Specialisation II. M Logistics and Mobility: Specialisation Traffic Planning Logistics and Mobility: Specialisation Production Man Mechanical Engineering: Core Qualification: Elective	ompulsory ompulsory ering: Elective Compulsory lisation Energy Technology: Elective Com lisation Maritime Technologies: Elective C Mathematics & Engineering Science: Elect and Systems: Elective Compulsory agement and Processes: Elective Compu Compulsory	Compulsory ive Compulsory	
	Digital Mechanical Engineering: Core Qualification: C Electrical Engineering: Core Qualification: Elective C Engineering Science: Specialisation Electrical Engine Green Technologies: Energy, Water, Climate: Special Green Technologies: Energy, Water, Climate: Special Computer Science in Engineering: Specialisation II. N Logistics and Mobility: Specialisation Traffic Planning Logistics and Mobility: Specialisation Production Man Mechanical Engineering: Core Qualification: Elective Mechatronics: Specialisation Naval Engineering: Core Mechatronics: Core Qualification: Compulsory Mechatronics: Specialisation Robot- and Machine-Sy:	ompulsory prince in the second	Compulsory ive Compulsory	
	Digital Mechanical Engineering: Core Qualification: C Electrical Engineering: Core Qualification: Elective C Engineering Science: Specialisation Electrical Engine Green Technologies: Energy, Water, Climate: Special Green Technologies: Energy, Water, Climate: Special Computer Science in Engineering: Specialisation II. M Logistics and Mobility: Specialisation Traffic Planning Logistics and Mobility: Specialisation Production Man Mechanical Engineering: Core Qualification: Elective Mechatronics: Specialisation Naval Engineering: Com Mechatronics: Specialisation Robot- and Machine-Sys Mechatronics: Specialisation Electrical Systems: Elec	ompulsory prince in the second	Compulsory ive Compulsory	
	Digital Mechanical Engineering: Core Qualification: C Electrical Engineering: Core Qualification: Elective C Engineering Science: Specialisation Electrical Engine Green Technologies: Energy, Water, Climate: Special Green Technologies: Energy, Water, Climate: Special Computer Science in Engineering: Specialisation II. M Logistics and Mobility: Specialisation Traffic Planning Logistics and Mobility: Specialisation Production Man Mechanical Engineering: Core Qualification: Elective Mechatronics: Specialisation Naval Engineering: Com Mechatronics: Specialisation Robot- and Machine-Sys Mechatronics: Specialisation Electrical Systems: Elec Technomathematics: Specialisation III. Engineering S	ompulsory prompulsory ering: Elective Compulsory lisation Energy Technology: Elective Com lisation Maritime Technologies: Elective Co Mathematics & Engineering Science: Elect and Systems: Elective Compulsory agement and Processes: Elective Compu Compulsory pulsory stems: Compulsory tive Compulsory science: Elective Compulsory	compulsory ive Compulsory Isory	
	Digital Mechanical Engineering: Core Qualification: C Electrical Engineering: Core Qualification: Elective C Engineering Science: Specialisation Electrical Engine Green Technologies: Energy, Water, Climate: Special Green Technologies: Energy, Water, Climate: Special Computer Science in Engineering: Specialisation II. M Logistics and Mobility: Specialisation Traffic Planning Logistics and Mobility: Specialisation Production Man Mechanical Engineering: Core Qualification: Elective Mechatronics: Specialisation Naval Engineering: Com Mechatronics: Specialisation Robot- and Machine-Sys Mechatronics: Specialisation Electrical Systems: Elect Technomathematics: Specialisation III. Engineering S Engineering and Management - Major in Logistics and	ompulsory pering: Elective Compulsory lisation Energy Technology: Elective Com lisation Maritime Technologies: Elective Co Mathematics & Engineering Science: Elect and Systems: Elective Compulsory agement and Processes: Elective Compu Compulsory upulsory stems: Compulsory tive Compulsory science: Elective Compulsory d Mobility: Specialisation Traffic Planning	ompulsory ive Compulsory lsory and Systems: Eld	
	Digital Mechanical Engineering: Core Qualification: C Electrical Engineering: Core Qualification: Elective C Engineering Science: Specialisation Electrical Engine Green Technologies: Energy, Water, Climate: Special Green Technologies: Energy, Water, Climate: Special Computer Science in Engineering: Specialisation II. M Logistics and Mobility: Specialisation Traffic Planning Logistics and Mobility: Specialisation Production Man Mechanical Engineering: Core Qualification: Elective Mechatronics: Specialisation Naval Engineering: Com Mechatronics: Specialisation Robot- and Machine-Sys Mechatronics: Specialisation Electrical Systems: Elect Technomathematics: Specialisation III. Engineering S Engineering and Management - Major in Logistics an	ompulsory pering: Elective Compulsory lisation Energy Technology: Elective Com lisation Maritime Technologies: Elective Co Mathematics & Engineering Science: Elect and Systems: Elective Compulsory agement and Processes: Elective Compu Compulsory upulsory stems: Compulsory tive Compulsory science: Elective Compulsory d Mobility: Specialisation Traffic Planning d Mobility: Specialisation Information Tec	ompulsory ive Compulsory lsory and Systems: Ele hnology: Elective	Compulsory
	Digital Mechanical Engineering: Core Qualification: C Electrical Engineering: Core Qualification: Elective C Engineering Science: Specialisation Electrical Engine Green Technologies: Energy, Water, Climate: Special Green Technologies: Energy, Water, Climate: Special Computer Science in Engineering: Specialisation II. M Logistics and Mobility: Specialisation Traffic Planning Logistics and Mobility: Specialisation Production Man Mechanical Engineering: Core Qualification: Elective Mechatronics: Specialisation Naval Engineering: Core Mechatronics: Specialisation Robot- and Machine-Sys Mechatronics: Specialisation Electrical Systems: Elect Technomathematics: Specialisation III. Engineering S Engineering and Management - Major in Logistics an Engineering and Management - Major in Logistics	ompulsory pering: Elective Compulsory lisation Energy Technology: Elective Com lisation Maritime Technologies: Elective Co Mathematics & Engineering Science: Elect and Systems: Elective Compulsory agement and Processes: Elective Compu Compulsory upulsory stems: Compulsory tive Compulsory science: Elective Compulsory d Mobility: Specialisation Traffic Planning d Mobility: Specialisation Information Tec	ompulsory ive Compulsory lsory and Systems: Ele hnology: Elective	Compulsory
	Digital Mechanical Engineering: Core Qualification: C Electrical Engineering: Core Qualification: Elective C Engineering Science: Specialisation Electrical Engine Green Technologies: Energy, Water, Climate: Special Green Technologies: Energy, Water, Climate: Special Computer Science in Engineering: Specialisation II. M Logistics and Mobility: Specialisation Traffic Planning Logistics and Mobility: Specialisation Production Man Mechanical Engineering: Core Qualification: Elective Mechatronics: Specialisation Naval Engineering: Com Mechatronics: Specialisation Robot- and Machine-Sys Mechatronics: Specialisation Electrical Systems: Elect Technomathematics: Specialisation III. Engineering S Engineering and Management - Major in Logistics an	ompulsory pering: Elective Compulsory lisation Energy Technology: Elective Com lisation Maritime Technologies: Elective Co Mathematics & Engineering Science: Elect and Systems: Elective Compulsory agement and Processes: Elective Compu Compulsory apulsory stems: Compulsory tive Compulsory science: Elective Compulsory d Mobility: Specialisation Traffic Planning d Mobility: Specialisation Information Tec and Mobility: Specialisation Production 1	and Systems: Ele hnology: Elective Management and	Compulsory Processes: Electi

Course L0293: Electrical Mac	hines and Actuators
Тур	Lecture
Hrs/wk	3
СР	4
Workload in Hours	Independent Study Time 78, Study Time in Lecture 42
Lecturer	Prof. Thorsten Kern, Dennis Kähler
Language	DE
Cycle	SoSe
Content	Electric field: Coulomb's law, flux (field) line, work, potential, capacitor, energy, force, capacitive actuators
	Magnetic field: force, flux line, Ampere's law, field at bounderies, flux, magnetic circuit, hysteresis, induction, self-induction, mutual inductance, transformer, electromagnetic actuators
	Synchronous machines, construction and layout, equivalent single line diagrams, no-load and short-cuircuit characteristics, vector diagrams, motor and generator operation, stepper motors
	DC-Machines: Construction and layout, torque generation mechanismen, torque vs speed characteristics, commutation,
	Asynchronous Machines. Magnetic field, construction and layout, equivalent single line diagram, complex stator current diagram (Heylands 'diagram), torque vs. speed characteristics, rotor layout (squirrel-cage vs. sliprings),
	Drives with variable speed, inverter fed operation, special drives
Literature	Hermann Linse, Roland Fischer: "Elektrotechnik für Maschinenbauer", Vieweg-Verlag; Signatur der Bibliothek der TUHH: ETB 313
	Ralf Kories, Heinz Schmitt-Walter: "Taschenbuch der Elektrotechnik"; Verlag Harri Deutsch; Signatur der Bibliothek der TUHH: ETB 122
	"Grundlagen der Elektrotechnik" - anderer Autoren
	Fachbücher "Elektrische Maschinen"

Course L0294: Electrical Machines and Actuators		
Тур	Recitation Section (large)	
Hrs/wk	2	
CP	2	
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28	
Lecturer	Prof. Thorsten Kern, Dennis Kähler	
Language	DE	
Cycle	SoSe	
Content	See interlocking course	
Literature	See interlocking course	

Courses				
		_		
Title		Typ Lecture	Hrs/wk	СР
	rogramming Concepts, Data Handling & Communication (L2689) rogramming Concepts, Data Handling & Communication (L2690)	Recitation Section (small)	3 2	3 3
Module Responsible		Rectation Section (Smail)	L	5
	None			
Recommended Previous	None			
Knowledge				
-	After taking part successfully, students have reached the fo	lowing loarning rocults		
Professional Competence	Arter taking part successfully, students have reached the to	lowing learning results		
Knowledge				
Skills				
SKIIIS				
Personal Competence				
Social Competence				
Autonomy				
Workload in Hours	Independent Study Time 110, Study Time in Lecture 70			
Credit points	6			
Course achievement	Compulsory Bonus Form Descriptio			
		inden semesterbegleitend statt.		
Examination				
Examination duration and	120 min			
scale				
	General Engineering Science (German program, 7 sem	ester): Specialisation Mechanica	I Engineering, F	ocus Biomechani
Following Curricula				
	General Engineering Science (German program, 7 semester			
	General Engineering Science (German program, 7 semester	: Specialisation Green Technolog	les, Focus Renew	able Energy: Elect
	Compulsory General Engineering Science (German program, 7 semes	ter): Specialisation Mechanical	Engineering Foc	us Energy System
	Compulsory	ter). Specialisation mechanical	Lingineering, Toe	us Energy Syster
	General Engineering Science (German program, 7 seme	ster): Specialisation Mechanical	Engineering, Foc	us Aircraft Syste
	Engineering: Compulsory		5,	
	General Engineering Science (German program, 7 sem	ester): Specialisation Mechanica	al Engineering, I	ocus Mechatroni
	Compulsory			
	General Engineering Science (German program, 7 semeste	r): Specialisation Mechanical Eng	ineering, Focus P	roduct Developm
	and Production: Elective Compulsory			
	General Engineering Science (German program, 7 semester): Specialisation Mechanical Engi	neering, Focus Th	eoretical Mechani
	Engineering: Elective Compulsory			
	General Engineering Science (German program, 7 semester	: Specialisation Electrical Engine	ering: Elective Co	mpulsory
	Bioprocess Engineering: Core Qualification: Compulsory			
	Chemical and Bioprocess Engineering: Core Qualification: Co	ompulsory		
	Electrical Engineering: Core Qualification: Compulsory	Eporar Systems / Bonowable Epo	raioci Electivo Co	mpulcony
	Green Technologies: Energy, Water, Climate: Specialisation Logistics and Mobility: Specialisation Information Technolog		ingres. Elective Co	mpuisoi y
	Mechatronics: Specialisation Robot- and Machine-Systems: (
	Mechatronics: Specialisation Medical Engineering: Compulse			
	Mechatronics: Specialisation Dynamic Systems and AI: Com	,		
	Mechatronics: Specialisation Electrical Systems: Elective Co			
	Process Engineering: Core Qualification: Compulsory			
	5 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5			

Course L2689: Computer Sci	Course L2689: Computer Science for Engineers - Programming Concepts, Data Handling & Communication	
Тур	Lecture	
Hrs/wk	3	
СР	3	
Workload in Hours	Independent Study Time 48, Study Time in Lecture 42	
Lecturer	Prof. Sibylle Fröschle	
Language	DE	
Cycle	SoSe	
Content		
Literature	John V. Guttag: Introduction to Computation and Programming Using Python.	
	With Application to Understanding Data. 2nd Edition. The MIT Press, 2016.	

Course L2690: Computer Sci	Course L2690: Computer Science for Engineers - Programming Concepts, Data Handling & Communication	
Тур	Recitation Section (small)	
Hrs/wk	2	
CP	3	
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28	
Lecturer	Prof. Sibylle Fröschle	
Language	DE	
Cycle	SoSe	
Content	See interlocking course	
Literature	See interlocking course	

Courses				
Title		Тур	Hrs/wk	СР
Power Industry (L0316)		Lecture	1	1
Energy Systems and Energy Industr	y (L0315)	Lecture	2	2
Renewable Energy (L0313)		Lecture	2	2
Renewable Energy (L1434)		Recitation Section (small)	1	1
Module Responsible	Prof. Martin Kaltschmitt			
Admission Requirements	None			
Recommended Previous	none			
Knowledge				
Educational Objectives	After taking part successfully, students	have reached the following learning results		
Professional Competence				
Skills	applicable to many energy systems in the students can explain the environme Students are able to apply methodolog energy systems. Furthermore, they car under certain given conditions. Ther standardized solutions of a problem.	egard to subject-related contexts. The student general, especially for renewable energy system ental benefits from the use of such systems. ies for detailed determination of energy demand a evaluate energy systems technically, environme efore, they can choose the necessary subject ions and possible approaches to its processing finitext.	or energy productio entally and economic t-specific calculation	n for various types cally and design the n rules, also for r
Personal Competence				
	The students are able to analyze suit:	able technical alternatives and to assess them	with technical, econ	omical and ecologic
		is allows them to make an effective contribuition		-
Autonomy		surces , acquire the particular knowledge about	the subject area and	d transform it to ne
	questions.			
Workload in Hours	Independent Study Time 96, Study Time	e in Lecture 84		
Credit points	6			
Course achievement	None			
Examination	Written exam			
Examination duration and	3 hours written exam			
scale				
Assignment for the	General Engineering Science (German	program, 7 semester): Specialisation Mechan	cal Engineering Eo	cus Energy System

Course L0316: Power Industry		
Тур	Lecture	
Hrs/wk		
CP	1	
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14	
Lecturer	Prof. Andreas Wiese	
Language	DE	
Cycle	SoSe	
Content	 Electrical energy in the energy system Demand and use of electrical energy (households, industry, "new" buyers (including e-mobility)) Electricity generation electricity generation technologies using fossil fuels and their characteristics combined heat and power technologies and their production characteristics electricity generation from renewable energy technologies and their characteristics electricity generation of electrical energy challenges of fluctuating electricity generation by distributed systems (electricity market, electricity stock exchange, emissions trading) District heating industry Legal and administrative aspects Energy Act support instruments for renewable energy CHP Act 	
Literature	Folien der Vorlesung	

Course L0315: Energy System	ns and Energy Industry
Тур	Lecture
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Prof. Martin Kaltschmitt
Language	DE
Cycle	SoSe
Content	 Energy: development and significance Fundamentals and basic concepts Energy demand and future trends (heat, electricity, fuels) Energy reserve and sources Cost and efficiency calculation Final and effective energy from petroleum, natural gas, coal, uranium and other Legal, administrative and organizational aspects of energy systems Energy systems as a permanent optimization task
Literature	Kopien der Folien

Course 10212, Bonourship Fr	
Course L0313: Renewable En	
Тур	Lecture
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Prof. Martin Kaltschmitt
Language	DE/EN
Cycle	SoSe
Content	 introduction solar energy for heat and power generation wind power for electricity generation hydropower for electricity generation ocean energy for electricity generation geothermal energy for heat and electricity generation
Literature	 Kaltschmitt, M.; Streicher, W.; Wiese, A. (Hrsg.): Erneuerbare Energien - Systemtechnik, Wirtschaftlichkeit, Umweltaspekte; Springer, Berlin, Heidelberg, 2006, 4. Auflage Kaltschmitt, M.; Streicher, W.; Wiese, A. (Hrsg.): Renewable Energy - Technology, Economics and Environment; Springer, Berlin, Heidelberg, 2007

Course L1434: Renewable Er	iergy
Тур	Recitation Section (small)
Hrs/wk	1
CP	1
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14
Lecturer	Prof. Martin Kaltschmitt
Language	DE/EN
Cycle	SoSe
Content	Students work on different tasks in the field of renewable energies. They present their solutions in the exercise lesson and discuss it with other students and the lecturer. Possible tasks in the field of renewable energies are: Solar thermal heat Concentrating solare power Photovoltaic Windenergie Hydropower Heat pump Deep geothermal energy
Literature	 Kaltschmitt, M.; Streicher, W.; Wiese, A. (Hrsg.): Erneuerbare Energien - Systemtechnik, Wirtschaftlichkeit, Umweltaspekte; Springer, Berlin, Heidelberg, 2006, 4. Auflage Kaltschmitt, M.; Streicher, W.; Wiese, A. (Hrsg.): Renewable Energy - Technology, Economics and Environment; Springer, Berlin, Heidelberg, 2007

Focus Aircraft Systems Engineering

The area of specialization "Aircraft System Engineering" prepares participating students for diverse kind of professions in the field of aviation and related industries. Students learn how to use typical methods of systems engineering as well as the application of modern, computer-based techniques for system design, analysis and evaluation. Furthermore required knowledge from different fields of aviation including aircraft systems and air transportation system is discussed.

Additionally students get insight into current research activities, e.g. in the area of fuel cells and electrical energy supply, actuators, avionics systems and software or hydraulic energy supply.

Module M0596: Adva	nced Mechanical Design Project
Courses	
Title Advanced Mechanical Design Proje	t (L0266) Typ Hrs/wk CP Project-/problem-based Learning 4 6
Module Responsible	Dr. Jens Schmidt
Admission Requirements	None
Recommended Previous Knowledge	Mechanical Engineering: DesignAdvanced Mechanical Engineering Design
Educational Objectives	After taking part successfully, students have reached the following learning results
Professional Competence Knowledge	 After passing the module, students are able to: express the procedure for systematically handling of complex design tasks , describe working principles, their use and combination possibilities, explain guidelines for designing for function and manufacturing,
Skills	 explain advanced use-oriented knowledge of machine elements. After passing the module, students are able to: analyze complex tasks and develop principle solutions using sketches, convert principle solutions into a detailed design, use methods to design and solve engineering design tasks systematically and solution-oriented, create a technical documentation including all necessary technical drawings to understand the functions of the system, document calculations of selected machine elements clearly and in detail.
Personal Competence Social Competence	 After passing the module, students are able to: present and discuss solutions and technical drawings within groups, reflect the own results in the work groups of the course
Autonomy	 After passing the module, students are able to: independently solve complex design projects, while motivating themselves, acquiring necessary knowledge and selectin appropriate methods, to independently solve problems.
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56
Credit points Course achievement	6 Compulsory Bonus Form Description Yes None Attestation
Examination	Written exam
Examination duration and scale	180
Assignment for the Following Curricula	General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Aircraft System Engineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Product Developmen and Production: Compulsory
	Mechanical Engineering: Core Qualification: Compulsory

Course L0266: Advanced Med	chanical Design Project
Тур	Project-/problem-based Learning
Hrs/wk	4
CP	6
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56
Lecturer	Dr. Jens Schmidt, Dr. Volkert Wollesen
Language	DE
Cycle	WiSe
Content	Das Konstruktionsprojekt gliedert sich in den Entwurf eines Getriebes sowie die Lösungsfindung.
	Getriebekonstruktion in Einzelarbeit
	Erarbeitung von Lösungsprinzipien
	Berechnung von Maschinenelementen
	Entwurf eines Getriebes im Hauptschnitt plus allen Außenansichten
	Erstellung einer ausführlichen Dokumentation
	Lösungsfindung
	 Methodische Erarbeitung von prinzipiellen Lösungskonzepten
	Erstellen einer Dokumentation
Literature	 Dubbel, Taschenbuch für den Maschinenbau; Grote, KH., Feldhusen, J.(Hrsg.); Springer-Verlag, aktuelle Auflage. Maschinenelemente, Band I-III; Niemann, G., Springer-Verlag, aktuelle Auflage. Maschinen- und Konstruktionselemente; Steinhilper, W., Röper, R., Springer Verlag, aktuelle Auflage. Einführung in die DIN-Normen; Klein, M., Teubner-Verlag. Konstruktionslehre, Pahl, G.; Beitz, W., Springer-Verlag, aktuelle Auflage. Maschinenelemente 1-2; Schlecht, B., Pearson Verlag, aktuelle Auflage. Maschinenelemente - Gestaltung, Berechnung, Anwendung; Haberhauer, H., Bodenstein, F., Springer-Verlag, aktuelle Auflage. Roloff/Matek Maschinenelemente; Wittel, H., Muhs, D., Jannasch, D., Voßiek, J., Springer Vieweg, aktuelle Auflage. Sowie weitere Bücher zu speziellen Themen

Tribe Typ Hrs/Wk CP Computational Hub Dynamics 11 (0233) Rectanon Sactian (large) 2 3 Module Responsible Prof. Thomas Rung Admission Requirements None Rectanon Sactian (large) 2 3 Admission Requirements Suidents should have sound knowledge of engineering mathematics (series expansions, internal & vector calculus), and be fam Recommended Previous Suidents will have the required combined knowledge of thermo-fluid dynamics and numerical analysis to translate gen price/solar denomerican and scores algorithms denomiced privation (addition of thermo-fluid dynamics and numerical analysis to translate gen price/solar denomerican the other nolicous (prevents) and differental equations. Recommended Previous Suidents will have the required combined knowledge of thermo-fluid dynamics and numerical analysis to translate gen price/solar denomined regioners in rule docaree algorithms denomined. For explain and a unmerical analysis to translate gen price/solar discrete station and algorithms denomine? Dec. They are familiar with most numerical analysis to translate gen price/solar discrete station and algorithms denomine? Dec. They are familiar with explorement and discrete station and algorithms denomine? Dec. They are familiar with most numerical analysis. Previoual Competence Social Competence None dec. The students are able to discuss problems, present the results of their own analysis, and jointly develop, implement and report computation atagerithm devinere anaphylogh	Courses				
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Naval Architecture: Core Qualification: Compulsory				ompulsory	
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Course L0235: Computationa	al Fluid Dynamics I
Тур	Lecture
Hrs/wk	2
CP	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Prof. Thomas Rung
Language	DE
Cycle	WiSe
Content	Fundamentals of computational modelling of thermofluid dynamic problems. Development of numerical algorithms.
	 Partial differential equations Foundations of finite numerical approximations Computation of potential flows Introduction of finite-differences Approximation of convective, diffusive and transient transport processes Formulation of boundary conditions and initial conditions Assembly and solution of algebraic equation systems Facets of weighted -residual approaches Finite volume methods Basics of grid generation
Literature	Ferziger and Peric: Computational Methods for Fluid Dynamics, Springer

ourse L0419: Computational Fluid Dynamics I		
Тур	Recitation Section (large)	
Hrs/wk	2	
СР	3	
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28	
Lecturer	Prof. Thomas Rung	
Language	DE	
Cycle	WiSe	
Content	See interlocking course	
Literature	See interlocking course	

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Courses				
Title		Тур	Hrs/wk	СР
Numerical Mathematics I (L0417)		Lecture Recitation Section (small)	2	3 3
Numerical Mathematics I (L0418)		Recitation Section (Small)	Z	3
Module Responsible	Prof. Sabine Le Borne			
Admission Requirements	None			
Recommended Previous	Mathematik I + II for Engineering Students (german	or english) or Analysis & Linear Ald	nebra I + II for Te	chnomathematic
Knowledge	basic MATLAB/Python knowledge			
Educational Objectives	After taking part successfully, students have reached the	ollowing learning results		
Professional Competence				
Knowledge	Students are able to			
	 name numerical methods for interpolation integrat 	ion loost squares problems, sigon	value problems r	oplinger root fin
	 name numerical methods for interpolation, integrat problems and to explain their serie ideas 	ion, least squares problems, eigen	alue problems, i	Ionninear root nin
	problems and to explain their core ideas,			
	repeat convergence statements for the numerical n			
	explain aspects for the practical execution of nume	ical methods with respect to comp	utational and sto	rage complexitx.
Skills	Students are able to			
	 implement, apply and compare numerical methods 	using MATLAB/Python.		
	 justify the convergence behaviour of numerical met 		nd solution algori	ithm
	 select and execute a suitable solution approach for 		ina sonation argon	
		a given problem		
Personal Competence				
Social Competence	Students are able to			
	• work together in betergeneously compared tooms	(i.e. teams from different study of	rograms and bas	karound knowlod
	 work together in heterogeneously composed teams 			
	explain theoretical foundations and support each ot	ner with practical aspects regarding	g the implementa	icion of algorithm
Autonomy	Students are capable			
	 to assess whether the supporting theoretical and pr 		l individually or ir	i a team,
	 to assess their individual progess and, if necessary, 	to ask questions and seek help.		
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56			
Credit points				
Course achievement				
Examination				
Examination duration and	90 minutes			
scale) Constitution Commuter Colored	Commuter ma	
Assignment for the	General Engineering Science (German program, 7 semeste			
Following Curricula	General Engineering Science (German program, 7 semeste			-
	General Engineering Science (German program, 7 ser	nester): Specialisation Mechanica	I Engineering, F	ocus Biomechar
	Compulsory			
	General Engineering Science (German program, 7 semest	er): Specialisation Mechanical Engir	neering, Focus Tr	ieoretical Mechar
	Engineering: Compulsory		F acility and F acility Facility Facility Facility Facility Facility Facility Fa	Alara the Court
	General Engineering Science (German program, 7 sem	ester): Specialisation Mechanical	Engineering, Foo	us Aircraft Syste
	Engineering: Elective Compulsory			
	General Engineering Science (German program, 7 semest	er): Specialisation Mechanical Engli	neering, Focus M	echatronics: Elec
	Compulsory			
	General Engineering Science (German program, 7 sem	ester): Specialisation Mechanical I	Engineering, Foc	us Energy Syste
	Elective Compulsory			
	General Engineering Science (German program, 7 semeste			
	General Engineering Science (German program, 7 semeste			
	Bioprocess Engineering: Specialisation A - General Bioproc	ess Engineering: Elective Compulso	ory	
	Data Science: Core Qualification: Compulsory			
	Electrical Engineering: Core Qualification: Elective Comput	sory		
	Engineering Science: Core Qualification: Compulsory			
	Green Technologies: Energy, Water, Climate: Specialisatio	n Energy Technology: Elective Com	pulsory	
	Computer Science in Engineering: Core Qualification: Com	pulsory		
	Mechanical Engineering: Specialisation Theoretical Mechan	nical Engineering: Compulsory		
	5 5 5 6 6 6 6 6 6 6 6 6 6 6 6 6 6 6 6 6			
	Mechanical Engineering: Specialisation Energy Systems: E	lective Compulsory		
			Compulsory	

Course L0417: Numerical Ma	thematics I		
Тур	Lecture		
Hrs/wk			
CP	3		
Workload in Hours	ndependent Study Time 62, Study Time in Lecture 28		
Lecturer	Prof. Sabine Le Borne		
Language	EN		
Cycle	WiSe		
Content	 Finite precision arithmetic, error analysis, conditioning and stability Linear systems of equations: LU and Cholesky factorization, condition Interpolation: polynomial, spline and trigonometric interpolation Nonlinear equations: fixed point iteration, root finding algorithms, Newton's method Linear and nonlinear least squares problems: normal equations, Gram Schmidt and Householder orthogonalization, singular value decomposition, regularizatio, Gauss-Newton and Levenberg-Marquardt methods Eigenvalue problems: power iteration, inverse iteration, QR algorithm Numerical differentiation Numerical integration: Newton-Cotes rules, error estimates, Gauss quadrature, adaptive quadrature 		
Literature	 Gander/Gander/Kwok: Scientific Computing: An introduction using Maple and MATLAB, Springer (2014) Stoer/Bulirsch: Numerische Mathematik 1, Springer Dahmen, Reusken: Numerik f ür Ingenieure und Naturwissenschaftler, Springer 		

Course L0418: Numerical Mathematics I	
Тур	Recitation Section (small)
Hrs/wk	2
CP	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Prof. Sabine Le Borne, Dr. Jens-Peter Zemke
Language	EN
Cycle	WiSe
Content	See interlocking course
Literature	See interlocking course

Courses				
ītle		Тур	Hrs/wk	СР
imulation and Design of Mechatro	nic Systems (L1822)	Lecture	2	2
imulation and Design of Mechatro		Recitation Section (large)	1	2
imulation and Design of Mechatro	nic Systems (L1824)	Practical Course	1	2
Module Responsible	Prof. Robert Seifried			
Admission Requirements	None			
Recommended Previous	Fundatmentals of mechanics, control theory and electrical engineering			
Knowledge				
Educational Objectives	After taking part successfully, students	have reached the following learning results		
Professional Competence				
Knowledge	Students are able to describe methods	and calculations for design, modeling, simulation and	d optimization of m	nechatronic syste
Chille				
SKIIIS	s Students are able to apply modern algorithms for modeling of mechatronic systems. They can identify, simulate and design sin systems and implement those in laboratory conditions.			
	systems and implement those in labora	tory conditions.		
Personal Competence				
Social Competence	Students are able to work goal-oriented in small mixed groups and present results to target groups.			
Autonomy	ny Students are able to recognize and improve knowledge deficits independently.			
	With instructor assistance, students are	able to evaluate their own knowledge level and def	ne a further cours	e of study.
Workload in Hours				
Credit points	6			
Course achievement	None			
Examination	Written exam			
Examination duration and				
scale				
Assignment for the	General Engineering Science (Germar	program, 7 semester): Specialisation Mechanica	l Engineering, For	cus Aircraft Syst
-	Engineering: Elective Compulsory		5 5.	2
-		program, 7 semester): Specialisation Mechanical En	gineering, Focus M	lechatronics: Elec
	Compulsory		-	
	Mechatronics: Core Qualification: Comp			

course Erozz. Simulation an	a besign of Hechacronic Systems	
Тур	Lecture	
Hrs/wk	2	
CP		
Workload in Hours	Jependent Study Time 32, Study Time in Lecture 28	
Lecturer	of. Robert Seifried	
Language	E	
Cycle	WiSe	
Content	Mechatronic Design	
	Modeling	
	Model Identifikation	
	Numerical Methods in simulation	
	Applications and examples in Matlab $^{\circledast}$ and Simulink $^{\circledast}$	
Literature	Skript zur Veranstaltung	
	Weitere Literatur in der Veranstaltung	

Course L1823: Simulation and Design of Mechatronic Systems	
Тур	Recitation Section (large)
Hrs/wk	1
CP	2
Workload in Hours	Independent Study Time 46, Study Time in Lecture 14
Lecturer	Prof. Robert Seifried
Language	DE
Cycle	WiSe
Content	See interlocking course
Literature	See interlocking course

Course L1824: Simulation and Design of Mechatronic Systems		
Тур	Practical Course	
Hrs/wk		
CP	2	
Workload in Hours	Independent Study Time 46, Study Time in Lecture 14	
Lecturer	Prof. Robert Seifried	
Language	DE	
Cycle	WiSe	
Content	See interlocking course	
Literature	See interlocking course	

commended Previous Knowledge Fu M Aducational Objectives Aducational Competence		-	Hrs/wk 2 2	CP 2 2 2
roduct Development (L0269) ment of Lightweight Design Pr Module Responsible Pr nission Requirements Nr commended Previous Ar Knowledge Fu M ducational Objectives Ar iessional Competence	rof. Dieter Krause lone dvanced Knowledge about engineering de: undamentals of Mechanical Engineering De lechanical Engineering: Design dvanced Mechanical Engineering Design	Project-/problem-based Learn Lecture Lecture	ning 2 2	2 2
ment of Lightweight Design Pr Module Responsible Pr nission Requirements Nr commended Previous Ar Knowledge Ft Adducational Objectives Ar ressional Competence	rof. Dieter Krause lone dvanced Knowledge about engineering de: undamentals of Mechanical Engineering De lechanical Engineering: Design dvanced Mechanical Engineering Design	ign:	2	
nission Requirements Nu commended Previous Ar Knowledge Fu M Aducational Objectives Ar ressional Competence	lone dvanced Knowledge about engineering de: undamentals of Mechanical Engineering De lechanical Engineering: Design dvanced Mechanical Engineering Design	-		
commended Previous Arrowledge Fu Knowledge Arrowledge A	dvanced Knowledge about engineering de undamentals of Mechanical Engineering De lechanical Engineering: Design dvanced Mechanical Engineering Design	-		
Knowledge Fu M Aducational Objectives Fessional Competence	undamentals of Mechanical Engineering De lechanical Engineering: Design dvanced Mechanical Engineering Design	-		
ducational Objectives Al	lechanical Engineering: Design dvanced Mechanical Engineering Design	sign		
ducational Objectives Al	dvanced Mechanical Engineering Design			
ducational Objectives At				
essional Competence	fter taking part successfully, students have			
-		reached the following learning results		
Knowledge A				
	fter completing the module, students are o	apable of:		
		3D-CAD-Systems, PDM- and FEM-Systems ent CAE-Systems in the product development p	rocess	
Skills				
SKIIIS				
At	fter completing the module, students are a	ble to:		
	product structuring	stems with regards to the desired requiremen AD-,PDM- and/or FEM-Systems with shared work		cation schemes and
Personal Competence				
Social Competence Af	fter completing the module, students are a	ble to:		
	To develop a project plan and allocatPresent project results as a team for	e work appropriate work packages in the frame nstance in a presentation	vork of group disc	ussions
Autonomy St	tudents are capable of			
, laconomy of				
	 independently adapt to a CAE-Tool ar 	d complete a given practical task with it		
Workload in Hours In	ndependent Study Time 96, Study Time in I	ecture 84		
Credit points 6				
course acmevement	ompulsory Bonus Form	Description		
Ye		andCAE-Teamprojekt inkl. Vortrag und Ausar	beitung	
Frankland M				
	0			
	eneral Engineering Science (German pro	gram 7 semester): Specialisation Mechanical	Engineering For	us Aircraft System
-	ngineering: Compulsory	g, ·	,	
-		ram, 7 semester): Specialisation Mechanical En	gineering, Focus P	roduct Developmen
aı	nd Production: Compulsory			
	ngineering Science: Specialisation Mechan			
		m, 7 semester): Specialisation Mechanical Engir	neering: Elective C	ompulsory
			diast Elective Com	pulcon
Social Competence Advancements Social Competence Advancements Social Competence Advancement Social S	product structuring design an exemplary product using C fter completing the module, students are a To develop a project plan and allocat Present project results as a team for tudents are capable of: independently adapt to a CAE-Tool ar dependent Study Time 96, Study Time in 1 ompulsory Bonus Form es 20 % Subject theoretica practical work Vritten exam 0 General Engineering Science (German prog nd Production: Compulsory igneering Science (English progra igneering Science (Serman progra igneering Science (English progra igneering Science (Serman progra igneering Science (Serman progra igneering Science (English progra igneering Science (Serman progra ignee	AD-,PDM- and/or FEM-Systems with shared work ble to: e work appropriate work packages in the framework instance in a presentation d complete a given practical task with it ecture 84 Description andCAE-Teamprojekt inkl. Vortrag und Ausar gram, 7 semester): Specialisation Mechanical En cal Engineering: Elective Compulsory m, 7 semester): Specialisation Mechanical Engin uct Development and Production: Compulsory aft Systems Engineering: Compulsory	load work of group discu beitung Engineering, Foc gineering, Focus F heering: Elective C	ussions cus Aircraft Product Dev ompulsory

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

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

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

Courses				
Title		Тур	Hrs/wk	СР
Production Process Organization (L	0925)	Lecture	2	3
Quality Management (L0926)		Lecture	2	3
Module Responsible	Prof. Hermann Lödding			
Admission Requirements	None			
Recommended Previous	None			
Knowledge				
Educational Objectives	After taking part successfully, students hav	ve reached the following learning results		
Professional Competence				
Knowledge	Students are able to explain the contents of	of the lecture of the module.		
Skills	Students are able to apply the methods an	d models in the module to industrial problem	ns.	
Personal Competence				
Social Competence	-			
Autonomy	-			
Workload in Hours	Independent Study Time 124, Study Time i	n Lecture 56		
Credit points	6			
Course achievement	None			
Examination	Written exam			
Examination duration and	180 Minuten			
scale				
Assignment for the	General Engineering Science (German p	rogram, 7 semester): Specialisation Mecha	anical Engineering, Foo	cus Aircraft Syste
Following Curricula	Engineering: Compulsory			
	General Engineering Science (German pro	gram, 7 semester): Specialisation Mechanic	al Engineering, Focus F	Product Developm
	and Production: Compulsory			
	General Engineering Science (German prog	gram, 7 semester): Specialisation Advanced	Materials: Elective Com	pulsory
	Engineering Science: Specialisation Mecha	tronics: Elective Compulsory		
	Engineering Science: Specialisation Mecha	nical Engineering: Elective Compulsory		
	Engineering Science: Specialisation Mecha	nical Engineering: Compulsory		
	Engineering Science: Specialisation Advance	ced Materials: Elective Compulsory		
	Logistics and Mobility: Specialisation Produ	ction Management and Processes: Compulse	ory	
	Mechanical Engineering: Core Qualification	: Elective Compulsory		
	Engineering and Management - Major in Lo	distics and Mobility: Specialisation Production	n Management and Pro	Cassas: Compulso

Course L0925: Production Pr	ocess Organization
Тур	Lecture
Hrs/wk	2
СР	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Prof. Hermann Lödding
Language	
Cycle	SoSe
Content	(A) Introduction
	(B) Product planning
	(C) Process planning
	(D) Procurement
	(E) Manufacturing
	(F) Production planning and control (PPC)
	(G) Distribution
	(H) Cooperation
Literature	Wiendahl, HP.: Betriebsorganisation für Ingenieure
	Vorlesungsskript

Course L0926: Quality Manag	gement
Тур	Lecture
Hrs/wk	2
CP	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Prof. Hermann Lödding
Language	EN
Cycle	SoSe
Content	 Definition and Relevance of Quality Continuous Quality Improvement Quality Management in Product Development Quality Management in Production Processes Design of Experiments
Literature	 Pfeifer, Tilo: Quality Management. Strategies, Methods, Techniques; Hanser-Verlag, München 2002 Pfeifer, Tilo: Qualitätsmanagement. Strategien, Methoden, Techniken; Hanser-Verlag, München, 3. Aufl. 2001 Mitra, Amitava: Fundamentals of Quality Control and Improvement; Wiley; Macmillan, 2008 Kleppmann, W.: Taschenbuch Versuchsplanung. Produkte und Prozesse optimieren; Hanser-Verlag, München, 6. Aufl. 2009

Module Manual B.Sc. "General Engineering Science (German program, 7 semester)"

Module M0767: Aeror	autical Systems			
Courses				
Title		Тур	Hrs/wk	СР
Fundamentals of Aircraft Systems (Lecture	2	2
Fundamentals of Aircraft Systems (Recitation Section (small) Lecture	1	1
Air Transportation Systems (L0591) Air Transportation Systems (L0816)		Recitation Section (large)	-	2
Module Responsible			-	-
Admission Requirements				
	Basics of mathematics, mechanics and the	hermodynamics		
Knowledge				
-	After taking part successfully, students h	ave reached the following learning results		
Professional Competence				
Knowledge		the structure and design of an aircraft, as well		-
	aircraft. In addition, a basic knowledge of the relationchips, the key parameters, roles and ways of working in different			different subsyster
	in the air transport is acquired.			
Skills		ing students can gain a deeper understanding		
		ition, they can apply the learned methods for th	e design and assessn	nent of subsystems
	the air transportation system in the conte	ext of the overall system.		
Personal Competence				
Social Competence	Students are made aware of interdisciplin	nary communication in groups.		
Autonomy	Students are able to independently and	alyze different system concepts and their tech	nical implementation	n as well as to thi
	system oriented.			
Workload in Hours	Independent Study Time 96, Study Time	in Lecture 84		
Credit points	6			
Course achievement	None			
Examination	Written exam			
Examination duration and	150 min			
scale				
Assignment for the	General Engineering Science (German	program, 7 semester): Specialisation Mechan	ical Engineering, Fo	cus Aircraft Syster
Following Curricula	Engineering: Compulsory			
	Data Science: Specialisation II. Applicatio	on: Elective Compulsory		
	Logistics and Mobility: Specialisation Traf	ffic Planning and Systems: Elective Compulsory		
	Mechanical Engineering: Specialisation A	ircraft Systems Engineering: Compulsory		
	Engineering and Management - Major in	Logistics and Mobility: Specialisation Traffic Plan	ning and Systems: El	lective Compulsory

Course L0741: Fundamentals	s of Aircraft Systems
Тур	Lecture
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Prof. Frank Thielecke
Language	DE
Cycle	SoSe
Content	 Development of aircrafts, fundamentals of flight physics, propulsion systems, analysis of ranges and loads, aircraft-structures and materials Hydraulic and electrical power systems, landing gear systems, flight-control and high-lift systems, air conditioning systems
Literature	 Shevell, R. S.: Fundamentals of Flight TÜV Rheinland: Luftfahrtzeugtechnik in Theorie und Praxis Wild: Transport Category Aircraft Systems

Course L0742: Fundamentals of Aircraft Systems		
Тур	Recitation Section (small)	
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	

Course L0591: Air Transport	ation Systems
Тур	Lecture
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Prof. Volker Gollnick
Language	DE
Cycle	SoSe
Content	 Air transport as part of the global transportation system Legal basis of air transportation Safety and security aspects Aircraft basics The role of the aircraft amnufacturer The role of the aircraft operator Airport operation The principles of air traffic management Environmental aspects of air transportation
Literature	 V. Gollnick, D. Schmitt: "Air Transport System", Springer-Verlag, ISBN 978-3-7091-1879-5 H. Mensen: "Handbuch der Luftfahrt", Springer-Verlag, 2003 J.P. Clark: "Buying the Big Jets", ISBN 9781317170341, Taylor & Francis, 2017 Mike Hirst: The Air Transport System, AIAA, 2008 D.P. Raymer: "Aircraft Design - A Conceptual Approach", AIAA Education Series, 2006, ISBN 1-56347-281-3 N. Ashford: "Airport Operations", McGraw-Hill, 1997, ISBN 0-07-003077-4 P. Maurer: "Luftverkehrsmanagement", Oldenbourg-Verlag, ISBN 3-486-27422-8 H. Mensen: "Moderne Flugsicherung", Springer-Verlag, 2004, ISBN 3-540-20581-0

Course L0816: Air Transportation Systems		
Тур	Recitation Section (large)	
Hrs/wk	1	
CP	1	
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14	
Lecturer	Prof. Volker Gollnick	
Language	DE	
Cycle	SoSe	
Content	See interlocking course	
Literature	See interlocking course	

Courses				
Fitle	agramming Concerts, Data Uandling & Communication (12690)	Typ Lecture	Hrs/wk 3	СР 3
	ogramming Concepts, Data Handling & Communication (L2689 ogramming Concepts, Data Handling & Communication (L2690		2	3
Module Responsible		Rectation Section (Small)	L	5
-	None			
Recommended Previous	NUIE			
Knowledge				
-	After taking part successfully, students have reached the	allowing loarning results		
-	Alter taking part successionly, students have reached the			
Professional Competence				
Knowledge Skills				
SKIIIS				
Personal Competence				
Social Competence				
Autonomy				
Workload in Hours	Independent Study Time 110, Study Time in Lecture 70			
Credit points	6			
Course achievement	Compulsory Bonus Form Descript	ion		
	No 10 % Attestation Testat	finden semesterbegleitend statt.		
Examination	Written exam			
Examination duration and	120 min			
scale				
Assignment for the	General Engineering Science (German program, 7 se	nester): Specialisation Mechanic	al Engineering, F	ocus Biomechan
Following Curricula	Compulsory			
	General Engineering Science (German program, 7 semester			
	General Engineering Science (German program, 7 semeste	r): Specialisation Green Technolog	gies, Focus Renew	able Energy: Elect
	Compulsory			_
	General Engineering Science (German program, 7 sem	ester): Specialisation Mechanical	Engineering, Foc	us Energy Syster
	Compulsory			
	General Engineering Science (German program, 7 sem	ester): Specialisation Mechanical	Engineering, Foo	us Aircraft Syste
	Engineering: Compulsory General Engineering Science (German program, 7 se	mostor): Specialisation Mechanic	al Engineering	ocus Mochatron
	Compulsory	nester). Specialisation Mechanic	ai Liigineering, i	ocus Mechacion
	General Engineering Science (German program, 7 semes	er): Specialisation Mechanical En	nineering Focus P	roduct Developm
	and Production: Elective Compulsory		gineering, rocus r	
	General Engineering Science (German program, 7 semest	er): Specialisation Mechanical Eng	ineering, Focus Th	eoretical Mechan
	Engineering: Elective Compulsory		<u>.</u> ,	
	General Engineering Science (German program, 7 semest	r): Specialisation Electrical Engine	ering: Elective Co	mpulsory
	Bioprocess Engineering: Core Qualification: Compulsory			
	Chemical and Bioprocess Engineering: Core Qualification:	Compulsory		
	Electrical Engineering: Core Qualification: Compulsory			
	Green Technologies: Energy, Water, Climate: Specialisatio	1 Energy Systems / Renewable En	ergies: Elective Co	mpulsory
	Logistics and Mobility: Specialisation Information Technology	gy: Compulsory		
	Mechatronics: Specialisation Robot- and Machine-Systems	Compulsory		
	Mechatronics: Specialisation Medical Engineering: Comput	sory		
	Mechatronics: Specialisation Dynamic Systems and AI: Con			
	Mechatronics: Specialisation Electrical Systems: Elective C	ompulsory		
	Process Engineering: Core Qualification: Compulsory			

Course L2689: Computer Science for Engineers - Programming Concepts, Data Handling & Communication		
Тур	Lecture	
Hrs/wk	3	
CP	3	
Workload in Hours	Independent Study Time 48, Study Time in Lecture 42	
Lecturer	Prof. Sibylle Fröschle	
Language	DE	
Cycle	SoSe	
Content		
Literature	John V. Guttag: Introduction to Computation and Programming Using Python.	
	With Application to Understanding Data. 2nd Edition. The MIT Press, 2016.	

Course L2690: Computer Science for Engineers - Programming Concepts, Data Handling & Communication		
Тур	Recitation Section (small)	
Hrs/wk	2	
CP	3	
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28	
Lecturer	Prof. Sibylle Fröschle	
Language	DE	
Cycle	SoSe	
Content	See interlocking course	
Literature	See interlocking course	

Courses				
Title		Тур	Hrs/wk	СР
Modeling, Simulation and Optimiza	tion (EN) (L2446)	Integrated Lecture	4	6
Module Responsible	Prof. Benedikt Kriegesmann			
Admission Requirements	None			
Recommended Previous	Sound knowledge of engineering mathema	atics, engineering mechanics and fluid mechanic	cs	
Knowledge				
Educational Objectives	After taking part successfully, students ha	ve reached the following learning results		
Professional Competence				
Knowledge	Students will have an overview of various	s technical problems and the differential equat	ions, which describe	them. Students w
	gave an overview of different solution app	roaches and for which kind of problems they ca	n be used for.	
Skille	Students are able to solve different techni	cal problems with the introduced discretization	mothods	
JAIIIS		cal problems with the introduced discretization	methous.	
Personal Competence				
Social Competence	The students are able to discuss problems	and jointly develop solution strategies.		
Autonomi	The students are able to develop colution	skyskasies for sevenley problems calf consistent	and aritically analyse	e reculte
Autonomy	The students are able to develop solution	strategies for complex problems self-consistent	and critically analyse	e results.
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	General Engineering Science (German pro	gram, 7 semester): Specialisation Mechanical E	ngineering, Focus Th	neoretical Mechanic
Following Curricula	Engineering: Compulsory			
	General Engineering Science (German pro	gram, 7 semester): Specialisation Advanced Ma	terials: Compulsory	
	General Engineering Science (German p	rogram, 7 semester): Specialisation Mechanic	al Engineering, Foo	us Aircraft Syster
	Engineering: Elective Compulsory			
		gram, 7 semester): Specialisation Mechanical E	ingineering, Focus M	echatronics: Electi
	Compulsory			
	Engineering Science: Core Qualification: C			
	Engineering Science: Specialisation Advan			
	Engineering Science: Specialisation Mecha Engineering Science: Specialisation Mecha			
	Engineering Science: Specialisation Biome			
		eoretical Mechanical Engineering: Compulsory		
	Mechanical Engineering: Specialisation Me			
	Mechanical Engineering: Specialisation Air			
		craft Systems Engineering: Compulsory		
	Technomathematics: Specialisation III. Eng	gineering Science: Elective Compulsory		

Course L2446: Modeling, Simulation and Optimization (EN)	
Тур	Integrated Lecture
Hrs/wk	4
CP	6
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56
Lecturer	Prof. Benedikt Kriegesmann, Prof. Alexander Düster, Prof. Robert Seifried, Prof. Thomas Rung
Language	EN
Cycle	SoSe
Content	 Partial Differential Equations in technical problems Overview of modelling approaches Finite Approximation Methods - Finite Differences / Elements / Volumes Introduction to the Discrete Element Method Numerical methods for time dependent problems Gradient-based optimization
Literature	Michael Schäfer, Computational Engineering - Introduction to Numerical Methods, Springer.

Focus Mechatronics

In the focus "Mechatronics" students learn next to the knowledge and skills of mechanical engineering deeper knowledge and skills of electrical and mechatronics engineering and are therefore able to solve interdisciplinary problems in mechatronics, those sub-disciplines and related disciplines.

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Courses	
Title	Typ Hrs/wk CP
Circuit Theory (L0566)	Lecture 3 4
Circuit Theory (L0567)	Recitation Section (small) 2 2
	Prof. Alexander Kölpin
Admission Requirements	
	Electrical Engineering I and II, Mathematics I and II
Knowledge	
Educational Objectives	After taking part successfully, students have reached the following learning results
Professional Competence	
-	Students are able to explain the basic methods for calculating electrical circuits. They know the Fourier series analysis of li
	networks driven by periodic signals. They know the methods for transient analysis of linear networks in time and in freque
	domain, and they are able to explain the frequency behaviour and the synthesis of passive two-terminal-circuits.
Skills	The students are able to calculate currents and voltages in linear networks by means of basic methods, also when drive
	periodic signals. They are able to calculate transients in electrical circuits in time and frequency domain and are able to explain
	respective transient behaviour. They are able to analyse and to synthesize the frequency behaviour of passive two-term
	circuits.
Personal Competence	
Social Competence	Students work on exercise tasks in small guided groups. They are encouraged to present and discuss their results within
	group.
Autonomy	The students are able to find out the required methods for solving the given practice problems. Possibilities are given to test
	knowledge during the lectures continuously by means of short-time tests. This allows them to control independently
	educational objectives. They can link their gained knowledge to other courses like Electrical Engineering I and Mathematics I.
Werkleed in Herre	Independent Chudu Time 110, Chudu Time in Lesture 70
Credit points	Independent Study Time 110, Study Time in Lecture 70
Course achievement	
Examination	Written exam
Examination duration and	150 min
scale	
Assignment for the	General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Mechatro
Following Curricula	
· · · · · · · · · · · · · · · · · · ·	General Engineering Science (German program, 7 semester): Specialisation Electrical Engineering: Compulsory
	Electrical Engineering: Core Qualification: Compulsory
	Engineering Science: Specialisation Electrical Engineering: Compulsory
	Computer Science in Engineering: Specialisation II. Mathematics & Engineering Science: Elective Compulsory
	Mechatronics: Specialisation Electrical Systems: Compulsory
	Mechatronics: Specialisation Dynamic Systems and Al: Compulsory
	Mechatronics: Core Qualification: Compulsory
	Mechatronics: Specialisation Robot- and Machine-Systems: Compulsory
	Technomathematics: Specialisation III. Engineering Science: Elective Compulsory

Course L0566: Circuit Theory	
Тур	Lecture
Hrs/wk	3
CP	4
Workload in Hours	Independent Study Time 78, Study Time in Lecture 42
Lecturer	Prof. Alexander Kölpin, Dr. Fabian Lurz
Language	DE
Cycle	WiSe
Content	- Circuit theorems
	- N-port circuits
	- Periodic excitation of linear circuits
	- Transient analysis in time domain
	- Transient analysis in frequency domain; Laplace Transform
	- Frequency behaviour of passive one-ports
	<u> </u>
Literature	- M. Albach, "Grundlagen der Elektrotechnik 1", Pearson Studium (2011)
	- M. Albach, "Grundlagen der Elektrotechnik 2", Pearson Studium (2011)
	- L. P. Schmidt, G. Schaller, S. Martius, "Grundlagen der Elektrotechnik 3", Pearson Studium (2011)
	- T. Harriehausen, D. Schwarzenau, "Moeller Grundlagen der Elektrotechnik", Springer (2013)
	- A. Hambley, "Electrical Engineering: Principles and Applications", Pearson (2008)
	- R. C. Dorf, J. A. Svoboda, "Introduction to electrical circuits", Wiley (2006)
	- L. Moura, I. Darwazeh, "Introduction to Linear Circuit Analysis and Modeling", Amsterdam Newnes (2005)

urse L0567: Circuit Theory	
Recitation Section (small)	
2	
2	
Independent Study Time 32, Study Time in Lecture 28	
Prof. Alexander Kölpin, Dr. Fabian Lurz	
DE	
WiSe	
see interlocking course	
siehe korrespondierende Lehrveranstaltung	

Courses				
Title		Тур	Hrs/wk	СР
Simulation and Design of Mechatro	nic Systems (L1822)	Lecture	2	2
Simulation and Design of Mechatro	nic Systems (L1823)	Recitation Section (large)	1	2
imulation and Design of Mechatro	nic Systems (L1824)	Practical Course	1	2
Module Responsible	Prof. Robert Seifried			
Admission Requirements	None			
Recommended Previous	Fundatmentals of mechanics, control theor	ry and electrical engineering		
Knowledge				
Educational Objectives	After taking part successfully, students have	ve reached the following learning results		
Professional Competence				
Knowledge	Students are able to describe methods and	calculations for design, modeling, simulation and	optimization of n	nechatronic syster
Chille	Students are able to apply modern algorithms for modeling of mechatronic systems. They can identify, simulate and design simp			
581115			n identify, simula	ite and design sim
	systems and implement those in laboratory	y conditions.		
Personal Competence				
Social Competence	Students are able to work goal-oriented in small mixed groups and present results to target groups.			
Autonomy	Students are able to recognize and improve	e knowledge deficits independently.		
	With instructor assistance, students are ab	le to evaluate their own knowledge level and defin	e a further cours	e of study.
Workload in Hours				
Credit points	6			
Course achievement	None			
Examination	Written exam			
Examination duration and				
scale				
Assignment for the	General Engineering Science (German p	rogram, 7 semester): Specialisation Mechanical	Engineering, Foo	cus Aircraft Syste
Following Curricula	Engineering: Elective Compulsory	-		-
-		gram, 7 semester): Specialisation Mechanical Engi	neering, Focus M	lechatronics: Elect
	Compulsory	- · · · · ·	-	
	Mechatronics: Core Qualification: Compulso	orv		

Course L1822: Simulation an	d Design of Mechatronic Systems
Тур	Lecture
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Prof. Robert Seifried
Language	DE
Cycle	WiSe
Content	Mechatronic Design
	Modeling
	Model Identifikation
	Numerical Methods in simulation
	Applications and examples in Matlab $^{\circledast}$ and Simulink $^{\circledast}$
Literature	Skript zur Veranstaltung
	Weitere Literatur in der Veranstaltung

Course L1823: Simulation an	Course L1823: Simulation and Design of Mechatronic Systems	
Тур	Recitation Section (large)	
Hrs/wk	1	
CP	2	
Workload in Hours	Independent Study Time 46, Study Time in Lecture 14	
Lecturer	Prof. Robert Seifried	
Language	DE	
Cycle	WiSe	
Content	See interlocking course	
Literature	See interlocking course	

Course L1824: Simulation an	ourse L1824: Simulation and Design of Mechatronic Systems	
Тур	Practical Course	
Hrs/wk	1	
CP	2	
Workload in Hours	Independent Study Time 46, Study Time in Lecture 14	
Lecturer	Prof. Robert Seifried	
Language	DE	
Cycle	WiSe	
Content	See interlocking course	
Literature	See interlocking course	

-				
Courses				
Title		Тур	Hrs/wk	СР
Numerical Mathematics I (L0417)		Lecture	2	3
Numerical Mathematics I (L0418)		Recitation Section (small)	2	3
Module Responsible	Prof. Sabine Le Borne			
Admission Requirements	None			
Recommended Previous	Mathematik I + II for Engineering Students (german of a student of a studentof a student of	or english) or Analysis & Linear Al	nebra I + II for Te	chnomathematic
Knowledge	basic MATLAB/Python knowledge		gebruit i nier re	
Educational Objectives	After taking part successfully, students have reached the fo	llowing learning results		
Professional Competence				
Knowledge	Students are able to			
	 name numerical methods for internalation, integratic 	n loast squares problems, sigon	value problems r	onlinear root find
	 name numerical methods for interpolation, integration problems and to explain their services 	in, least squares problems, eigen	alue problems, i	Ionninear root nint
	problems and to explain their core ideas,	thodo		
	 repeat convergence statements for the numerical me explain aspects for the practical execution of numeric 		utational and sto	rado comploxity
	explain aspects for the practical execution of humen	carmetrious with respect to comp		lage complexity.
CI ///				
SKIIIS	Students are able to			
	 implement, apply and compare numerical methods upper section of the section of the	sing MATLAB/Python,		
	• justify the convergence behaviour of numerical meth	ods with respect to the problem a	nd solution algori	ithm,
	 select and execute a suitable solution approach for a 	given problem.		
Personal Competence				
Social Competence	Students are able to			
	work together in heterogeneously composed teams (i.e., teams from different study p	rograms and bac	karound knowled
	explain theoretical foundations and support each oth			
Autonomy	Students are capable			
	 to assess whether the supporting theoretical and practical 	ctical excercises are better solved	l individually or in	a team
	 to assess their individual progess and, if necessary, to 		individually of it	la team,
	, ··, ··, ··, ··, ··, ··, ··, ··, ··, ··			
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 minutes			
scale				
Assignment for the	General Engineering Science (German program, 7 semester): Specialisation Computer Science	e: Compulsory	
	General Engineering Science (German program, 7 semester			ory
2	General Engineering Science (German program, 7 sem	-		-
	Compulsory		, .	
	General Engineering Science (German program, 7 semester): Specialisation Mechanical Engi	neering, Focus Th	eoretical Mechan
	Engineering: Compulsory			
	General Engineering Science (German program, 7 seme	ster): Specialisation Mechanical	Engineering, Foo	us Aircraft Syste
	Engineering: Elective Compulsory			
	General Engineering Science (German program, 7 semester	r): Specialisation Mechanical Engi	neering, Focus M	echatronics: Elec
	Compulsory			
	General Engineering Science (German program, 7 semes	ster): Specialisation Mechanical	Engineering, Foc	us Energy Syste
	Elective Compulsory			
	General Engineering Science (German program, 7 semester): Specialisation Advanced Materia	als: Compulsory	
	General Engineering Science (German program, 7 semester): Specialisation Data Science: Co	mpulsory	
	Bioprocess Engineering: Specialisation A - General Bioproce	ss Engineering: Elective Compulso	ory	
	Data Science: Core Qualification: Compulsory			
	Electrical Engineering: Core Qualification: Elective Compulse	ory		
	Engineering Science: Core Qualification: Compulsory			
	Green Technologies: Energy, Water, Climate: Specialisation	Energy Technology: Elective Com	pulsory	
	Computer Science in Engineering: Core Qualification: Comp	ulsory		
	Mechanical Engineering: Specialisation Theoretical Mechani			
	Mechanical Engineering: Specialisation Energy Systems: Ele	ctive Compulsory		
	Mechanical Engineering: Specialisation Energy Systems: Ele Theoretical Mechanical Engineering: Technical Complement		Compulsory	

Course L0417: Numerical Ma	thematics I		
Тур	Lecture		
Hrs/wk	2		
CP	3		
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28		
Lecturer	Prof. Sabine Le Borne		
Language	EN		
Cycle	WiSe		
Content	 Finite precision arithmetic, error analysis, conditioning and stability Linear systems of equations: LU and Cholesky factorization, condition Interpolation: polynomial, spline and trigonometric interpolation Nonlinear equations: fixed point iteration, root finding algorithms, Newton's method Linear and nonlinear least squares problems: normal equations, Gram Schmidt and Householder orthogonalization, singular value decomposition, regularizatio, Gauss-Newton and Levenberg-Marquardt methods Eigenvalue problems: power iteration, inverse iteration, QR algorithm Numerical differentiation 		
	 Numerical differentiation Numerical integration: Newton-Cotes rules, error estimates, Gauss quadrature, adaptive quadrature 		
Literature	 Gander/Gander/Kwok: Scientific Computing: An introduction using Maple and MATLAB, Springer (2014) Stoer/Bulirsch: Numerische Mathematik 1, Springer Dahmen, Reusken: Numerik f ür Ingenieure und Naturwissenschaftler, Springer 		

Course L0418: Numerical Ma	ourse L0418: Numerical Mathematics I	
Тур	Recitation Section (small)	
Hrs/wk	2	
CP	3	
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28	
Lecturer	Prof. Sabine Le Borne, Dr. Jens-Peter Zemke	
Language	EN	
Cycle	WiSe	
Content	See interlocking course	
Literature	See interlocking course	

Courses				
Title		Тур	Hrs/wk	СР
Electrical Machines and Actuators	,L0293)	Lecture	3	4
Electrical Machines and Actuators	L0294)	Recitation Section (large)	2	2
Module Responsible	Prof. Thorsten Kern			
Admission Requirements	None			
Recommended Previous	Basics of mathematics, in particular complexe numb	ers, integrals, differentials		
Knowledge	Basics of electrical engineering and mechanical engi	neering		
Educational Objections				
Educational Objectives Professional Competence	After taking part successfully, students have reached	a the following learning results		
-	Students can to draw and explain the basic principle	s of electric and magnetic fields		
	They can describe the function of the standard characteristic curves. For typically used drives they from the power grid to the driven engine.	types of electric machines and prese		
Skills	Students are able to calculate two-dimensional electric they apply the usual methods of the design autor		rromagnetic circu	uits with air gap. F
	They can calulate the operational performance of e and characteristic curves. They apply the usual equi	-	cteristic data and	d selected quantiti
Personal Competence				
Social Competence		a and magnetic fields for applications. Th		aluca independen
Autonomy	Students are able independently to calculate electric the operational performance of electric machines fr and characteristic curves.			
Workload in Hours	Independent Study Time 110, Study Time in Lecture	70		
Credit points				
Course achievement				
Examination				
Examination duration and scale	Design of four machines and actuators, review of dea	sign files		
	General Engineering Science (German program, 7	semester): Specialisation Mechanical	Engineering Foc	us Energy System
Following Curricula		semestery. Specialisation Mechanical	Engineering, roc	us Energy System
· · · · · · · · · · · · · · · · · · ·	General Engineering Science (German program,	7 semester): Specialisation Mechanica	al Engineering, I	Focus Mechatronio
	Compulsory			
	General Engineering Science (German program, 7 se	emester): Specialisation Mechanical Engir	neering, Focus Th	eoretical Mechanio
	Engineering: Elective Compulsory			
	General Engineering Science (German program, 7 se		ering: Elective Co	mpulsory
	General Engineering Science (German program, 7 se	mester): Specialisation Electrical Enginee		
	Digital Mechanical Engineering: Core Qualification: C	Compulsory		
	Digital Mechanical Engineering: Core Qualification: C Electrical Engineering: Core Qualification: Elective Co	ompulsory ompulsory		
	Digital Mechanical Engineering: Core Qualification: C Electrical Engineering: Core Qualification: Elective Co Engineering Science: Specialisation Electrical Engine	ompulsory ompulsory ering: Elective Compulsory		
	Digital Mechanical Engineering: Core Qualification: C Electrical Engineering: Core Qualification: Elective Co Engineering Science: Specialisation Electrical Engine Green Technologies: Energy, Water, Climate: Specia	ompulsory ompulsory ering: Elective Compulsory lisation Energy Technology: Elective Com		
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	Digital Mechanical Engineering: Core Qualification: C Electrical Engineering: Core Qualification: Elective Co Engineering Science: Specialisation Electrical Engine Green Technologies: Energy, Water, Climate: Special Green Technologies: Energy, Water, Climate: Special Computer Science in Engineering: Specialisation II. M	ompulsory ompulsory ering: Elective Compulsory lisation Energy Technology: Elective Com lisation Maritime Technologies: Elective C lathematics & Engineering Science: Elect	Compulsory	
	Digital Mechanical Engineering: Core Qualification: C Electrical Engineering: Core Qualification: Elective Co Engineering Science: Specialisation Electrical Engine Green Technologies: Energy, Water, Climate: Special Green Technologies: Energy, Water, Climate: Special	ompulsory ompulsory ering: Elective Compulsory lisation Energy Technology: Elective Com lisation Maritime Technologies: Elective C fathematics & Engineering Science: Elect and Systems: Elective Compulsory	Compulsory ive Compulsory	
	Digital Mechanical Engineering: Core Qualification: C Electrical Engineering: Core Qualification: Elective C Engineering Science: Specialisation Electrical Engine Green Technologies: Energy, Water, Climate: Special Green Technologies: Energy, Water, Climate: Special Computer Science in Engineering: Specialisation II. M Logistics and Mobility: Specialisation Traffic Planning	ompulsory ompulsory ering: Elective Compulsory lisation Energy Technology: Elective Com lisation Maritime Technologies: Elective C Mathematics & Engineering Science: Elect and Systems: Elective Compulsory agement and Processes: Elective Compu	Compulsory ive Compulsory	
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	Digital Mechanical Engineering: Core Qualification: C Electrical Engineering: Core Qualification: Elective C Engineering Science: Specialisation Electrical Engine Green Technologies: Energy, Water, Climate: Special Green Technologies: Energy, Water, Climate: Special Computer Science in Engineering: Specialisation II. M Logistics and Mobility: Specialisation Traffic Planning Logistics and Mobility: Specialisation Production Man Mechanical Engineering: Core Qualification: Elective Mechatronics: Specialisation Naval Engineering: Com Mechatronics: Specialisation Robot- and Machine-Sys Mechatronics: Specialisation Electrical Systems: Elec	ompulsory prince in the second	Compulsory ive Compulsory	
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	Digital Mechanical Engineering: Core Qualification: C Electrical Engineering: Core Qualification: Elective C Engineering Science: Specialisation Electrical Engine Green Technologies: Energy, Water, Climate: Special Green Technologies: Energy, Water, Climate: Special Computer Science in Engineering: Specialisation II. M Logistics and Mobility: Specialisation Traffic Planning Logistics and Mobility: Specialisation Production Man Mechanical Engineering: Core Qualification: Elective Mechatronics: Specialisation Naval Engineering: Com Mechatronics: Specialisation Robot- and Machine-Sys Mechatronics: Specialisation Electrical Systems: Elect Technomathematics: Specialisation III. Engineering S Engineering and Management - Major in Logistics and	ompulsory pering: Elective Compulsory lisation Energy Technology: Elective Com lisation Maritime Technologies: Elective Co Mathematics & Engineering Science: Elect and Systems: Elective Compulsory agement and Processes: Elective Compu Compulsory upulsory stems: Compulsory tive Compulsory science: Elective Compulsory d Mobility: Specialisation Traffic Planning	ompulsory ive Compulsory lsory and Systems: Eld	
	Digital Mechanical Engineering: Core Qualification: C Electrical Engineering: Core Qualification: Elective C Engineering Science: Specialisation Electrical Engine Green Technologies: Energy, Water, Climate: Special Green Technologies: Energy, Water, Climate: Special Computer Science in Engineering: Specialisation II. M Logistics and Mobility: Specialisation Traffic Planning Logistics and Mobility: Specialisation Production Man Mechanical Engineering: Core Qualification: Elective Mechatronics: Specialisation Naval Engineering: Com Mechatronics: Specialisation Robot- and Machine-Sys Mechatronics: Specialisation Electrical Systems: Elect Technomathematics: Specialisation III. Engineering S Engineering and Management - Major in Logistics an	ompulsory pering: Elective Compulsory lisation Energy Technology: Elective Com lisation Maritime Technologies: Elective Co Mathematics & Engineering Science: Elect and Systems: Elective Compulsory agement and Processes: Elective Compu Compulsory upulsory stems: Compulsory tive Compulsory science: Elective Compulsory d Mobility: Specialisation Traffic Planning d Mobility: Specialisation Information Tec	ompulsory ive Compulsory lsory and Systems: Ele hnology: Elective	Compulsory
	Digital Mechanical Engineering: Core Qualification: C Electrical Engineering: Core Qualification: Elective C Engineering Science: Specialisation Electrical Engine Green Technologies: Energy, Water, Climate: Special Green Technologies: Energy, Water, Climate: Special Computer Science in Engineering: Specialisation II. M Logistics and Mobility: Specialisation Traffic Planning Logistics and Mobility: Specialisation Production Man Mechanical Engineering: Core Qualification: Elective Mechatronics: Specialisation Naval Engineering: Core Mechatronics: Specialisation Robot- and Machine-Sys Mechatronics: Specialisation Electrical Systems: Elect Technomathematics: Specialisation III. Engineering S Engineering and Management - Major in Logistics an Engineering and Management - Major in Logistics	ompulsory pering: Elective Compulsory lisation Energy Technology: Elective Com lisation Maritime Technologies: Elective Co Mathematics & Engineering Science: Elect and Systems: Elective Compulsory agement and Processes: Elective Compu Compulsory upulsory stems: Compulsory tive Compulsory science: Elective Compulsory d Mobility: Specialisation Traffic Planning d Mobility: Specialisation Information Tec	ompulsory ive Compulsory lsory and Systems: Ele hnology: Elective	Compulsory
	Digital Mechanical Engineering: Core Qualification: C Electrical Engineering: Core Qualification: Elective C Engineering Science: Specialisation Electrical Engine Green Technologies: Energy, Water, Climate: Special Green Technologies: Energy, Water, Climate: Special Computer Science in Engineering: Specialisation II. M Logistics and Mobility: Specialisation Traffic Planning Logistics and Mobility: Specialisation Production Man Mechanical Engineering: Core Qualification: Elective Mechatronics: Specialisation Naval Engineering: Com Mechatronics: Specialisation Robot- and Machine-Sys Mechatronics: Specialisation Electrical Systems: Elect Technomathematics: Specialisation III. Engineering S Engineering and Management - Major in Logistics an	ompulsory pering: Elective Compulsory lisation Energy Technology: Elective Com lisation Maritime Technologies: Elective Co Mathematics & Engineering Science: Elect and Systems: Elective Compulsory agement and Processes: Elective Compu Compulsory apulsory stems: Compulsory tive Compulsory science: Elective Compulsory d Mobility: Specialisation Traffic Planning d Mobility: Specialisation Information Tec and Mobility: Specialisation Production 1	and Systems: Ele hnology: Elective Management and	Compulsory Processes: Electi

Course L0293: Electrical Mac	hines and Actuators
Тур	Lecture
Hrs/wk	3
СР	4
Workload in Hours	Independent Study Time 78, Study Time in Lecture 42
Lecturer	Prof. Thorsten Kern, Dennis Kähler
Language	DE
Cycle	SoSe
Content	Electric field: Coulomb's law, flux (field) line, work, potential, capacitor, energy, force, capacitive actuators
	Magnetic field: force, flux line, Ampere´s law, field at bounderies, flux, magnetic circuit, hysteresis, induction, self-induction, mutual inductance, transformer, electromagnetic actuators
	Synchronous machines, construction and layout, equivalent single line diagrams, no-load and short-cuircuit characteristics, vector diagrams, motor and generator operation, stepper motors
	DC-Machines: Construction and layout, torque generation mechanismen, torque vs speed characteristics, commutation,
	Asynchronous Machines. Magnetic field, construction and layout, equivalent single line diagram, complex stator current diagram (Heylands'diagram), torque vs. speed characteristics, rotor layout (squirrel-cage vs. sliprings),
	Drives with variable speed, inverter fed operation, special drives
Literature	Hermann Linse, Roland Fischer: "Elektrotechnik für Maschinenbauer", Vieweg-Verlag; Signatur der Bibliothek der TUHH: ETB 313
	Ralf Kories, Heinz Schmitt-Walter: "Taschenbuch der Elektrotechnik"; Verlag Harri Deutsch; Signatur der Bibliothek der TUHH: ETB 122
	"Grundlagen der Elektrotechnik" - anderer Autoren
	Fachbücher "Elektrische Maschinen"

Course L0294: Electrical Machines and Actuators	
Тур	Recitation Section (large)
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Prof. Thorsten Kern, Dennis Kähler
Language	DE
Cycle	SoSe
Content	See interlocking course
Literature	See interlocking course

Courses				
Fitle		Typ	Hrs/wk	СР
Gemiconductor Circuit Design (L07)	33)	Typ Lecture	3	4
Semiconductor Circuit Design (L08)		Recitation Section (small)	1	2
Module Responsible	NN			
Admission Requirements	None			
Recommended Previous	Fundamentals of electrical engineering			
Knowledge	r and americals of electrical engineering			
······································	Basics of physics, especially semiconductor pl	nysics		
Educational Objectives	After taking part successfully, students have r	eached the following learning results		
Professional Competence				
Knowledge				
	 Students are able to explain the function 	nality of different MOS devices in electronic cire	cuits.	
	 Students are able to explain how analo 	g circuits functions and where they are applied.		
		nality of fundamental operational amplifiers an		
	 Students know the fundamental digital 	logic circuits and can discuss their advantages	and disadvantage	:S.
		ry circuits and can explain their functionality an	d specifications.	
	 Students know the appropriate fields for 	r the use of bipolar transistors.		
Skills	 Students can calculate the specification 	ns of different MOS devices and can define the p	parameters of elec	ctronic circuits.
		ogic circuits and can design different types of lo		
	•	onal amplifiers and bipolar transistors for specif	-	
Personal Competence				
Social Competence				
	 Students are able work efficiently in he 			
	 Students working together in small gro 	ups can solve problems and answer professiona	I questions.	
Autonomy	• Students are able to assess their level	of knowledge.		
		2		
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	120 min			
scale				
Assignment for the	General Engineering Science (German program	n, 7 semester): Specialisation Electrical Engine	ering: Compulsory	t.
Following Curricula	General Engineering Science (German pro	gram, 7 semester): Specialisation Mechanica	al Engineering, F	ocus Mechatron
	Compulsory			
	Data Science: Core Qualification: Elective Con			
	Electrical Engineering: Core Qualification: Con			
	Engineering Science: Specialisation Electrical	5 5 1 5		
	Engineering Science: Specialisation Mechatron			
		n, 7 semester): Specialisation Electrical Enginee		
		n, 7 semester): Specialisation Mechatronics: Cor	1	
		on II. Mathematics & Engineering Science: Elect	tive Compulsory	
	Mechanical Engineering: Specialisation Mecha			
	Mechatronics: Specialisation Electrical System	s: Compulsory		
	Mechatronics: Core Qualification: Compulsory	ing Suchemer Flacking Commutation		
	Mechatronics: Specialisation Robot- and Mach			
	Technomathematics: Specialisation III. Engine			

se L0763: Semiconducto	r Circuit Design
Тур	Lecture
Hrs/wk	3
CP	4
Workload in Hours	Independent Study Time 78, Study Time in Lecture 42
Lecturer	Prof. Matthias Kuhl
Language	DE
Cycle	SoSe
Content	 Repetition Semiconductorphysics and Diodes Functionality and characteristic curve of bipolar transistors Basic circuits with bipolar transistors Functionality and characteristic curve of MOS transistors Basic circuits with MOS transistors for amplifiers Operational amplifiers and their applications Typical applications for analog and digital circuits Realization of logical functions Basic circuits with MOS transistors for combinational logic Memory circuits Basic circuits with MOS transistors for sequential logic Basic concepts of analog-to-digital and digital-to-analog-converters
Literature	U. Tietze und Ch. Schenk, E. Gamm, Halbleiterschaltungstechnik, Springer Verlag, 14. Auflage, 2012, ISBN 3540428496 R. J. Baker, CMOS - Circuit Design, Layout and Simulation, J. Wiley & Sons Inc., 3. Auflage, 2011, ISBN: 0471700555 H. Göbel, Einführung in die Halbleiter-Schaltungstechnik, Berlin, Heidelberg Springer-Verlag Berlin Heidelberg, 2011, ISBN 9783642208874 ISBN: 9783642208867 URL: http://site.ebrary.com/lib/alltitles/docDetail.action?docID=10499499 URL: http://dx.doi.org/10.1007/978-3-642-20887-4 URL: http://ebooks.ciando.com/book/index.cfm/bok_id/319955 URL: http://www.ciando.com/img/bo

Course L0864: Semiconducto	or Circuit Design
Тур	Recitation Section (small)
Hrs/wk	1
CP	2
Workload in Hours	Independent Study Time 46, Study Time in Lecture 14
Lecturer	Prof. Matthias Kuhl, Weitere Mitarbeiter
Language	DE
Cycle	SoSe
Content	 Basic circuits and characteristic curves of bipolar transistors Basic circuits and characteristic curves of MOS transistors for amplifiers Realization and dimensioning of operational amplifiers Realization of logic functions Basic circuits with MOS transistors for combinational and sequential logic Memory circuits Circuits for analog-to-digital and digital-to-analog converters Design of exemplary circuits
Literature	 U. Tietze und Ch. Schenk, E. Gamm, Halbleiterschaltungstechnik, Springer Verlag, 14. Auflage, 2012, ISBN 3540428496 R. J. Baker, CMOS - Circuit Design, Layout and Simulation, J. Wiley & Sons Inc., 3. Auflage, 2011, ISBN: 0471700555 H. Göbel, Einführung in die Halbleiter-Schaltungstechnik, Berlin, Heidelberg Springer-Verlag Berlin Heidelberg, 2011, ISBN: 9783642208874 ISBN: 9783642208867 URL: http://site.ebrary.com/lib/alltitles/docDetail.action?docID=10499499 URL: http://dx.doi.org/10.1007/978-3-642-20887-4 URL: http://ebooks.ciando.com/book/index.cfm/bok_id/319955 URL: http://www.ciando.com/img/bo

Courses					
Title		т	ур	Hrs/wk	СР
	Programming Concepts, Data Handling & Communication (L26		ecture	3	3
Computer Science for Engineers - P	Programming Concepts, Data Handling & Communication (L26	690) R	ecitation Section (small)	2	3
Module Responsible	Prof. Sibylle Fröschle				
Admission Requirements	None				
Recommended Previous					
Knowledge					
Educational Objectives	After taking part successfully, students have reached the	he following	learning results		
Professional Competence					
Knowledge					
Skills					
Demonstration of the second					
Personal Competence					
Social Competence					
Autonomy		_			
	Independent Study Time 110, Study Time in Lecture 70	U			
Credit points		cription			
Course achievement			emesterbegleitend statt.		
Examination					
Examination duration and					
scale	120 mm				
Assignment for the	General Engineering Science (German program, 7	comostor):	Specialization Mechanics	Engineering E	ocus Biomochan
Following Curricula	5 5 7 7 5 7	semester).	Specialisation Mechanica	ii Liigineeniig, i	ocus biomechan
ronowing curricula	General Engineering Science (German program, 7 semi	ester): Sneci	alisation Biomedical Engin	eering: Compulse)rv
	General Engineering Science (German program, 7 semi General Engineering Science (German program, 7 semi				
	Compulsory	ester). spee	unsation oreen reenholog	ies, i ocus iteriew	uble Energy. Elec
	General Engineering Science (German program, 7 s	emester): S	pecialisation Mechanical	Engineering. Foc	us Enerav Svste
	Compulsory				
	General Engineering Science (German program, 7 s	semester): S	pecialisation Mechanical	Engineering, Foc	us Aircraft Syste
	Engineering: Compulsory			5 5.	
	General Engineering Science (German program, 7	semester):	Specialisation Mechanica	al Engineering, I	ocus Mechatron
	Compulsory				
	General Engineering Science (German program, 7 sem	nester): Spe	cialisation Mechanical Eng	ineering, Focus P	roduct Developm
	and Production: Elective Compulsory				
	General Engineering Science (German program, 7 sem	nester): Spec	ialisation Mechanical Engi	neering, Focus Th	eoretical Mechan
	Engineering: Elective Compulsory				
	General Engineering Science (German program, 7 seme	ester): Speci	alisation Electrical Engine	ering: Elective Co	mpulsory
	Bioprocess Engineering: Core Qualification: Compulsory	-			
	Chemical and Bioprocess Engineering: Core Qualification	on: Compuls	ory		
	Electrical Engineering: Core Qualification: Compulsory				
	Green Technologies: Energy, Water, Climate: Specialisa			rgies: Elective Co	mpulsory
	Logistics and Mobility: Specialisation Information Techn				
	Mechatronics: Specialisation Robot- and Machine-Syste		SULY		
	Mechatronics: Specialisation Medical Engineering: Com Mechatronics: Specialisation Dynamic Systems and AI:				
	Mechatronics: Specialisation Dynamic Systems and Al: Mechatronics: Specialisation Electrical Systems: Electiv				
	Process Engineering: Core Qualification: Compulsory	e compuiso	у		

Course L2689: Computer Science for Engineers - Programming Concepts, Data Handling & Communication		
Тур	Lecture	
Hrs/wk	3	
CP	3	
Workload in Hours	Independent Study Time 48, Study Time in Lecture 42	
Lecturer	Prof. Sibylle Fröschle	
Language	DE	
Cycle	SoSe	
Content		
Literature	John V. Guttag: Introduction to Computation and Programming Using Python.	
	With Application to Understanding Data. 2nd Edition. The MIT Press, 2016.	

Course L2690: Computer Science for Engineers - Programming Concepts, Data Handling & Communication	
Тур	Recitation Section (small)
Hrs/wk	2
CP	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Prof. Sibylle Fröschle
Language	DE
Cycle	SoSe
Content	See interlocking course
Literature	See interlocking course

Module M0854: Mathe	ematics IV			
Courses				
Title		Тур	Hrs/wk	CP
Differential Equations 2 (Partial Diff	-	Lecture	2	1
Differential Equations 2 (Partial Diff	erential Equations) (L1044)	Recitation Section (small)	1	1
Differential Equations 2 (Partial Diff	erential Equations) (L1045)	Recitation Section (large)	1	1
Complex Functions (L1038)		Lecture	2	1
Complex Functions (L1041)		Recitation Section (small)	1	1
Complex Functions (L1042)		Recitation Section (large)	1	1
Module Responsible	Prof. Marko Lindner			
-	None			
Recommended Previous Knowledge	Mathematics I - III			
-	After the literation of the second seco			
Educational Objectives	After taking part successfully, students have reach	ed the following learning results		
Professional Competence				
Knowledge				
	 Students can name the basic concepts in Ma 	thematics IV. They are able to explain the	m using appropri	ate examples.
	 Students can discuss logical connections be 	tween these concepts. They are capable	of illustrating th	ese connections wi
	the help of examples.			
	 They know proof strategies and can reprodu 	ce them.		
Skills	Students can model problems in Mathemat	ice IV with the help of the concents studi	od in this course	Moroover they a
	Students can model problems in Mathemat		eu in this course	. Moreover, they a
	capable of solving them by applying establis	hed methods.		
	 Students are able to discover and verify furt 	her logical connections between the conce	pts studied in the	e course.
	 For a given problem, the students can dev 	elop and execute a suitable approach, a	ind are able to c	ritically evaluate the
	results.			
Personal Competence				
Social Competence				
	 Students are able to work together in teams 	. They are capable to use mathematics as	a common langu	age.
	 In doing so, they can communicate new con 	cepts according to the needs of their coop	perating partners	. Moreover, they ca
	design examples to check and deepen the u	nderstanding of their peers.		
Autonomy	 Students are capable of checking their under 	orstanding of complex concepts on their s	wn Thoy can sr	ocify open question
			wiii. They can sp	ecity open question
	precisely and know where to get help in solv			
	 Students have developed sufficient persister 	ence to be able to work for longer period	ls in a goal-orien	ted manner on ha
	problems.			
Workload in Hours	Independent Study Time 68, Study Time in Lecture	112		
Credit points	6			
Course achievement	None			
Examination	Written exam			
Examination duration and	60 min (Complex Functions) + 60 min (Differential	Equations 2)		
scale				
	Conoral Engineering Crience (Comment	competer), Engelslighter Electrical Engl	oring, Commut-	
5	General Engineering Science (German program, 7 s		5 1 .	, ,
Following Curricula	General Engineering Science (German program	, 7 semester): Specialisation Mechanica	al Engineering,	Focus Mechatronic
	Compulsory			
	General Engineering Science (German program, 7 s	semester): Specialisation Naval Architectur	re: Compulsorv	
	General Engineering Science (German program, 7	•		enretical Mechanic
		semester). Specialisation Mechanical Engli	icening, rocus II	
	Engineering: Elective Compulsory			
	Electrical Engineering: Core Qualification: Compulse	ory		
	General Engineering Science (English program, 7 s	emester): Specialisation Electrical Enginee	ring: Compulsory	,
	Computer Science in Engineering: Specialisation II.			
			ive compulsory	
	Mechanical Engineering: Specialisation Mechatronic	cs: Compulsory		
	Mechanical Engineering: Specialisation Theoretical	Mechanical Engineering: Elective Compuls	sory	
	Mechanical Engineering: Specialisation Theoretical Mechatronics: Core Qualification: Compulsory	Mechanical Engineering: Elective Compuls	sory	
	Mechatronics: Core Qualification: Compulsory		sory	
	,			

Course L1043: Differential Ec	quations 2 (Partial Differential Equations)
Тур	Lecture
Hrs/wk	2
СР	1
Workload in Hours	Independent Study Time 2, Study Time in Lecture 28
Lecturer	Dozenten des Fachbereiches Mathematik der UHH
Language	DE
Cycle	SoSe
Content	Main features of the theory and numerical treatment of partial differential equations
Literature	 Examples of partial differential equations First order quasilinear differential equations Normal forms of second order differential equations Harmonic functions and maximum principle Maximum principle for the heat equation Wave equation Liouville's formula Special functions Difference methods Finite elements http://www.math.uni-hamburg.de/teaching/export/tuhh/index.html

Course L1044: Differential Equations 2 (Partial Differential Equations)	
Тур	Recitation Section (small)
Hrs/wk	1
СР	1
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14
Lecturer	Dozenten des Fachbereiches Mathematik der UHH
Language	DE
Cycle	SoSe
Content	See interlocking course
Literature	See interlocking course

Course L1045: Differential Equations 2 (Partial Differential Equations)		
Тур	Recitation Section (large)	
Hrs/wk	1	
CP	1	
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14	
Lecturer	Dozenten des Fachbereiches Mathematik der UHH	
Language	DE	
Cycle	SoSe	
Content	See interlocking course	
Literature	See interlocking course	

Course L1038: Complex Functions		
Тур	Lecture	
Hrs/wk	2	
CP	1	
Workload in Hours	Independent Study Time 2, Study Time in Lecture 28	
Lecturer	Dozenten des Fachbereiches Mathematik der UHH	
Language	DE	
Cycle	SoSe	
Content	Main features of complex analysis	
	 Functions of one complex variable Complex differentiation Conformal mappings Complex integration Cauchy's integral theorem Cauchy's integral formula Taylor and Laurent series expansion Singularities and residuals Integral transformations: Fourier and Laplace transformation 	
Literature	 http://www.math.uni-hamburg.de/teaching/export/tuhh/index.html 	

Course L1041: Complex Functions		
Тур	Recitation Section (small)	
Hrs/wk	1	
CP	1	
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14	
Lecturer	Dozenten des Fachbereiches Mathematik der UHH	
Language	DE	
Cycle	SoSe	
Content	See interlocking course	
Literature	See interlocking course	

Course L1042: Complex Functions	
Тур	Recitation Section (large)
Hrs/wk	1
СР	1
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14
Lecturer	Dozenten des Fachbereiches Mathematik der UHH
Language	DE
Cycle	SoSe
Content	See interlocking course
Literature	See interlocking course

Courses				
Title		Тур	Hrs/wk	СР
Modeling, Simulation and Optimiza	tion (EN) (L2446)	Integrated Lecture	4	6
Module Responsible	Prof. Benedikt Kriegesmann			
Admission Requirements	None			
Recommended Previous	Sound knowledge of engineering mathema	atics, engineering mechanics and fluid mechanic	S	
Knowledge				
Educational Objectives	After taking part successfully, students ha	ve reached the following learning results		
Professional Competence				
Knowledge	Students will have an overview of various	s technical problems and the differential equati	ons, which describe	e them. Students w
	gave an overview of different solution app	roaches and for which kind of problems they car	n be used for.	
Skille	Students are able to solve different techni	cal problems with the introduced discretization r	nethods	
JAIIIS			nethous.	
Personal Competence				
Social Competence	The students are able to discuss problems	and jointly develop solution strategies.		
Autonomy	The students are able to develop colution	strategies for complex problems self consistent	and critically analys	o roculto
Autonomy	The students are able to develop solution	strategies for complex problems self-consistent		e results.
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	General Engineering Science (German pro	gram, 7 semester): Specialisation Mechanical Er	ngineering, Focus Th	neoretical Mechanic
Following Curricula	Engineering: Compulsory			
	General Engineering Science (German pro	gram, 7 semester): Specialisation Advanced Mat	erials: Compulsory	
	General Engineering Science (German p	rogram, 7 semester): Specialisation Mechanic	al Engineering, Foo	cus Aircraft Syster
	Engineering: Elective Compulsory			
		gram, 7 semester): Specialisation Mechanical E	ngineering, Focus M	lechatronics: Electi
	Compulsory			
	Engineering Science: Core Qualification: Co			
	Engineering Science: Specialisation Advan Engineering Science: Specialisation Mecha			
	Engineering Science: Specialisation Mecha			
	Engineering Science: Specialisation Biome			
		eoretical Mechanical Engineering: Compulsory		
	Mechanical Engineering: Specialisation Me			
	Mechanical Engineering: Specialisation Air			
		craft Systems Engineering: Compulsory		
	Mechanical Engineering. Specialisation All	ciait systems Engineering. Compulsory		
	Technomathematics: Specialisation III. Eng			

Course L2446: Modeling, Simulation and Optimization (EN)		
Тур	Integrated Lecture	
Hrs/wk	4	
CP	6	
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56	
Lecturer	Prof. Benedikt Kriegesmann, Prof. Alexander Düster, Prof. Robert Seifried, Prof. Thomas Rung	
Language	EN	
Cycle	SoSe	
Content	 Partial Differential Equations in technical problems Overview of modelling approaches Finite Approximation Methods - Finite Differences / Elements / Volumes Introduction to the Discrete Element Method Numerical methods for time dependent problems Gradient-based optimization 	
Literature	Michael Schäfer, Computational Engineering - Introduction to Numerical Methods, Springer.	

Focus Product Development and Production

The specialization Product Development and Production in the field of study Mechanical Engineering of the course of study General Engineering Science enables a consecutive study of the master Product Development and Production. The specialization maps the product creation process from systematic and methodical development of products, including concept development, design, utilisation of 3D-CAD and Product data management systems, material selection, simulation and test to production, the planning and control and the use of modern manufacturing processes, to high-performance materials.

Courses	
Title Advanced Mechanical Design Proje	t (L0266) Typ Hrs/wk CP Project-/problem-based Learning 4 6
Module Responsible	Dr. Jens Schmidt
Admission Requirements	None
Recommended Previous Knowledge	Mechanical Engineering: DesignAdvanced Mechanical Engineering Design
Educational Objectives	After taking part successfully, students have reached the following learning results
Professional Competence Knowledge	After passing the module, students are able to:
	 express the procedure for systematically handling of complex design tasks , describe working principles, their use and combination possibilities, explain guidelines for designing for function and manufacturing, explain advanced use-oriented knowledge of machine elements.
Skills	After passing the module, students are able to: analyze complex tasks and develop principle solutions using sketches, convert principle solutions into a detailed design, use methods to design and solve engineering design tasks systematically and solution-oriented, create a technical documentation including all necessary technical drawings to understand the functions of the system, document calculations of selected machine elements clearly and in detail.
Personal Competence Social Competence	 After passing the module, students are able to: present and discuss solutions and technical drawings within groups, reflect the own results in the work groups of the course
Autonomy	 After passing the module, students are able to: independently solve complex design projects, while motivating themselves, acquiring necessary knowledge and selectir appropriate methods, to independently solve problems.
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56
Credit points	6
Course achievement	Compulsory Bonus Form Description Yes None Attestation Image: Computer of the second s
Examination	Written exam
Examination duration and scale	180
Assignment for the Following Curricula	General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Aircraft System Engineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Product Developme and Production: Compulsory

Course L0266: Advanced Med	chanical Design Project	
Тур	Project-/problem-based Learning	
Hrs/wk	4	
CP	6	
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56	
Lecturer	Dr. Jens Schmidt, Dr. Volkert Wollesen	
Language	DE	
Cycle	WiSe	
Content	Das Konstruktionsprojekt gliedert sich in den Entwurf eines Getriebes sowie die Lösungsfindung.	
	Getriebekonstruktion in Einzelarbeit	
	Erarbeitung von Lösungsprinzipien	
	Berechnung von Maschinenelementen	
	Entwurf eines Getriebes im Hauptschnitt plus allen Außenansichten	
	Erstellung einer ausführlichen Dokumentation	
	Lösungsfindung	
	 Methodische Erarbeitung von prinzipiellen Lösungskonzepten 	
	Erstellen einer Dokumentation	
Literature	 Dubbel, Taschenbuch für den Maschinenbau; Grote, KH., Feldhusen, J.(Hrsg.); Springer-Verlag, aktuelle Auflage. Maschinenelemente, Band I-III; Niemann, G., Springer-Verlag, aktuelle Auflage. Maschinen- und Konstruktionselemente; Steinhilper, W., Röper, R., Springer Verlag, aktuelle Auflage. Einführung in die DIN-Normen; Klein, M., Teubner-Verlag. Konstruktionslehre, Pahl, G.; Beitz, W., Springer-Verlag, aktuelle Auflage. Maschinenelemente 1-2; Schlecht, B., Pearson Verlag, aktuelle Auflage. Maschinenelemente - Gestaltung, Berechnung, Anwendung; Haberhauer, H., Bodenstein, F., Springer-Verlag, aktuelle Auflage. Roloff/Matek Maschinenelemente; Wittel, H., Muhs, D., Jannasch, D., Voßiek, J., Springer Vieweg, aktuelle Auflage. Sowie weitere Bücher zu speziellen Themen 	

Courses				
		T	Harr facility	<u></u>
Title Fundamentals of Machine Tools (L0	689)	Typ Lecture	Hrs/wk 2	CP 2
Fundamentals of Machine Tools (L1		Recitation Section (large)	1	1
Forming and Cutting Technology (L	0613)	Lecture	2	2
Forming and Cutting Technology (L	0614)	Recitation Section (large)	1	1
Module Responsible	Prof. Jan Hendrik Dege			
Admission Requirements	None			
	without major course assessment			
Knowledge	internship recommended			
	Previous knowledge in mathematics, mechanics ar	nd electrical engineering		
Educational Objectives	After taking part successfully, students have reach	ed the following learning results		
Professional Competence				
Knowledge	Students are able to			
	explain the basics of chip formation and me	chanisms and models of machining		
	 explain the basics of chip formation and me explain methods and parameters for design 		processes and to	ols.
	 explain technical concepts of machine tool b 			
	 explain types, constructions and functions of 	f CNC-machines and give an overview on n	nulti-machine sys	stems.
	explain equipment components.			
Skills	Students are able to			
Skiis				
	 select tool geometry, cutting materials, pro 	ocess parameters and appropriate measur	ing technique in	accordance with t
	requirements.			
	estimate occurring forces and temperatures		d mailling a	
	 select appropriate machine tools for machine assess the quality of a machine tools and to 		a mining.	
	• assess the quality of a machine tools and to	detect weak points.		
Personal Competence				
Social Competence	e Students are able to			
	develop solutions in a production environme	ent with qualified personnel at technical lev	el and represent	decisions.
Autonomy	Students are able to			
	interpret independently cutting processes.			
	create independently NC programs.			
	 select independently machine tools by refer 			
	 assess own strengths and weaknesses in get 			
	 assess their learning progress and define gather and the second se			
	 assess possible consequences of their action 	15.		
	Independent Study Time 96, Study Time in Lecture	2 84		
Credit points				
Course achievement	None			
Examination				
	180 min			
scale	General Engineering Science (German program, 7	competer), Specialization Machanical Fra	incoring Eccus	Product Douglas
	and Production: Compulsory	semester), specialisation Mechanical Eng	meening, Focus I	
Following Curricula	Mechanical Engineering: Specialisation Product De	velopment and Production: Compulsory		
	Mechatronics: Specialisation Robot- and Machine-S			
		Jacana, Elective compulsory		

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

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

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

Course L0614: Forming and	ourse L0614: Forming and Cutting Technology		
Тур	Recitation Section (large)		
Hrs/wk	1		
CP	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		

Module M1901: Mate	ials Science Laboratory					
Courses						
Fitle		Тур	Hrs/wk	СР		
Companion Lecture for Materials So		Lecture	2	2		
Material Science Laboratory (L1235)	Practical Course	4	4		
Module Responsible	Prof. Kaline Pagnan Furlan					
Admission Requirements	None					
Recommended Previous	none					
Knowledge						
Educational Objectives	After taking part successfully, students have	ve reached the following learning results				
Professional Competence						
Knowledge	Students are able to give a summary of	the technical details of experiments in the	area of materials sc	iences and illustra		
	respective relationships. They are capable	e of describing and communicating relevant	problems and questio	ns using appropria		
	technical language. They can explain the t	ypical process of solving practical problems a	nd present related res	ults.		
Skills	Skills The students can transfer their fundamental knowledge on material sciences to the process of solving practical					
	identify and overcome typical problems during the realization of experiments in the context of material sciences.					
Personal Competence						
	Students are able to cooperate in small are	ouns in order to conduct experiments in the c	ontext of materials sci	iences They are a		
Social competence	Students are able to cooperate in small groups in order to conduct experiments in the context of materials sciences. They are a to effectively present and explain their results alone or in groups in front of a qualified audience.					
	to encervery present and explain their res	and alone of in groups in none of a qualified a	dulence.			
Autonomy	Students are capable of solving problems	in the context of materials sciences using pr	ovided literature. They	y are able to fill ga		
	in as well as extent their knowledge using	the literature and other sources provided by t	he supervisor.			
Workload in Hours	Independent Study Time 96, Study Time in	lecture 84				
Credit points						
Course achievement						
Examination	Subject theoretical and practical work					
		nd online learning modules with integrated ch	eckina			
scale			<u> </u>			
Assignment for the	General Engineering Science (German pro	gram, 7 semester): Specialisation Mechanica	l Engineering, Focus F	Product Developme		
-	and Production: Elective Compulsory					
· ····································	General Engineering Science (German program, 7 semester): Specialisation Advanced Materials: Compulsory					
	Engineering Science: Specialisation Advanced Materials: Compulsory					
	Engineering Science: Specialisation Advanced Materials: Compulsory					
	Engineering Science: Specialisation Mechanical Engineering: Elective Compulsory Mechanical Engineering: Specialisation Product Development and Production: Compulsory					
			ı y			
		terials in Engineering Sciences: Compulsory	Chudian Flantius Com	nulaanu		
	Product Development, Materials and Produ	ction: Technical Complementary Course Core	Studies: Elective Com	puisory		

Course L1088: Companion Le	ecture for Materials Science Laboratory
Тур	Lecture
Hrs/wk	2
CP	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 Scien	nce Laboratory
Тур	Practical Course
Hrs/wk	4
CP	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 M0599: Digita	al Product Devel	opment and Lig	htweight De	sign		
Courses						
Title CAE-Team Project (L0271) Digital Product Development (L026 Development of Lightweight Desig				Typ Project-/problem-based Learning Lecture Lecture	Hrs/wk 2 2 2	CP 2 2 2
				Lecture	Z	Z
Module Responsible						
Admission Requirements Recommended Previous		hout onginooring docio	p.			
Knowledge	Fundamentals of Mecha	5 5 5				
	Mechanical Engineering	g: Design				
	Advanced Mechanical B	Engineering Design				
Educational Objectives	After taking part succe	ssfully, students have r	eached the followi	ng learning results		
Professional Competence						
Knowledge	After completing the m	odule, students are cap	able of:			
		inctional principle of 3 Eteraction of the differe		0M- and FEM-Systems the product development proces	s	
Skills						
	After completing the module, students are able to:					
	product structur	ing	5	to the desired requirements su 4-Systems with shared workload	ich as classifi	cation schemes and
Personal Competence						
-	After completing the m	odule, students are abl	e to:			
		ject plan and allocate v results as a team for ins		vork packages in the framework ation	of group discu	ussions
Autonomy	Students are capable o	f:				
	 independently a 	dapt to a CAE-Tool and	complete a given	practical task with it		
Workload in Hours	Independent Study Tim	e 96, Study Time in Le	cture 84			
Credit points	6					
Course achievement	Compulsory Bonus	Form	Description			
	Yes 20 %		andCAE-Teampro	ojekt inkl. Vortrag und Ausarbeitu	ing	
		practical work				
	Written exam					
Examination duration and scale	90					
Assignment for the	General Engineering S	cience (German prog	am, 7 semester)	: Specialisation Mechanical Eng	ineering, Foc	us Aircraft Systems
Following Curricula	Engineering: Compulso					
			m, 7 semester): S	pecialisation Mechanical Engine	ering, Focus P	roduct Development
	and Production: Compu		I Facilitati di Si	-time Commuterer		
	Engineering Science: S				na, Elective C	ompulsory
				ecialisation Mechanical Engineeri d Production: Compulsory	iig: Elective C	ompulsory
	Mechanical Engineering			, ,		
				plementary Course Core Studies:	Elective Com	pulsory

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

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

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

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Courses					
Title		Тур	Hrs/wk	СР	
Production Process Organization (L	0925)	Lecture	2	3	
Quality Management (L0926)		Lecture	2	3	
•	Prof. Hermann Lödding				
Admission Requirements					
Recommended Previous	None				
Knowledge					
Educational Objectives	After taking part successfully, students ha	ve reached the following learning results			
Professional Competence					
Knowledge	Students are able to explain the contents of the lecture of the module.				
Skills	Students are able to apply the methods an	nd models in the module to industrial probler	ms.		
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 Minuten				
scale					
Assignment for the	General Engineering Science (German p	rogram, 7 semester): Specialisation Mech	anical Engineering, Foo	us Aircraft Syste	
Following Curricula	Engineering: Compulsory				
	General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Product Developmer				
	and Production: Compulsory				
	General Engineering Science (German pro	gram, 7 semester): Specialisation Advanced	Materials: Elective Com	pulsory	
	Engineering Science: Specialisation Mechatronics: Elective Compulsory				
	Engineering Science: Specialisation Mechanical Engineering: Elective Compulsory				
	Engineering Science: Specialisation Mechanical Engineering: Compulsory				
	Engineering Science: Specialisation Advanced Materials: Elective Compulsory				
	Logistics and Mobility: Specialisation Prod	uction Management and Processes: Compuls	ory		
	Mechanical Engineering: Core Qualification	n: Elective Compulsory			
	Engineering and Management - Major in L	ogistics and Mobility: Specialisation Production	on Management and Pro	cesses: Compulso	

Course L0925: Production Pr	ocess Organization		
Тур	Lecture		
Hrs/wk			
СР			
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28		
Lecturer	Prof. Hermann Lödding		
Language			
Cycle	SoSe		
Content	(A) Introduction		
	(B) Product planning		
	(C) Process planning		
	(D) Procurement		
	(E) Manufacturing		
	(F) Production planning and control (PPC)		
	(G) Distribution		
	(H) Cooperation		
Literature	Wiendahl, HP.: Betriebsorganisation für Ingenieure		
	Vorlesungsskript		

Course L0926: Quality Manag	gement
Тур	Lecture
Hrs/wk	2
CP	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Prof. Hermann Lödding
Language	EN
Cycle	SoSe
Content	 Definition and Relevance of Quality Continuous Quality Improvement Quality Management in Product Development Quality Management in Production Processes Design of Experiments
Literature	 Pfeifer, Tilo: Quality Management. Strategies, Methods, Techniques; Hanser-Verlag, München 2002 Pfeifer, Tilo: Qualitätsmanagement. Strategien, Methoden, Techniken; Hanser-Verlag, München, 3. Aufl. 2001 Mitra, Amitava: Fundamentals of Quality Control and Improvement; Wiley; Macmillan, 2008 Kleppmann, W.: Taschenbuch Versuchsplanung. Produkte und Prozesse optimieren; Hanser-Verlag, München, 6. Aufl. 2009

Courses					
Title		Тур	Hrs/wk	СР	
	rogramming Concepts, Data Handling & Communication (L2689)	Lecture	3	3	
Computer Science for Engineers - P	rogramming Concepts, Data Handling & Communication (L2690)	Recitation Section (small)	2	3	
Module Responsible	Prof. Sibylle Fröschle				
Admission Requirements	None				
Recommended Previous					
Knowledge					
Educational Objectives	After taking part successfully, students have reached the	ollowing learning results			
Professional Competence					
Knowledge					
Skills					
Personal Competence					
Social Competence					
Autonomy					
Workload in Hours	Independent Study Time 110, Study Time in Lecture 70				
Credit points	6				
Course achievement	Compulsory Bonus Form Descript				
E		finden semesterbegleitend statt.			
Examination					
Examination duration and	120 min				
scale					
Assignment for the	General Engineering Science (German program, 7 ser	nester): Specialisation Mechanic	al Engineering, F	ocus Biomechan	
Following Curricula					
	General Engineering Science (German program, 7 semester): Specialisation Biomedical Engineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Green Technologies, Enguise Renewable Energy: Election				
	General Engineering Science (German program, 7 semester): Specialisation Green Technologies, Focus Renewable Energy: Electi Compulsory				
		stor), Enocialization Machanical	Engineering For	us Eporal Susta	
	General Engineering Science (German program, 7 sem Compulsory	ster). Specialisation Mechanical	Engineering, Foc	us Energy Syster	
	General Engineering Science (German program, 7 sem	ester): Specialisation Mechanical	Engineering For	us Aircraft Syste	
	Engineering: Compulsory	stery. Specialisation mechanical	Engineering, Too	as Anerare Syste	
	General Engineering Science (German program, 7 se	nester): Specialisation Mechanic	al Engineering. I	ocus Mechatron	
	Compulsory		<u> </u>		
	General Engineering Science (German program, 7 semes	er): Specialisation Mechanical En	gineering, Focus F	roduct Developm	
	and Production: Elective Compulsory				
	General Engineering Science (German program, 7 semest	er): Specialisation Mechanical Eng	ineering, Focus Th	eoretical Mechan	
	Engineering: Elective Compulsory				
	General Engineering Science (German program, 7 semeste	r): Specialisation Electrical Engine	eering: Elective Co	mpulsory	
	Bioprocess Engineering: Core Qualification: Compulsory				
	Chemical and Bioprocess Engineering: Core Qualification:	Compulsory			
	Electrical Engineering: Core Qualification: Compulsory				
	Green Technologies: Energy, Water, Climate: Specialisatio	n Energy Systems / Renewable En	ergies: Elective Co	mpulsory	
	Logistics and Mobility: Specialisation Information Technolo				
	Mechatronics: Specialisation Robot- and Machine-Systems: Compulsory				
	Mechatronics: Specialisation Medical Engineering: Comput				
	Mechatronics: Specialisation Dynamic Systems and AI: Con				
	Mechatronics: Specialisation Electrical Systems: Elective C	ompulsory			
	Process Engineering: Core Qualification: Compulsory				

Course L2689: Computer Sci	Course L2689: Computer Science for Engineers - Programming Concepts, Data Handling & Communication		
Тур	Lecture		
Hrs/wk	3		
CP	3		
Workload in Hours	Independent Study Time 48, Study Time in Lecture 42		
Lecturer	Prof. Sibylle Fröschle		
Language	DE		
Cycle	SoSe		
Content			
Literature	John V. Guttag: Introduction to Computation and Programming Using Python.		
	With Application to Understanding Data. 2nd Edition. The MIT Press, 2016.		

Course L2690: Computer Science for Engineers - Programming Concepts, Data Handling & Communication		
Тур	Recitation Section (small)	
Hrs/wk	2	
CP	3	
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28	
Lecturer	Prof. Sibylle Fröschle	
Language	DE	
Cycle	SoSe	
Content	See interlocking course	
Literature	See interlocking course	

Courses				
Title		Тур	Hrs/wk	СР
Production Engineering I (L0608)		Lecture	2	2
Production Engineering I (L0612)		Recitation Section (large)	1	1
Production Engineering II (L0610)		Lecture	2	2
Production Engineering II (L0611)		Recitation Section (large)	1	1
Module Responsible	Prof. Jan Hendrik Dege			
Admission Requirements	None			
Recommended Previous	no course assessments required			
Knowledge				
	internship recommended			
Educational Objectives	After taking part successfully, students ha	ave reached the following learning results		
Professional Competence		5 5		
-	Students are able to			
Knowledge				
	 name basic criteria for the selection 	n of manufacturing processes.		
	 name the main groups of Manufact 	uring Technology.		
	 name the application areas of diffe 	rent manufacturing processes.		
	 name boundaries, advantages and 	disadvantages of the different manufacturing pro	cess.	
	 describe elements, geometric prop 	erties and kinematic variables and requirements f	or tools, workpiece	and process.
	 explain the essential models of ma 	nufacturing technology.		
Skills	Students are able to			
en ne				
	 select manufacturing processes in 	accordance with the requirements.		
	 design manufacturing processes for 	r simple tasks to meet the required tolerances of	the component to l	be produced.
	 assess components in terms of the 	ir production-oriented construction.		
Personal Competence				
Social Competence	Students are able to			
	 develop solutions in a production e 	nvironment with qualified personnel at technical l	evel and represent	decisions.
Autonomy	Students are able to			
	 interpret independently the manufactorial 			
	 assess own strengths and weaknes 			
	 assess their learning progress and 			
	 assess possible consequences of the 	neir actions.		
Workload in Hours	Independent Study Time 96, Study Time i	n Lecture 84		
Credit points	6			
Course achievement				
Examination	Written exam			
Examination duration and	120 min			
scale				
	General Engineering Science (German pro	ogram, 7 semester): Specialisation Mechanical En	gineering. Focus T	heoretical Mechania
-	Engineering: Elective Compulsory			
r onowing curricula		ogram, 7 semester): Specialisation Mechanical Er	aineering Focus	Product Developme
	and Production: Compulsory	ogram, / semester). Specialisation Mechanical El	ignicening, rocus i	
	Digital Mechanical Engineering: Core Qua	lification: Compulson		
	Engineering Science: Specialisation Mech			
	Engineering Science: Specialisation Mecha		needing Co	
		gram, 7 semester): Specialisation Mechanical Engl		лу
		ate: Specialisation Energy Technology: Elective Co	mpulsory	
		uction Management and Processes: Compulsory		
	Mechanical Engineering: Core Qualificatio	n: Compulsory		
	Mechatronics: Specialisation Naval Engine	eering: Compulsory		
	Mechatronics: Core Qualification: Compute	sory		
	Mechatronics: Specialisation Medical Engi	neering: Elective Compulsory		
	Mechatronics: Specialisation Robot- and M			
		ogistics and Mobility: Specialisation Production Ma	anagement and Pro	ocesses: Compulso

Course L0608: Production En	igineering I
Тур	Lecture
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Prof. Jan Hendrik Dege
Language	DE
Cycle	SoSe
Content	 Manufacturing Accuracy Manufacturing Metrology Measurement Errors and Uncertainties Introduction to Forming Massiv forming and Sheet Metal Forming Introduction to Machining Technology Geometrically defined machining (Turning, milling, drilling, broaching, planning)
Literature	Dubbel, Heinrich (Grote, Karl-Heinrich.; Feldhusen, Jörg.; Dietz, Peter.; Ziegmann, Gerhard.;) Taschenbuch für den Maschinenbau : mit Tabellen. Berlin [u.a.] : Springer, 2007 Fritz, Alfred Herbert: Fertigungstechnik : mit 62 Tabellen. Berlin [u.a.] : Springer, 2004 Keferstein, Claus P (Dutschke, Wolfgang.;): Fertigungsmesstechnik : praxisorientierte Grundlagen, moderne Messverfahren. Wiesbaden : Teubner, 2008 Mohr, Richard: Statistik für Ingenieure und Naturwissenschaftler : Grundlagen und Anwendung statistischer Verfahren. Renningen : expert-Verl, 2008 Klocke, F., König, W.: Fertigungsverfahren Bd. 1 Drehen, Fäsen, Bohren. 8. Aufl., Springer (2008) Klocke, Fritz (König, Wilfried.;): Umformen. Berlin [u.a.] : Springer, 2006 Paucksch, E.: Zerspantechnik, Vieweg-Verlag, 1996 Tönshoff, H.K.; Denkena, B., Spanen. Grundlagen, Springer-Verlag (2004)

Course L0612: Production En	urse L0612: Production Engineering I		
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	SoSe		
Content	See interlocking course		
Literature	See interlocking course		

Course L0610: Production En	igineering II
Тур	Lecture
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Prof. Jan Hendrik Dege, Prof. Claus Emmelmann
Language	DE
Cycle	SoSe
Content	 Geometrically undefined machining (grinding, lapping, honing) Introduction into erosion technology Introduction into blastig processes Introduction to the manufacturing process forming (Casting, Powder Metallurgy, Composites) Fundamentals of Laser Technology Process versions and Fundamentals of Laser Joining Technology
Literature	Klocke, F., König, W.: Fertigungsverfahren Bd. 2 Schleifen, Honen, Läppen, 4. Aufl., Springer (2005) Klocke, F., König, W.: Fertigungsverfahren Bd. 3 Abtragen, Generieren und Lasermaterialbearbeitung. 4. Aufl., Springer (2007) Spur, Günter (Stöferle, Theodor.;): Urformen. München [u.a.] : Hanser, 1981 Schatt, Werner (Wieters, Klaus-Peter,; Kieback, Bernd,;): Pulvermetallurgie : Technologien und Werkstoffe. Berlin [u.a.] : Springer, 2007

Course L0611: Production En	ourse L0611: Production Engineering II		
Тур	Recitation Section (large)		
Hrs/wk	1		
CP	1		
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14		
Lecturer	Prof. Jan Hendrik Dege, Prof. Claus Emmelmann		
Language	DE		
Cycle	SoSe		
Content	See interlocking course		
Literature	See interlocking course		

Focus Theoretical Mechanical Engineering

The graduates acquire basic research and methodological oriented content mechanical engineering knowledge and associated mechanical engineering expertise to develop mathematical descriptions, analysis and synthesis of basic technical systems methods, products or processes. This course, concentrates on simulation technology, advanced mathematics and heat transfer, such that a continuous study in the Master program in Theoretical Mechanical Engineering is possible.

Courses				
Title		Тур	Hrs/wk	СР
Numerical Mathematics I (L0417)		Lecture	2	3
Numerical Mathematics I (L0418)		Recitation Section (small)	2	3
Module Responsible				
Admission Requirements	None			
Recommended Previous	Mathematik I + II for Engineering Students (german	or english) or Analysis & Linear Al	gebra I + II for Te	chnomathematicia
Knowledge	basic MATLAB/Python knowledge		-	
Educational Objectives	After taking part successfully, students have reached the	following learning results		
Professional Competence				
Knowledge	Students are able to			
	 name numerical methods for interpolation, integrat 	tion, least squares problems, eigen	value problems, r	onlinear root findi
	problems and to explain their core ideas,			
	repeat convergence statements for the numerical n	nethods,		
	explain aspects for the practical execution of nume	rical methods with respect to comp	utational and sto	rage complexitx.
Skills	Students are able to			
	 implement, apply and compare numerical methods 	using MATLAB/Python,		
	 justify the convergence behaviour of numerical met 		nd solution algori	ithm,
	 select and execute a suitable solution approach for 		-	
Personal Competence				
Social Competence	Students are able to			
	 work together in heterogeneously composed teams explain theoretical foundations and support each ot 			
Διιτοροφγ	Students are capable			
hatohomy				
	 to assess whether the supporting theoretical and pr to assess their individual progess and, if necessary, 		l individually or ir	n a team,
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56			
Credit points				
Course achievement				
	Written exam			
Examination duration and	90 minutes			
scale			<u> </u>	
	General Engineering Science (German program, 7 semeste			
Following Curricula	General Engineering Science (German program, 7 semeste			
	General Engineering Science (German program, 7 ser	mester): Specialisation Mechanica	ii Engineering, F	ocus Biomechani
	Compulsory General Engineering Science (German program, 7 semest	er): Specialisation Mechanical Engli	peering Focus Th	eoretical Mechani
	Engineering: Compulsory	er). Specialisation mechanical Engli	leening, rocus rr	
	General Engineering Science (German program, 7 sem	ester): Specialisation Mechanical	Engineering For	us Aircraft System
	Engineering: Elective Compulsory	isself. Specialisation mechanical	Engineering, Too	us Anerare Syster
	General Engineering Science (German program, 7 semest	er): Specialisation Mechanical Engi	neering, Focus M	echatronics: Electi
	Compulsory		5, 5,	
	General Engineering Science (German program, 7 sem	ester): Specialisation Mechanical	Engineering, Foc	us Energy Systen
	Elective Compulsory		-	
	General Engineering Science (German program, 7 semeste	er): Specialisation Advanced Materi	als: Compulsory	
	General Engineering Science (German program, 7 semeste	er): Specialisation Data Science: Co	mpulsory	
	Bioprocess Engineering: Specialisation A - General Bioproc	cess Engineering: Elective Compulse	ory	
	Data Science: Core Qualification: Compulsory			
	Electrical Engineering: Core Qualification: Elective Comput	sory		
	Engineering Science: Core Qualification: Compulsory			
	Groop Technologies: Energy Water, Climate: Specialisatie	n Energy Technology: Elective Com	pulsory	
	Green rechnologies. Lifergy, water, chinate. Specialisatio			
	Computer Science in Engineering: Core Qualification: Com	pulsory		
	Computer Science in Engineering: Core Qualification: Com Mechanical Engineering: Specialisation Theoretical Mechan Mechanical Engineering: Specialisation Energy Systems: E	nical Engineering: Compulsory lective Compulsory		
	Computer Science in Engineering: Core Qualification: Com Mechanical Engineering: Specialisation Theoretical Mechan	nical Engineering: Compulsory lective Compulsory ntary Course Core Studies: Elective	Compulsory	

Course L0417: Numerical Ma	thematics I			
Тур	Lecture			
Hrs/wk				
CP	3			
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28			
Lecturer	Prof. Sabine Le Borne			
Language	EN			
Cycle	WiSe			
Content	 Finite precision arithmetic, error analysis, conditioning and stability Linear systems of equations: LU and Cholesky factorization, condition Interpolation: polynomial, spline and trigonometric interpolation Nonlinear equations: fixed point iteration, root finding algorithms, Newton's method Linear and nonlinear least squares problems: normal equations, Gram Schmidt and Householder orthogonalization, singular value decomposition, regularizatio, Gauss-Newton and Levenberg-Marquardt methods Eigenvalue problems: power iteration, inverse iteration, QR algorithm Numerical differentiation 			
Literature	 8. Numerical integration: Newton-Cotes rules, error estimates, Gauss quadrature, adaptive quadrature Gander/Gander/Kwok: Scientific Computing: An introduction using Maple and MATLAB, Springer (2014) Stoer/Bulirsch: Numerische Mathematik 1, Springer Dahmen, Reusken: Numerik für Ingenieure und Naturwissenschaftler, Springer 			

Course L0418: Numerical Mathematics I		
Тур	Recitation Section (small)	
Hrs/wk	2	
CP	3	
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28	
Lecturer	Prof. Sabine Le Borne, Dr. Jens-Peter Zemke	
Language	EN	
Cycle	WiSe	
Content	See interlocking course	
Literature	See interlocking course	

Courses					
Title		Тур	Hrs/wk	СР	
Heat Transfer (L0458)		Lecture	3	4	
Heat Transfer (L0459)		Recitation Section (large)	2	2	
Module Responsible	Dr. Andreas Moschallski				
Admission Requirements	None				
Recommended Previous	Technical Thermodynamics I, II and Fluid Dyna	mics			
Knowledge					
Educational Objectives	After taking part successfully, students have re	eached the following learning results			
Professional Competence					
Knowledge	The students can				
	- explain the technical terms,				
	- classify the various physical processes of hea	t transfer in terms of conduction-based and r	adiation-based me	chanisms,	
	- simplify and critically analyze complex heat t	ransfer processes using models,			
	mathedically develop colutions to tools				
	 methodically develop solutions to tasks. 				
Skills	The students are able to				
	- describe the physics of the different Heat Transfer mechanism,				
	- simplifywith models, calculate and evaluate c	omplex Heat Transfer processes,			
	- critically question and answer statements on	heat transfer,			
	- solve excersises self-consistent and in small of	groups.			
Personal Competence					
-	In lectures and exercises, the students can u	se many examples and experiments to disc	uss in small group	os in a goal-orient	
	manner, develop a solution and present it. W				
	work out targeted solutions.				
	-				
Autonomy	The students can check their level of knowledg	e by means of repetition questions at the be	ginning of the lectu	ires and describe	
	discuss answers in exchange with the other stu	udents. In the exercises, the students work in	small groups on th	ne methods taugh	
	the lectures in complex tasks and critically ana	lyze the results in the auditorium.			
Workload in Hours	Independent Study Time 110, Study Time in Le	ecture 70			
Credit points	6				
Course achievement	None				
Examination	Written exam				
Examination duration and	120 min				
scale					
0	General Engineering Science (German progr	am, 7 semester): Specialisation Mechanica	Engineering, Foc	us Energy Syster	
-	Compulsory				
	General Engineering Science (German program				
	General Engineering Science (German program	n, 7 semester): Specialisation Mechanical Eng	Jineering, Focus Th	eoretical Mechani	
	Engineering: Compulsory				
	Energy Systems: Technical Complementary Co				
	Integrated Building Technology: Core Qualifica	tion: Compulsory			
	Mechanical Engineering: Specialisation Energy				

Course L0458: Heat Transfer	
Тур	Lecture
Hrs/wk	3
СР	4
Workload in Hours	Independent Study Time 78, Study Time in Lecture 42
Lecturer	Dr. Andreas Moschallski
Language	DE
Cycle	WiSe
Content	Dimensional analysis, Heat Conduction (steady and unsteady) , Convective Heat Transfer (natural convection, forced convection), Two-phase Heat Transfer (evaporation, condensation), Thermal Radiation, Heat Transfer on a thermodynamic view, thermotechnical devices, measures of temperature and heat flux
Literature	 Herwig, H.; Moschallski, A.: Wärmeübertragung, 4. Auflage, Springer Vieweg Verlag, Wiesbaden, 2019 Herwig, H.: Wärmeübertragung von A-Z, Springer- Verlag, Berlin, Heidelberg, 2000 Baehr, H.D.; Stephan, K.: Wärme- und Stoffübertragung, 2. Auflage, Springer Verlag, Berlin, Heidelberg, 1996

Course L0459: Heat Transfer	irse L0459: Heat Transfer	
Тур	Recitation Section (large)	
Hrs/wk	2	
CP	2	
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28	
Lecturer	Dr. Andreas Moschallski	
Language	DE	
Cycle	WiSe	
Content	See interlocking course	
Literature	See interlocking course	

Courses				
Title		Тур	Hrs/wk	СР
Electrical Machines and Actuators	L0293)	Lecture	3	4
Electrical Machines and Actuators	L0294)	Recitation Section (large)	2	2
Module Responsible	Prof. Thorsten Kern			
Admission Requirements	None			
Recommended Previous	Basics of mathematics, in particular complexe numbers	, integrals, differentials		
Knowledge	Basics of electrical engineering and mechanical engine	ring		
	basics of electrical engineering and mechanical engine	anig		
Educational Objectives	After taking part successfully, students have reached the	e following learning results		
Professional Competence				
Knowledge	Students can to draw and explain the basic principles o	electric and magnetic fields.		
	They can describe the function of the standard ty	pes of electric machines and prese	nt the correspon	ding equations a
	characteristic curves. For typically used drives they car			
	from the power grid to the driven engine.		energy entereney	or the more syst
Skills	Students are able to calculate two-dimensional electri		rromagnetic circu	uits with air gap.
	this they apply the usual methods of the design auf ele	tric machines.		
	They can calulate the operational performance of elec	tric machines from their given charac	cteristic data and	d selected quantit
	and characteristic curves. They apply the usual equival	ent circuits and graphical methods.		
Personal Competence				
Social Competence	none			
Autonomy	Students are able independently to calculate electric a	nd magnatic fields for applications. Th	ey are able to ar	nalyse independer
	the operational performance of electric machines from	the charactersitic data and theycan	calculate thereo	f selected quantit
	and characteristic curves.			
Workload in Hours	Independent Study Time 110, Study Time in Lecture 70			
Credit points				
Course achievement				
	Subject theoretical and practical work			
	Design of four machines and actuators, review of desig	n files		
scale				
	General Engineering Science (German program, 7 s	mester): Specialisation Mechanical I	Engineering, Foc	us Energy Syster
Following Curricula	Compulsory General Engineering Science (German program, 7	semester): Specialisation Mechanica	l Engineering	Focus Mechatroni
	Compulsory	semester). Specialisation mechanica	in Engineering, i	focus meenatrom
	General Engineering Science (German program, 7 sem	ester): Specialisation Mechanical Engir	neerina. Focus Th	eoretical Mechani
	Engineering: Elective Compulsory		3,	
	General Engineering Science (German program, 7 seme	ster): Specialisation Electrical Enginee	ering: Elective Co	mpulsory
	Digital Mechanical Engineering: Core Qualification: Com			-
	Electrical Engineering: Core Qualification: Elective Com	pulsory		
	1	na: Elective Compulsory		
	Engineering Science: Specialisation Electrical Engineeri	igi Elective compaisory		
	Engineering Science: Specialisation Electrical Engineeri Green Technologies: Energy, Water, Climate: Specialisa		pulsory	
		tion Energy Technology: Elective Com		
	Green Technologies: Energy, Water, Climate: Specialisa	tion Energy Technology: Elective Com tion Maritime Technologies: Elective C	ompulsory	
	Green Technologies: Energy, Water, Climate: Specialisa Green Technologies: Energy, Water, Climate: Specialisa Computer Science in Engineering: Specialisation II. Mat Logistics and Mobility: Specialisation Traffic Planning ar	tion Energy Technology: Elective Com tion Maritime Technologies: Elective C nematics & Engineering Science: Elect d Systems: Elective Compulsory	ive Compulsory	
	Green Technologies: Energy, Water, Climate: Specialisa Green Technologies: Energy, Water, Climate: Specialisa Computer Science in Engineering: Specialisation II. Mat Logistics and Mobility: Specialisation Traffic Planning ar Logistics and Mobility: Specialisation Production Manag	tion Energy Technology: Elective Com tion Maritime Technologies: Elective C nematics & Engineering Science: Elect d Systems: Elective Compulsory ement and Processes: Elective Compul	ive Compulsory	
	Green Technologies: Energy, Water, Climate: Specialisa Green Technologies: Energy, Water, Climate: Specialisa Computer Science in Engineering: Specialisation II. Mat Logistics and Mobility: Specialisation Traffic Planning ar Logistics and Mobility: Specialisation Production Manag Mechanical Engineering: Core Qualification: Elective Co	tion Energy Technology: Elective Com tion Maritime Technologies: Elective C nematics & Engineering Science: Elect d Systems: Elective Compulsory ement and Processes: Elective Compul mpulsory	ive Compulsory	
	Green Technologies: Energy, Water, Climate: Specialisa Green Technologies: Energy, Water, Climate: Specialisa Computer Science in Engineering: Specialisation II. Mat Logistics and Mobility: Specialisation Traffic Planning ar Logistics and Mobility: Specialisation Production Manag Mechanical Engineering: Core Qualification: Elective Co Mechatronics: Specialisation Naval Engineering: Compu	tion Energy Technology: Elective Com tion Maritime Technologies: Elective C nematics & Engineering Science: Elect d Systems: Elective Compulsory ement and Processes: Elective Compul mpulsory	ive Compulsory	
	Green Technologies: Energy, Water, Climate: Specialisa Green Technologies: Energy, Water, Climate: Specialisa Computer Science in Engineering: Specialisation II. Mat Logistics and Mobility: Specialisation Traffic Planning ar Logistics and Mobility: Specialisation Production Manag Mechanical Engineering: Core Qualification: Elective Co Mechatronics: Specialisation Naval Engineering: Compu Mechatronics: Core Qualification: Compulsory	tion Energy Technology: Elective Com tion Maritime Technologies: Elective C nematics & Engineering Science: Elect d Systems: Elective Compulsory ement and Processes: Elective Compul mpulsory lsory	ive Compulsory	
	Green Technologies: Energy, Water, Climate: Specialisa Green Technologies: Energy, Water, Climate: Specialisa Computer Science in Engineering: Specialisation II. Mat Logistics and Mobility: Specialisation Traffic Planning ar Logistics and Mobility: Specialisation Production Manag Mechanical Engineering: Core Qualification: Elective Co Mechatronics: Specialisation Naval Engineering: Compu Mechatronics: Core Qualification: Compulsory Mechatronics: Specialisation Robot- and Machine-Syste	tion Energy Technology: Elective Com tion Maritime Technologies: Elective C nematics & Engineering Science: Elect d Systems: Elective Compulsory ement and Processes: Elective Compul mpulsory lsory	ive Compulsory	
	Green Technologies: Energy, Water, Climate: Specialisa Green Technologies: Energy, Water, Climate: Specialisa Computer Science in Engineering: Specialisation II. Mat Logistics and Mobility: Specialisation Traffic Planning ar Logistics and Mobility: Specialisation Production Manag Mechanical Engineering: Core Qualification: Elective Co Mechatronics: Specialisation Naval Engineering: Compu Mechatronics: Core Qualification: Compulsory Mechatronics: Specialisation Robot- and Machine-Syste Mechatronics: Specialisation Electrical Systems: Electiv	tion Energy Technology: Elective Com tion Maritime Technologies: Elective C mematics & Engineering Science: Elect d Systems: Elective Compulsory ement and Processes: Elective Compul mpulsory lsory ms: Compulsory e Compulsory	ive Compulsory	
	Green Technologies: Energy, Water, Climate: Specialisa Green Technologies: Energy, Water, Climate: Specialisa Computer Science in Engineering: Specialisation II. Mat Logistics and Mobility: Specialisation Traffic Planning ar Logistics and Mobility: Specialisation Production Manag Mechanical Engineering: Core Qualification: Elective Co Mechatronics: Specialisation Naval Engineering: Compu Mechatronics: Core Qualification: Compulsory Mechatronics: Specialisation Robot- and Machine-Syste Mechatronics: Specialisation Electrical Systems: Electiv Technomathematics: Specialisation III. Engineering Science	tion Energy Technology: Elective Com tion Maritime Technologies: Elective C mematics & Engineering Science: Elect d Systems: Elective Compulsory ement and Processes: Elective Compul mpulsory lsory ms: Compulsory e Compulsory nce: Elective Compulsory	ompulsory ive Compulsory lsory	active Compulsory
	Green Technologies: Energy, Water, Climate: Specialisa Green Technologies: Energy, Water, Climate: Specialisa Computer Science in Engineering: Specialisation II. Mat Logistics and Mobility: Specialisation Traffic Planning ar Logistics and Mobility: Specialisation Production Manag Mechanical Engineering: Core Qualification: Elective Co Mechatronics: Specialisation Naval Engineering: Compu Mechatronics: Core Qualification: Compulsory Mechatronics: Specialisation Robot- and Machine-Syste Mechatronics: Specialisation Electrical Systems: Electiv Technomathematics: Specialisation III. Engineering Scie Engineering and Management - Major in Logistics and M	tion Energy Technology: Elective Com tion Maritime Technologies: Elective C mematics & Engineering Science: Elect d Systems: Elective Compulsory ement and Processes: Elective Compul mpulsory lsory ms: Compulsory nce: Compulsory nce: Elective Compulsory obility: Specialisation Traffic Planning	ompulsory ive Compulsory lsory and Systems: Ele	
	Green Technologies: Energy, Water, Climate: Specialisa Green Technologies: Energy, Water, Climate: Specialisa Computer Science in Engineering: Specialisation II. Mat Logistics and Mobility: Specialisation Traffic Planning ar Logistics and Mobility: Specialisation Production Manag Mechanical Engineering: Core Qualification: Elective Co Mechatronics: Specialisation Naval Engineering: Compu Mechatronics: Specialisation Robot- and Machine-Syste Mechatronics: Specialisation Electrical Systems: Electiv Technomathematics: Specialisation III. Engineering Scie Engineering and Management - Major in Logistics and M	tion Energy Technology: Elective Com tion Maritime Technologies: Elective C mematics & Engineering Science: Elect d Systems: Elective Compulsory ement and Processes: Elective Compul mpulsory lsory ms: Compulsory nce: Elective Compulsory obility: Specialisation Traffic Planning obility: Specialisation Information Tec	ompulsory ive Compulsory lsory and Systems: Ele hnology: Elective	Compulsory
	Green Technologies: Energy, Water, Climate: Specialisa Green Technologies: Energy, Water, Climate: Specialisa Computer Science in Engineering: Specialisation II. Mat Logistics and Mobility: Specialisation Traffic Planning ar Logistics and Mobility: Specialisation Production Manag Mechanical Engineering: Core Qualification: Elective Co Mechatronics: Specialisation Naval Engineering: Compu Mechatronics: Specialisation Robot- and Machine-Syste Mechatronics: Specialisation Electrical Systems: Electiv Technomathematics: Specialisation III. Engineering Scie Engineering and Management - Major in Logistics and M Engineering and Management - Major in Logistics and M	tion Energy Technology: Elective Com tion Maritime Technologies: Elective C mematics & Engineering Science: Elect d Systems: Elective Compulsory ement and Processes: Elective Compul mpulsory lsory ms: Compulsory nce: Elective Compulsory obility: Specialisation Traffic Planning obility: Specialisation Information Tec	ompulsory ive Compulsory lsory and Systems: Ele hnology: Elective	Compulsory
	Green Technologies: Energy, Water, Climate: Specialisa Green Technologies: Energy, Water, Climate: Specialisa Computer Science in Engineering: Specialisation II. Mat Logistics and Mobility: Specialisation Traffic Planning ar Logistics and Mobility: Specialisation Production Manag Mechanical Engineering: Core Qualification: Elective Co Mechatronics: Specialisation Naval Engineering: Compu Mechatronics: Specialisation Robot- and Machine-Syste Mechatronics: Specialisation Electrical Systems: Electiv Technomathematics: Specialisation III. Engineering Scie Engineering and Management - Major in Logistics and M	tion Energy Technology: Elective Com tion Maritime Technologies: Elective C mematics & Engineering Science: Elect d Systems: Elective Compulsory ement and Processes: Elective Compul mpulsory lsory ms: Compulsory nce: Elective Compulsory obility: Specialisation Traffic Planning obility: Specialisation Information Tec l Mobility: Specialisation Production M	and Systems: Ele hnology: Elective Aanagement and	Compulsory Processes: Elect

Course L0293: Electrical Mac	hines and Actuators
Тур	Lecture
Hrs/wk	3
СР	4
Workload in Hours	Independent Study Time 78, Study Time in Lecture 42
Lecturer	Prof. Thorsten Kern, Dennis Kähler
Language	DE
Cycle	SoSe
Content	Electric field: Coulomb's law, flux (field) line, work, potential, capacitor, energy, force, capacitive actuators
	Magnetic field: force, flux line, Ampere's law, field at bounderies, flux, magnetic circuit, hysteresis, induction, self-induction, mutual inductance, transformer, electromagnetic actuators
	Synchronous machines, construction and layout, equivalent single line diagrams, no-load and short-cuircuit characteristics, vector diagrams, motor and generator operation, stepper motors
	DC-Machines: Construction and layout, torque generation mechanismen, torque vs speed characteristics, commutation,
	Asynchronous Machines. Magnetic field, construction and layout, equivalent single line diagram, complex stator current diagram (Heylands ´diagram), torque vs. speed characteristics, rotor layout (squirrel-cage vs. sliprings),
	Drives with variable speed, inverter fed operation, special drives
Literature	Hermann Linse, Roland Fischer: "Elektrotechnik für Maschinenbauer", Vieweg-Verlag; Signatur der Bibliothek der TUHH: ETB 313
	Ralf Kories, Heinz Schmitt-Walter: "Taschenbuch der Elektrotechnik"; Verlag Harri Deutsch; Signatur der Bibliothek der TUHH: ETB 122
	"Grundlagen der Elektrotechnik" - anderer Autoren
	Fachbücher "Elektrische Maschinen"

Course L0294: Electrical Mac	Course L0294: Electrical Machines and Actuators	
Тур	Recitation Section (large)	
Hrs/wk	2	
CP	2	
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28	
Lecturer	Prof. Thorsten Kern, Dennis Kähler	
Language	DE	
Cycle	SoSe	
Content	See interlocking course	
Literature	See interlocking course	

Courses				
Title		Тур	Hrs/wk	СР
Modeling, Simulation and Optimiza	tion (EN) (L2446)	Integrated Lecture	4	6
Module Responsible	Prof. Benedikt Kriegesmann			
Admission Requirements	None			
Recommended Previous	Sound knowledge of engineering mathematics	, engineering mechanics and fluid mechanics	5	
Knowledge				
Educational Objectives	After taking part successfully, students have r	eached the following learning results		
Professional Competence				
Knowledge	Students will have an overview of various tee	hnical problems and the differential equation	ons, which describe	them. Students w
	gave an overview of different solution approac	hes and for which kind of problems they can	be used for.	
Skille	Students are able to solve different technical p	roblems with the introduced discretization r	aothods	
JAIIIS	Students are able to solve unrerent technical p	in oblems with the introduced discretization in	lethous.	
Personal Competence				
Social Competence	The students are able to discuss problems and	jointly develop solution strategies.		
Autonomy	The students are able to develop solution strat	agies for complex problems calf consistent -	and critically analyse	roculto
Autonomy	The students are able to develop solution strat	egies for complex problems self-consistent a	and critically analyse	e results.
Workload in Hours	Independent Study Time 124, Study Time in Le	ecture 56		
Credit points	6			
Course achievement	None			
Examination	Oral exam			
Examination duration and	30 min			
scale				
Assignment for the	General Engineering Science (German program	n, 7 semester): Specialisation Mechanical En	igineering, Focus Th	eoretical Mechanic
Following Curricula	Engineering: Compulsory			
	General Engineering Science (German program	n, 7 semester): Specialisation Advanced Mate	erials: Compulsory	
	General Engineering Science (German progr	am, 7 semester): Specialisation Mechanica	al Engineering, Foc	us Aircraft System
	Engineering: Elective Compulsory			
	General Engineering Science (German program	n, 7 semester): Specialisation Mechanical Er	ngineering, Focus M	echatronics: Electiv
	Compulsory			
	Engineering Science: Core Qualification: Comp			
	Engineering Science: Specialisation Advanced Engineering Science: Specialisation Mechanica			
	Engineering Science: Specialisation Mechatron			
	Engineering Science: Specialisation Mechanon			
	Mechanical Engineering: Specialisation Theore			
	Mechanical Engineering: Specialisation Mecha			
	Mechanical Engineering: Specialisation Aircraf			
	Mechanical Engineering: Specialisation Aircraf			
	Technomathematics: Specialisation III. Engine	ering Science: Elective Compulsory		

Course L2446: Modeling, Simulation and Optimization (EN)		
Тур	Integrated Lecture	
Hrs/wk	4	
CP	6	
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56	
Lecturer	Prof. Benedikt Kriegesmann, Prof. Alexander Düster, Prof. Robert Seifried, Prof. Thomas Rung	
Language	EN	
Cycle	SoSe	
Content	 Partial Differential Equations in technical problems Overview of modelling approaches Finite Approximation Methods - Finite Differences / Elements / Volumes Introduction to the Discrete Element Method Numerical methods for time dependent problems Gradient-based optimization 	
Literature	Michael Schäfer, Computational Engineering - Introduction to Numerical Methods, Springer.	

Courses				
Title		Тур	Hrs/wk	СР
Machine Learning I (L2432)		Lecture	2	3
Machine Learning I (L2433)		Recitation Section (small)	3	3
Module Responsible	Prof. Nihat Ay			
Admission Requirements	None			
Recommended Previous	Linear Algebra, Analysis, Basic Programming C	Course		
Knowledge				
Educational Objectives	After taking part successfully, students have r	eached the following learning results		
Professional Competence				
Knowledge	The students know			
	general principles of machine learn	ing learning: supervised/unsupervised learni	na apperative/d	lescriptive learni
	parametric/non-parametric learning		ng, generative/o	lescriptive learnin
		orks, support vector machines, clustering, dime	ensionality reduct	ion kernel metho
	 fundamentals of statistical learning the 		indicitiently reduce	
		r learning, reinforcement learning, generative	adversarial net	works and adapt
	control			
Skills	The students can			
	 apply machine learning methods to con 	crete problems		
	 select and evaluate suitable methods for 			
	 evaluate the quality of a trained data-data-data-data-data-data-data-dat			
	 work with known software frameworks 			
	 adapt the architecture and cost function 	n of neural networks to specific problems		
	 show the limits of machine learning me 	thods		
Personal Competence		in demonstration and in the same Theory and the same		
Social Competence		independently and in teams. They can exchang	le ideas with each	i other and use th
	individual strengths to solve the problem.			
Autonomy	Students are able to independently investigate	e a complex problem and assess which compete	encies are require	d to solve it.
Workload in Hours	Independent Study Time 110, Study Time in L	ecture 70		
Credit points	6			
Course achievement	Compulsory Bonus Form No 20 % Excercises	Description		
For a start start				
Examination				
Examination duration and	90 min			
scale		- 7		
		n, 7 semester): Specialisation Mechanical Engir	ieering, Focus Th	eoretical Mechani
Following Curricula	Engineering: Elective Compulsory	n, 7 semester): Specialisation Data Science: Co	mpulcony	
		and Software Engineering: Elective Compulsory		
	Data Science: Core Qualification: Computer	and Software Engineering. Elective compulsory		
	Engineering Science: Specialisation Advanced	Materials: Elective Compulsory		
	Engineering Science: Specialisation Mechatror			
	Engineering Science: Specialisation Data Scien			
	Engineering Science: Specialisation Mechanica			
	Computer Science in Engineering: Specialisati	5 5 1 5		
	Logistics and Mobility: Specialisation Informati			
	5 , 1	tical Mechanical Engineering: Elective Compuls	ory	
	Mechatronics: Specialisation Dynamic System			
	Technomathematics: Specialisation II. Informa	tics: Elective Compulsory		
	Engineering and Management - Major in Logist			

Тур	Lecture
Hrs/wk	
CP	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Prof. Nihat Ay
Language	DE/EN
Cycle	SoSe
Content	 History of neuroscience and machine learning (in particular, the age of deep learning) McCulloch-Pitts neurons and binary Artificial Neural Networks Boolean and threshold functions Universality of McCulloch-Pitts neural networks Learning and the perceptron convergence theorem Support vector machines Harmonic analysis of Boolean functions Continuous Artificial Neural Networks Kolmogorov's superposition theorem Universal approximation with continuous neural networks Approximation error and the gradient decent method: the general idea The stochastic gradient decent method (Robbins-Monro and Kiefer-Wolfowitz cases) Multilayer networks and the backpropagation algorithm Statistical Learning Theory
Literature	 Martin Anthony and Peter L. Bartlett. Neural Network Learning: Theoretical Foundations. Cambridge University Press, 1995 Martin Anthony. Discrete Mathematics of Neural Networks: Selected Topics. SIAM Monographs on Discrete Mathematics Applications, 1987. Mehryar Mohri, Afshin Rostamizadeh and Ameet Talwalkar. Foundations of Machine Learning, Second Edition. MIT Pres 2018. Christopher M. Bishop. Pattern Recognition and Machine Learning. Information Science and Statistics. Springer-Verlag, 200 Bernhard Schölkopf, Alexander Smola. Learning with Kernels: Support Vector Machines, Regularization, Optimization, a Beyond. Adaptive Computation and Machine Learning series. MIT Press, Cambridge, MA, 2002. Luc Devroye, László Györfi, Gábor Lugosi. A Probabilistic Theory of Pattern Recognition. Springer, 1996. Vladimir Vapnik. The Nature of Statistical Learning Theory. Springer-Verlag: New York, Berlin, Heidelberg, 1995.

Course L2433: Machine Lear	Course L2433: Machine Learning I	
Тур	Recitation Section (small)	
Hrs/wk	3	
CP	3	
Workload in Hours	Independent Study Time 48, Study Time in Lecture 42	
Lecturer	Prof. Nihat Ay	
Language	DE/EN	
Cycle	SoSe	
Content	See interlocking course	
Literature	See interlocking course	

Module M0854: Mathe	ematics IV			
Courses				
		_		
Title		Тур	Hrs/wk	CP
Differential Equations 2 (Partial Diff	erential Equations) (L1043)	Lecture	2	1
Differential Equations 2 (Partial Diff	erential Equations) (L1044)	Recitation Section (small)	1	1
Differential Equations 2 (Partial Diff	erential Equations) (L1045)	Recitation Section (large)	1	1
Complex Functions (L1038)		Lecture	2	1
Complex Functions (L1041)		Recitation Section (small)	1	1
Complex Functions (L1042)		Recitation Section (large)	1	1
		Neclation Section (large)	1	1
Module Responsible				
•	None			
Recommended Previous Knowledge	Mathematics I - III			
Educational Objectives	After taking part successfully, students have reached t	he following learning results		
Professional Competence				
Knowledge	 Students can name the basic concepts in Mathe 	matics IV. They are able to explain the	m using appropri	ate examples.
	 Students can discuss logical connections between the second second			
	5	en mese concepts. They are capable	or muscialing th	ese connections w
	the help of examples.			
	 They know proof strategies and can reproduce t 	hem.		
Skills	• Chudente con model problems in Mathematics	N/ with the belo of the concents studi	ad in this source	Maraayar thay a
	 Students can model problems in Mathematics 			. Moreover, they a
	capable of solving them by applying established	methods.		
	 Students are able to discover and verify further 	logical connections between the conce	pts studied in the	e course.
	• For a given problem, the students can develo	and execute a suitable approach, a	nd are able to c	ritically evaluate t
		o and execute a banable approach, a		including evaluate t
	results.			
Personal Competence				
Social Competence	 Students are able to work together in teams. Th 	ov are capable to use mathematics as	a common langu	200
	 In doing so, they can communicate new conception 	ts according to the needs of their coop	erating partners	. Moreover, they c
	design examples to check and deepen the unde	rstanding of their peers.		
Autonomy	• Students are capable of checking their underst	anding of complex concents on their e	wn Thou con cr	ocify open questio
	 Students are capable of checking their underst 		wn. They can sp	ecity open questio
	precisely and know where to get help in solving	them.		
	 Students have developed sufficient persistence 	e to be able to work for longer period	s in a goal-orien	ted manner on ha
	problems.			
	prosterior			
Workload in Hours	Independent Study Time 68, Study Time in Lecture 11:)		
Credit points		-		
Course achievement				
Examination				
	60 min (Complex Functions) + 60 min (Differential Equ	ations 2)		
	to finin (complex Functions) + to finin (Differential Equ			
scale				
Assignment for the	General Engineering Science (German program, 7 sem	ester): Specialisation Electrical Enginee	ering: Compulsor	у
Following Curricula				-
			gg,	
	Compulsory			
	General Engineering Science (German program, 7 sem	ester): Specialisation Naval Architectur	e: Compulsory	
	General Engineering Science (German program, 7 sem	ester): Specialisation Mechanical Engir	neering, Focus Th	neoretical Mechani
	Engineering: Elective Compulsory	-		
	Electrical Engineering: Core Qualification: Compulsory			
	General Engineering Science (English program, 7 seme	ester): Specialisation Electrical Engineer	ring: Compulsory	
	Computer Science in Engineering: Specialisation II. Ma	thematics & Engineering Science: Elect	ive Compulsorv	
	Mechanical Engineering: Specialisation Mechatronics: (1	
	Mechanical Engineering: Specialisation Theoretical Me	chanical Engineering: Elective Compuls	ory	
	Mechatronics: Core Qualification: Compulsory			
	Naval Architecture: Core Qualification: Compulsory			
	Theoretical Mechanical Engineering: Technical Comple	montary Course Core Studies Flacture	Compulsor	
		mentary course core studies: Elective		

Course L1043: Differential Ec	quations 2 (Partial Differential Equations)	
Тур	Lecture	
Hrs/wk	2	
CP		
Workload in Hours	Independent Study Time 2, Study Time in Lecture 28	
Lecturer	Dozenten des Fachbereiches Mathematik der UHH	
Language	DE	
Cycle	SoSe	
Content	Main features of the theory and numerical treatment of partial differential equations	
Literature	 Examples of partial differential equations First order quasilinear differential equations Normal forms of second order differential equations Harmonic functions and maximum principle Maximum principle for the heat equation Wave equation Liouville's formula Special functions Difference methods Finite elements http://www.math.uni-hamburg.de/teaching/export/tuhh/index.html 	

Course L1044: Differential Equations 2 (Partial Differential Equations)	
Тур	Recitation Section (small)
Hrs/wk	1
CP	1
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14
Lecturer	Dozenten des Fachbereiches Mathematik der UHH
Language	DE
Cycle	SoSe
Content	See interlocking course
Literature	See interlocking course

Course L1045: Differential Equations 2 (Partial Differential Equations)	
Тур	Recitation Section (large)
Hrs/wk	1
СР	1
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14
Lecturer	Dozenten des Fachbereiches Mathematik der UHH
Language	DE
Cycle	SoSe
Content	See interlocking course
Literature	See interlocking course

Course L1038: Complex Functions		
Тур	Lecture	
Hrs/wk	2	
CP	1	
Workload in Hours	Independent Study Time 2, Study Time in Lecture 28	
Lecturer	Dozenten des Fachbereiches Mathematik der UHH	
Language	DE	
Cycle	SoSe	
Content	Main features of complex analysis	
Literature	 Functions of one complex variable Complex differentiation Conformal mappings Complex integration Cauchy's integral theorem Cauchy's integral formula Taylor and Laurent series expansion Singularities and residuals Integral transformations: Fourier and Laplace transformation 	
Literature	http://www.math.uni-hamburg.de/teaching/export/tuhh/index.html	

Course L1041: Complex Functions	
Тур	Recitation Section (small)
Hrs/wk	1
CP	1
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14
Lecturer	Dozenten des Fachbereiches Mathematik der UHH
Language	DE
Cycle	SoSe
Content	See interlocking course
Literature	See interlocking course

Course L1042: Complex Functions	
Тур	Recitation Section (large)
Hrs/wk	1
CP	1
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14
Lecturer	Dozenten des Fachbereiches Mathematik der UHH
Language	DE
Cycle	SoSe
Content	See interlocking course
Literature	See interlocking course

Courses					
Title			Тур	Hrs/wk	СР
	ogramming Concepts, Data Handling & Communication (Lecture	3	3
	ogramming Concepts, Data Handling & Communication (Recitation Section (small)	2	3
Module Responsible					
-	None				
Recommended Previous					
Knowledge					
Educational Objectives	After taking part successfully, students have reached	d the followin	g learning results		
Professional Competence			,		
Knowledge					
Skills					
Personal Competence					
Social Competence					
Autonomy					
Workload in Hours	ndependent Study Time 110, Study Time in Lecture	2 70			
Credit points	5				
course acmevement		Description			
		Testate finden	semesterbegleitend statt.		
Examination					
Examination duration and	120 min				
scale					
-	General Engineering Science (German program,	7 semester)	Specialisation Mechanica	l Engineering, F	ocus Biomechan
Following Curricula					
	General Engineering Science (German program, 7 se				
	General Engineering Science (German program, 7 se	emester): Spe	cialisation Green Technolog	ies, Focus Renew	able Energy: Elect
	Compulsory		- · · · · · · · · ·		
	General Engineering Science (German program, 7	/ semester):	Specialisation Mechanical	Engineering, Foc	us Energy Syster
	Compulsory	7 comostor);	Enocialization Machanical	Engineering For	us Aircraft Sucto
	General Engineering Science (German program, 7 Engineering: Compulsory	/ semester):	specialisation mechanical	Engineering, Foc	us Aircrait Syste
	General Engineering Science (German program,	7 comostor)	Specialisation Mechanics	A Engineering	ocus Mechatron
	Compulsory	/ Seriester/		in Engineering, i	ocus mechanon
	General Engineering Science (German program, 7 s	semester): Sp	ecialisation Mechanical Eng	ineering. Focus P	roduct Developm
	and Production: Elective Compulsory				
	General Engineering Science (German program, 7 se	emester): Spe	cialisation Mechanical Engi	neering, Focus Th	eoretical Mechan
	Engineering: Elective Compulsory	,	J	3,	
	General Engineering Science (German program, 7 se	emester): Spe	cialisation Electrical Engine	ering: Elective Co	mpulsory
E	Bioprocess Engineering: Core Qualification: Compuls	sory			
	Chemical and Bioprocess Engineering: Core Qualifica	ation: Compul	sory		
E	Electrical Engineering: Core Qualification: Compulso	ry			
(Green Technologies: Energy, Water, Climate: Specia	lisation Energ	y Systems / Renewable Ene	rgies: Elective Co	mpulsory
1	ogistics and Mobility: Specialisation Information Tec	chnology: Con	npulsory		
1	Mechatronics: Specialisation Robot- and Machine-System	stems: Compu	ilsory		
1	Mechatronics: Specialisation Medical Engineering: Co	ompulsory			
1	Mechatronics: Specialisation Dynamic Systems and A	AI: Compulsor	у		
	Mechatronics: Specialisation Electrical Systems: Elec	ctive Compuls	ory		
'					

Course L2689: Computer Science for Engineers - Programming Concepts, Data Handling & Communication		
Тур	Lecture	
Hrs/wk	3	
СР	3	
Workload in Hours	Independent Study Time 48, Study Time in Lecture 42	
Lecturer	Prof. Sibylle Fröschle	
Language	DE	
Cycle	SoSe	
Content		
Literature	John V. Guttag: Introduction to Computation and Programming Using Python.	
	With Application to Understanding Data. 2nd Edition. The MIT Press, 2016.	

Course L2690: Computer Science for Engineers - Programming Concepts, Data Handling & Communication		
Тур	Recitation Section (small)	
Hrs/wk	2	
CP	3	
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28	
Lecturer	Prof. Sibylle Fröschle	
Language	DE	
Cycle	SoSe	
Content	See interlocking course	
Literature	See interlocking course	

Module M0725: Produ	uction Engineering			
Courses				
Title		Тур	Hrs/wk	СР
Production Engineering I (L0608)		Lecture	2	2
Production Engineering I (L0612)		Recitation Section (large)	1	1
Production Engineering II (L0610)		Lecture	2	2
Production Engineering II (L0611)		Recitation Section (large)	1	1
Module Responsible	Prof. Jan Hendrik Dege			
Admission Requirements	None			
Recommended Previous	no course assessments required			
Knowledge	internship recommended			
Educational Objectives	After taking part successfully, students have reached th	e following learning results		
Professional Competence				
Knowledge	Students are able to			
	 name basic criteria for the selection of manufact 	uring processos		
	 name basic criteria for the selection of manufact name the main groups of Manufacturing Technol 			
	 name the application areas of different manufact 			
	 name the application areas of american manufact name boundaries, advantages and disadvantage 		55	
	 describe elements, geometric properties and king 			and process.
	 explain the essential models of manufacturing te 		toolo, noncpiece	
Skills	Students are able to			
	 select manufacturing processes in accordance w 	th the requirements.		
	 design manufacturing processes for simple tasks 		component to b	e produced.
	 assess components in terms of their production-or 	priented construction.		
Personal Competence				
Social Competence	Students are able to			
	 develop solutions in a production environment w 	ith qualified personnel at technical leve	el and represent	decisions.
			·	
Autonomy	Students are able to			
	 interpret independently the manufacturing proce 			
	 assess own strengths and weaknesses in general 			
	assess their learning progress and define gaps t	o be improved.		
	assess possible consequences of their actions.			
,				
Workload in Hours	Independent Study Time 96, Study Time in Lecture 84			
Credit points	6			
Course achievement	None			
Examination	Written exam			
Examination duration and	120 min			
scale				
Assignment for the	General Engineering Science (German program, 7 seme	ester): Specialisation Mechanical Engin	eering, Focus Th	eoretical Mechanical
Following Curricula	Engineering: Elective Compulsory			
_	General Engineering Science (German program, 7 sem	ester): Specialisation Mechanical Engi	neering, Focus P	roduct Development
	and Production: Compulsory			
	Digital Mechanical Engineering: Core Qualification: Com	pulsory		
	Engineering Science: Specialisation Mechanical Enginee	ring: Compulsory		
	Engineering Science: Specialisation Mechanical Engineer	ring: Compulsory		
	General Engineering Science (English program, 7 seme	ster): Specialisation Mechanical Engine	ering: Compulso	ry
	Green Technologies: Energy, Water, Climate: Specialisa	tion Energy Technology: Elective Com	oulsory	
	Logistics and Mobility: Specialisation Production Manage	ement and Processes: Compulsory		
	Mechanical Engineering: Core Qualification: Compulsory	/		
	Mechatronics: Specialisation Naval Engineering: Compu	lsory		
	Mechatronics: Core Qualification: Compulsory			
	Mechatronics: Specialisation Medical Engineering: Elect	ive Compulsory		
	Mechatronics: Specialisation Robot- and Machine-System			
	Engineering and Management - Major in Logistics and M			
	Engineering and Management - Major in Logistics and M	Iobility: Specialisation Production Mana	agement and Pro	cesses: Compulsory

Course L0608: Production Er	igineering I
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	SoSe
Content	 Manufacturing Accuracy Manufacturing Metrology Measurement Errors and Uncertainties Introduction to Forming Massiv forming and Sheet Metal Forming Introduction to Machining Technology Geometrically defined machining (Turning, milling, drilling, broaching, planning)
Literature	Dubbel, Heinrich (Grote, Karl-Heinrich.; Feldhusen, Jörg.; Dietz, Peter,; Ziegmann, Gerhard,;) Taschenbuch für den Maschinenbau : mit Tabellen. Berlin [u.a.] : Springer, 2007 Fritz, Alfred Herbert: Fertigungstechnik : mit 62 Tabellen. Berlin [u.a.] : Springer, 2004 Keferstein, Claus P (Dutschke, Wolfgang,;): Fertigungsmesstechnik : praxisorientierte Grundlagen, moderne Messverfahren. Wiesbaden : Teubner, 2008 Mohr, Richard: Statistik für Ingenieure und Naturwissenschaftler : Grundlagen und Anwendung statistischer Verfahren. Renningen : expert-Verl, 2008 Klocke, F., König, W.: Fertigungsverfahren Bd. 1 Drehen, Fäsen, Bohren. 8. Aufl., Springer (2008) Klocke, Fritz (König, Wilfried,;): Umformen. Berlin [u.a.] : Springer, 2006 Paucksch, E.: Zerspantechnik, Vieweg-Verlag, 1996 Tönshoff, H.K.; Denkena, B., Spanen. Grundlagen, Springer-Verlag (2004)

Course L0612: Production En	ourse L0612: Production Engineering I		
Тур	Recitation Section (large)		
Hrs/wk	1		
CP	1		
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14		
Lecturer	Prof. Jan Hendrik Dege		
Language	DE		
Cycle	SoSe		
Content	See interlocking course		
Literature	See interlocking course		

Course L0610: Production En	igineering II
Тур	Lecture
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Prof. Jan Hendrik Dege, Prof. Claus Emmelmann
Language	DE
Cycle	SoSe
Content	 Geometrically undefined machining (grinding, lapping, honing) Introduction into erosion technology Introduction into blastig processes Introduction to the manufacturing process forming (Casting, Powder Metallurgy, Composites) Fundamentals of Laser Technology Process versions and Fundamentals of Laser Joining Technology
Literature	Klocke, F., König, W.: Fertigungsverfahren Bd. 2 Schleifen, Honen, Läppen, 4. Aufl., Springer (2005) Klocke, F., König, W.: Fertigungsverfahren Bd. 3 Abtragen, Generieren und Lasermaterialbearbeitung. 4. Aufl., Springer (2007) Spur, Günter (Stöferle, Theodor.;): Urformen. München [u.a.] : Hanser, 1981 Schatt, Werner (Wieters, Klaus-Peter,; Kieback, Bernd,;): Pulvermetallurgie : Technologien und Werkstoffe. Berlin [u.a.] : Springer, 2007

Course L0611: Production En	ourse L0611: Production Engineering II		
Тур	Recitation Section (large)		
Hrs/wk	1		
CP	1		
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14		
Lecturer	Prof. Jan Hendrik Dege, Prof. Claus Emmelmann		
Language	DE		
Cycle	SoSe		
Content	See interlocking course		
Literature	See interlocking course		

Specialization Biomedical Engineering

The requirements into the health system increase continuously due to the aging population and the increasing expectations for the quality in life. A major aspect in this development is medical technology. This ranges from individual implants and prostheses to complex imaging and therapy equipment and its operation. Medical specialists and well educated engineers will have to cooperate closer and closer to understand the requirements from either side and develop solutions together. In order to cooperate, the engineers need in addition to their core engineering skills, a basic understanding of the "other" fields, which are Medicine and Economy. This enables them to understand operational planning as well as research and development in this highly interdisciplinary area. The program is aimed towards allowing the students to achieve these qualifications.

Courses					
Title	<u> </u>	Тур	Hrs/wk	СР	
Fundamentals of Materials Science	e I (L1085)	Lecture	2	2	
	e II (Advanced Ceramic Materials, Polymers and Composites) (L0506)	Lecture	2	2	
Physical and Chemical Basics of M		Lecture	2	2	
Module Responsible	Prof. Jörg Weißmüller				
Admission Requirements					
Recommended Previous	Highschool-level physics, chemistry und mathematics				
Knowledge					
Educational Objectives	After taking part successfully, students have reached the follow	ving learning results			
Professional Competence					
Knowledge	The students have acquired a fundamental knowledge on r	metals, ceramics and	polymers and can desc	ribe this knowled	
-	comprehensively. Fundamental knowledge here means specific	cally the issues of atom	nic structure, microstructu	ure, phase diagran	
	phase transformations, corrosion and mechanical properties. T				
	for materials and can identify relevant approaches for cha				
	phenomena back to the underlying physical and chemical laws				
Skills	The students are able to trace materials phenomena back t	to the underlying phy	sical and chemical laws	of nature. Materi	
	phenomena here refers to mechanical properties such as strength, ductility, and stiffness, chemical properties such as corrosio				
	resistance, and to phase transformations such as solidification	on, precipitation, or m	elting. The students can	explain the relat	
	between processing conditions and the materials microstructure, and they can account for the impact of microstructure on the				
	material's behavior.				
Personal Competence					
Social Competence					
Autonomy					
Workload in Hours	Independent Study Time 96, Study Time in Lecture 84				
Credit points	6				
Course achievement	None				
	Written exam				
Examination duration and scale					
	General Engineering Science (German program, 7 semester): S	necialisation Mechanic	al Engineering: Compulse		
	General Engineering Science (German program, 7 semester): S				
	General Engineering Science (German program, 7 semester): S			,	
	General Engineering Science (German program, 7 semester): S				
	Data Science: Specialisation II. Application: Elective Compulsor				
	Digital Mechanical Engineering: Core Qualification: Compulsory				
	Green Technologies: Energy, Water, Climate: Specialisation Ene		ive Compulsory		
	Logistics and Mobility: Specialisation Engineering Science: Elect				
	Logistics and Mobility: Specialisation Engineering Science. Lec		Compulsory		
	Mechanical Engineering: Core Qualification: Compulsory	Ind Frocesses. LIEULIVE	. compulsory		
	meenanical Engineering, core qualification, compuisory				
	Mechatronics: Core Qualification: Compulsory				
	Mechatronics: Core Qualification: Compulsory				
	Naval Architecture: Core Qualification: Compulsory	ective Compulsory			
		, ,	luction Management and	Processes. Elect	

Course L1085: Fundamentals	s of Materials Science I
Тур	Lecture
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Prof. Jörg Weißmüller
Language	DE
Cycle	WiSe
Content	
Literature	Vorlesungsskript
	W.D. Callister: Materials Science and Engineering - An Introduction. 5th ed., John Wiley & Sons, Inc., New York, 2000, ISBN 0-471- 32013-7 P. Haasen: Physikalische Metallkunde. Springer 1994

Course L0506: Fundamentals of Materials Science II (Advanced Ceramic Materials, Polymers and Composites)			
Тур	Lecture		
Hrs/wk	2		
СР	2		
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28		
Lecturer	Prof. Bodo Fiedler, Prof. Gerold Schneider		
Language	DE		
Cycle	SoSe		
Content	Chemische Bindungen und Aufbau von Festkörpern; Kristallaufbau; Werkstoffprüfung; Schweißbarkeit; Herstellung von Keramiken;		
	Aufbau und Eigenschaften der Keramik; Herstellung, Aufbau und Eigenschaften von Gläsern; Polymerwerkstoffe,		
	Makromolekularer Aufbau; Struktur und Eigenschaften der Polymere; Polymerverarbeitung; Verbundwerkstoffe		
Literature	Vorlesungsskript		
	W.D. Callister: Materials Science and Engineering -An Introduction-5th ed., John Wiley & Sons, Inc., New York, 2000, ISBN 0-471- 32013-7		

Course L1095: Physical and (Chemical Basics of Materials Science		
Тур	Lecture		
Hrs/wk	2		
CP	2		
Workload in Hours	lependent Study Time 32, Study Time in Lecture 28		
Lecturer	Gregor Vonbun-Feldbauer		
Language	DE		
Cycle	WiSe		
Content	 Motivation: "Atoms in Mechanical Engineering?" Basics: Force and Energy The electromagnetic Interaction "Detour": Mathematics (complex e-funktion etc.) The atom: Bohr's model of the atom Chemical bounds The multi part problem: Solutions and strategies Descriptions of using statistical thermodynamics Elastic theory of atoms Consequences of atomar properties on makroskopic Properties: Discussion of examples (metals, semiconductors, hybrid systems) 		
Literature	 Für den Elektromagnetismus: Bergmann-Schäfer: "Lehrbuch der Experimentalphysik", Band 2: "Elektromagnetismus", de Gruyter Für die Atomphysik: Haken, Wolf: "Atom- und Quantenphysik", Springer Für die Materialphysik und Elastizität: Hornbogen, Warlimont: "Metallkunde", Springer 		

Courses						
Title				Тур	Hrs/wk	СР
Embodiment Design and 3D-CAD Ir	troduction and Practica	Il Training (L0268)		Lecture	2	1
Mechanical Design Project I (L0695		5		Project-/problem-based Learning	3	2
Mechanical Design Project II (L0592)				Project-/problem-based Learning	3	2
Feam Project Design Methodology	(L0267)			Project-/problem-based Learning	2	1
Module Responsible	Prof. Dieter Krause					
Admission Requirements	None					
Recommended Previous						
Knowledge		of Mechanical Engineering	g Design			
	 Mechanics 					
		of Materials Science				
	 Production En 	gineering				
Educational Objectives	After taking part suc	cessfully, students have re	eached the followin	a learning results		
Professional Competence	· · · · · · · · · · · · · · · · · · ·	,,,		5		
-	After passing the mo	dule, students are able to:	:			
5						
		- ,	parts e.g. consider	ring load situation, materials an	d manufactur	ring requirements
	 describe basic 					
	 explain basics 	methods of engineering d	lesigning.			
Skills	After passing the mo	dule, students are able to:	:			
				cumentations e.g. using 3D CAE),	
		nents based on design gui		usly,		
		Iculate) used components,				
			ering design tasks	systamtically and solution-orie	nted,	
	 apply creativit 	ty techniques in teams.				
Personal Competence						
Social Competence	After passing the mo	dule, students are able to:	:			
	-		s including making	and documenting decisions,		
		use of scientific methods,				
	 present and discuss solutions and technical drawings within groups, reflect the own results in the work groups of the course. 					
	 reflect the ow 	n results in the work group	os of the course.			
Autonomy	Students are able					
	• to estimate their level of knowledge using activating methods within the lectures (e.g. with clickers),					
	 To solve engin 	neering design tasks syster	matically.			
Workload in Hours	Independent Study T	ime 40, Study Time in Lec	ture 140			
Credit points	6					
Course achievement	Compulsory Bonus	Form	Description			
	Yes None	Written elaboration	Teamprojekt k	Konstruktionsmethodik		
	Yes None	Written elaboration	Konstruktions	projekt 1		
	Yes None	Written elaboration	Konstruktions			
	Yes None	Written elaboration	3D-CAD-Prakt	ikum		
Examination	Written exam					
Examination duration and	180					
scale						
Assignment for the	General Engineering	Science (German program	n, 7 semester): Spe	cialisation Mechanical Engineer	ring: Compuls	ory
Following Curricula	General Engineering	Science (German program	n, 7 semester): Spe	cialisation Biomedical Engineer	ing: Compuls	ory
	General Engineering	Science (German program	n, 7 semester): Spe	cialisation Biomedical Engineer	ing: Compuls	ory
	Digital Mechanical Er	ngineering: Core Qualificat	ion: Compulsory			
	Engineering Science	: Specialisation Mechatron	ics: Compulsory			
	Engineering Science	: Specialisation Mechanica	l Engineering: Com	ipulsory		
	Engineering Science	: Specialisation Biomedical	l Engineering: Com	pulsory		
	Green Technologies:	Energy, Water, Climate: S	pecialisation Energ	gy Technology: Elective Compul	sory	
	Mechanical Engineer	ing: Core Qualification: Co	mpulsory			
	Mechatronics: Core (Qualification: Compulsory				
	Naval Architocturo: (Core Qualification: Compul	500/			

Course L0268: Embodiment D	Design and 3D-CAD Introduction and Practical Training
Тур	Lecture
Hrs/wk	2
CP	1
Workload in Hours	Independent Study Time 2, Study Time in Lecture 28
Lecturer	Prof. Dieter Krause
Language	DE
Cycle	WiSe
Content	 Basics of 3D CAD technology Practical course to apply a 3D CAD system Introduction to the system Sketching and creation of components Creation of assemblies Deriving technical drawings
Literature	 CAx für Ingenieure eine praxisbezogene Einführung; Vajna, S., Weber, C., Bley, H., Zeman, K.; Springer-Verlag, aktuelle Auflage. Handbuch Konstruktion; Rieg, F., Steinhilper, R.; Hanser; aktuelle Auflage. Dubbel, Taschenbuch für den Maschinenbau; Grote, KH., Feldhusen, J.(Hrsg.); Springer-Verlag, aktuelle Auflage. Technisches Zeichnen: Grundlagen, Normen, Beispiele, Darstellende Geometrie, Hoischen, H; Hesser, W; Cornelsen, aktuelle Auflage. Maschinenelemente, Band I-III; Niemann, G., Springer-Verlag, aktuelle Auflage. Maschinenelemente, Band I-III; Niemann, G., Springer-Verlag, aktuelle Auflage. Konstruktionslehre, Pahl, G.; Beitz, W., Springer-Verlag, aktuelle Auflage. Konstruktionslehre, Pahl, G.; Beitz, W., Springer-Verlag, aktuelle Auflage. Maschinenelemente 1-2; Schlecht, B., Pearson Verlag, aktuelle Auflage. Maschinenelemente - Gestaltung, Berechnung, Anwendung; Haberhauer, H., Bodenstein, F., Springer-Verlag, aktuelle Auflage. Roloff/Matek Maschinenelemente; Wittel, H., Muhs, D., Jannasch, D., Voßiek, J., Springer Vieweg, aktuelle Auflage.

Course L0695: Mechanical De	esign Project I		
Тур	Project-/problem-based Learning		
Hrs/wk			
CP	2		
Workload in Hours	Independent Study Time 18, Study Time in Lecture 42		
Lecturer	Prof. Thorsten Schüppstuhl		
Language	DE		
Cycle	WiSe		
Content	 Create a technical documentation of an existing mechanical model Consolidation of the following aspects of technical drawings: Presentation of technical objects and standardized parts (bearings, seals, shaft-hub joints, detachable connections, springs, axes and shafts) Sectional views Dimensioning Tolerances and surface specifications Creating a tally sheet 		
Literature	 Hoischen, H.; Hesser, W.: Technisches Zeichnen. Grundlagen, Normen, Beispiele, darstellende Geometrie, 33. Auflage. Berlin 2011. Labisch, S.; Weber, C.: Technisches Zeichnen. Selbstständig lernen und effektiv üben, 4. Auflage. Wiesbaden 2008. Fischer, U.: Tabellenbuch Metall, 43. Auflage. Haan-Gruiten 2005. 		

Course L0592: Mechanical D	esign Project II
Тур	Project-/problem-based Learning
Hrs/wk	3
CP	2
Workload in Hours	Independent Study Time 18, Study Time in Lecture 42
Lecturer	Prof. Wolfgang Hintze
Language	DE
Cycle	SoSe
Content	 Generation of sketches for functions and sub-functions Approximately calculation of shafts Dimension of bearings, screw connections and weld Generation of engineering drawings (assembly drawings, manufacturing drawing)
Literature	 Dubbel, Taschenbuch für Maschinenbau, Beitz, W., Küttner, KH, Springer-Verlag. Maschinenelemente, Band I - III, Niemann, G., Springer-Verlag. Maschinen- und Konstruktionselemente, Steinhilper, W., Röper, R., Springer-Verlag. Einführung in die DIN-Normen, Klein, M., Teubner-Verlag. Konstruktionslehre, Pahl, G., Beitz, W., Springer-Verlag.

ourse L0267: Team Project	Design Methodology		
Тур	Project-/problem-based Learning		
Hrs/wk	2		
CP			
Workload in Hours	dependent Study Time 2, Study Time in Lecture 28		
Lecturer	Prof. Dieter Krause		
Language	DE		
Cycle	SoSe		
Content	 Introduction to engineering designing methodology Team Project Design Methodology Creating requirement lists Problem formulation Creating functional structures Finding solutions Evaluation of the found concepts Documentation of the taken methodological steps and the concepts using presentation slides 		
Literature	 Dubbel, Taschenbuch für den Maschinenbau; Grote, KH., Feldhusen, J.(Hrsg.); Springer-Verlag, aktuelle Auflage. Maschinenelemente, Band I-III; Niemann, G., Springer-Verlag, aktuelle Auflage. Maschinen- und Konstruktionselemente; Steinhilper, W., Röper, R., Springer Verlag, aktuelle Auflage. Einführung in die DIN-Normen; Klein, M., Teubner-Verlag. Konstruktionslehre, Pahl, G.; Beitz, W., Springer-Verlag, aktuelle Auflage. Maschinenelemente 1-2; Schlecht, B., Pearson Verlag, aktuelle Auflage. Maschinenelemente - Gestaltung, Berechnung, Anwendung; Haberhauer, H., Bodenstein, F., Springer-Verlag, aktuelle Auflage. Roloff/Matek Maschinenelemente; Wittel, H., Muhs, D., Jannasch, D., Voßiek, J., Springer Vieweg, aktuelle Auflage. Sowie weitere Bücher zu speziellen Themen 		

Module M0680: Fluid	Dynamics			
Courses				
Title		Тур	Hrs/wk	СР
Fluid Mechanics (L0454)		Lecture	3	4
Fluid Mechanics (L0455)		Recitation Section (large)	2	2
Module Responsible	Prof. Thomas Rung			
Admission Requirements	None			
Recommended Previous	Students should have sound knowledge of engineering math	nematics, engineering mechanics	and thermodyna	mics.
Knowledge				
Educational Objectives	After taking part successfully, students have reached the fo	llowing learning results		
Professional Competence				
Skills	Students will have the required sound knowledge to explain the general principles of fluid engineering and physics of fluids. The are familiar with the similarities and differences between fluid mechanics and neighbouring subjects (thermodynamics, structura mechanics). Students can scientifically outline the rationale of flow physics using mathematical models. They are familiar wit most performance analysis methods -in particular their realms and limitations- and the prediction of fluid engineering devices. Students are able to apply fluid-engineering principles and flow-physics models for the analysis of technical systems. They are able			
	to explain physical relationships used to design fluid engineering devices. The lecture enables the student to carry out a necessary theoretical calculations for the fluid dynamic design of engineering devices on a scientific level.			
Personal Competence				
Social Competence	The students are able to discuss problems, present the re- address given technical goals.	sults of their own analysis, and jo	ointly develop sol	ution strategies th
Autonomy	The students are able to develop solution strategies for con results as well as external data with regards to the plausibil		hey are able to c	ritically analyse ov
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	General Engineering Science (German program, 7 semester): Specialisation Mechanical Engin	eering: Compulso	ory
Following Curricula	General Engineering Science (German program, 7 semester): Specialisation Biomedical Engin	eering: Compulso	ory
	General Engineering Science (German program, 7 semester): Specialisation Naval Architectur	e: Compulsory	
	Mechanical Engineering: Core Qualification: Compulsory			
	Naval Architecture: Core Qualification: Compulsory			
	Technomathematics: Specialisation III. Engineering Science:			

Course L0454: Fluid Mechani	ics
Тур	Lecture
Hrs/wk	3
CP	4
Workload in Hours	Independent Study Time 78, Study Time in Lecture 42
Lecturer	Prof. Thomas Rung
Language	DE/EN
Cycle	SoSe
Content	 continuum physics definition of fluids, difference to solids/structures and material properties of fluids dimensional analysis and similitude fluid forces and fluid statics transport and conservation of mass, momentum & energy fluid kinematics technically relevant flow models for incompressible fluids control volume & stream tube analysis vortical flow models potential flows boundary layer flows different types of conservation equations and their realm (Navier-Stokes/Euler/Bernoulli equations) analytical solutions for Navier-Stokes systems Analysis of internal flows (channels, pipes, open channels) and external flows, fundamentals of wing aerodynamics turbulent flows fundamentals of gas dynamics (1D compressible flows)
Literature	 the course primarily refers to / das Modul stütz sich bevorzugt auf : Munson, B.R.; Rothmayer, A.P.; Okiishi, T.H.; Huebsch, W.W.: Fundamentals of Fluid Mechanics, John Wiley & Sons. Spurk, J.; Aksel, N.: Strömungslehre, Springer. Schade, H.; Kunz, E., Kameier, F.; Paschereit, C.O.: Strömungslehere, De Gruyter. Herwig, H.: Strömungsmechanik, Springer. Herwig, H.: Strömungsmechanik von A-Z, Vieweg.

Course L0455: Fluid Mechani	ourse L0455: Fluid Mechanics	
Тур	Recitation Section (large)	
Hrs/wk	2	
CP	2	
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28	
Lecturer	Prof. Thomas Rung	
Language	DE/EN	
Cycle	SoSe	
Content	See interlocking course	
Literature	See interlocking course	

Courses				
Title		Тур	Hrs/wk	СР
Computational Mechanics (Exercise	es) (L1138)	Recitation Section (small)	2	2
Computational Multibody Dynamics	s (L1137)	Integrated Lecture	2	2
Computational Stuctural Mechanics	s (L2475)	Integrated Lecture	2	2
Module Responsible	Prof. Robert Seifried			
Admission Requirements	None			
Recommended Previous	Mathematics I-III and Engineering Mechanics	1-111		
Knowledge				
Educational Objectives	After taking part successfully, students have	reached the following learning results		
Professional Competence				
Knowledge	The students can			
	- describe the suispectie presedure use	d in manhaning anyta-		
	describe the axiomatic procedure use			
	 explain important steps in model designed present technical knowledge. 	yıı,		
	• present technical knowledge.			
Skills	The students can			
	- evolution the improvement elements of me	themstical (mechanical enclusic and model for	mation and ann	
		thematical / mechanical analysis and model for	mation, and appi	y it to the context
	their own problems;apply basic methods from numerical n	echanics to angine sting pucklasses		
		the methods and extend them to be applicable t		aata
	 estimate the reach and boundaries of 	the methods and extend them to be applicable t	o wider problem	sets.
Personal Competence				
Social Competence	The students can work in groups and support	t each other to overcome difficulties.		
Autonomy	Students are capable of determining their ow	vn strengths and weaknesses and to organize the	eir time and learn	ing based on those
Workload in Hours	Independent Study Time 96, Study Time in L	ecture 84		
Credit points	6			
Course achievement	None			
	Written exam			
Examination duration and				
scale	120 mm			
Assignment for the	Conoral Engineering Science (Corman progra	am, 7 semester): Specialisation Mechanical Engir	ooring: Compuls	000
Following Curricula		am, 7 semester): Specialisation Biomedical Engin		
Following curricula		am, 7 semester): Specialisation Naval Architectu	÷ .	JI y
	Energy Systems: Technical Complementary (e. compuisory	
	Mechanical Engineering: Core Qualification: (
	Mechatronics: Core Qualification: Compulsor			
	Naval Architecture: Core Qualification: Compusor			
	Technomathematics: Specialisation III. Engin			
		al Complementary Course Core Studies: Elective	Compulsory	
		a complementary course core stadies. Elective	COMPRISOLY	

Course L1138: Computationa	I Mechanics (Exercises)	
Тур	Recitation Section (small)	
Hrs/wk	2	
CP	2	
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28	
Lecturer	rof. Robert Seifried, Prof. Christian Cyron	
Language	Æ	
Cycle	SoSe	
Content		
Literature	K. Magnus, H.H. Müller-Slany: Grundlagen der Technischen Mechanik. 7. Auflage, Teubner (2009).	
	D. Gross, W. Hauger, J. Schröder, W. Wall: Technische Mechanik 1-4. 11. Auflage, Springer (2011).	

Course L1137: Computationa	Il Multibody Dynamics
Тур	Integrated Lecture
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Prof. Robert Seifried
Language	DE
Cycle	SoSe
Content	 Linear versus nonlinear vibration Numerical methods for time integration Concepts from analytical mechanics Spatial multibody systems Linearization of multibody systems Vibrations with multiple degrees of freedom: free, damped, forced, modal transformation Impacts Introduction to Matlab
Literature	K. Magnus, H.H. Müller-Slany: Grundlagen der Technischen Mechanik. 7. Auflage, Teubner (2009). D. Gross, W. Hauger, J. Schröder, W. Wall: Technische Mechanik 1-4. 11. Auflage, Springer (2011). W. Schiehlen, P. Eberhard: Technische Dynamik, Springer (2012).

Course L2475: Computationa	Il Stuctural Mechanics
Тур	Integrated Lecture
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Prof. Christian Cyron
Language	DE
Cycle	SoSe
Content	The lecture Computational Structural Mechanics extends the content of the lecture Engineering Mechanic II. It bridges the gap
	between the manual calculation of mechanical stress and deformation in systems with a particularly simple geometry and the
	efficent computer-based computation of general mechanical systems:
	Basics of linear continuum mechanics
	Planar structures: plate, membrane, slab
	Linientragwerke: beam, cable, truss
	Weak form and Galerkin's method
	Finite element method: theory and application
	Principles of mechanics: principle of virtual work, virtual displacements, virtual forces
Literature	Gross, Hauger, Wriggers, "Technische Mechanik 4", Springer

Courses	
Title Introduction to Anatomy (L0384)	Typ Hrs/wk CP Lecture 2 3
	Prof. Udo Schumacher
Admission Requirements	
	Students can listen to the lectures without any prior knowledge. Basic school knowledge of biology, chemistry / biochemi physics and Latin can be useful.
Knowledge	physics and Each can be aseful.
Educational Objectives	After taking part successfully, students have reached the following learning results
Professional Competence	
Knowledge	The lectures are about microscopic anatomy, describing the microscopic structure of tissues and organs, and about macroscopic
	anatomy which is about organs and organ systems. The lectures also contain an introduction to cell biology, human develop
	and to the central nervous system. The fundamentals of radiologic imaging are described as well, using projectional x-ray
	cross-sectional images. The Latin terms are introduced.
Skills	At the end of the lecture series the students are able to describe the microscopic as well as the macroscopic assembly
U.M.S	functions of the human body. The Latin terms are the prerequisite to understand medical literature. This knowledge is neede
	understand und further develop medical devices.
	These insights in human anatomy are the fundamentals to explain the role of structure and function for the development
	common diseases and their impact on the human body.
Personal Competence	
Social Competence	The students can participate in current discussions in biomedical research and medicine on a professional level. The Latin to
	are prerequisite for communication with physicians on a professional level.
Autonomy	The lectures are an introduction to the basics of anatomy and should encourage students to improve their knowledg
	themselves. Advice is given as to which further literature is suitable for this purpose. Likewise, the lecture series encour
	students to recognize and think critically about biomedical problems.
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Credit points	
Course achievement	
	Written exam
Examination duration and	
scale	So minutes
	General Engineering Science (German program, 7 semester): Specialisation Biomedical Engineering: Compulsory
-	General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Biomecha
3 • • • •	Compulsory
	Data Science: Specialisation II. Application: Elective Compulsory
	Electrical Engineering: Specialisation Medical Technology: Elective Compulsory
	Engineering Science: Specialisation Biomedical Engineering: Compulsory
	General Engineering Science (English program, 7 semester): Specialisation Biomedical Engineering: Compulsory
	Mechanical Engineering: Specialisation Biomechanics: Compulsory
	Biomedical Engineering: Specialisation Medical Technology and Control Theory: Elective Compulsory
	Biomedical Engineering: Specialisation Management and Business Administration: Elective Compulsory
	Biomedical Engineering: Specialisation Artificial Organs and Regenerative Medicine: Elective Compulsory
	Biomedical Engineering: Specialisation Implants and Endoprostheses: Elective Compulsory
	Technomathematics: Specialisation III. Engineering Science: Elective Compulsory

rse L0384: Introduction t	to Anatomy	
Тур	lecture	
Hrs/wk		
CP		
	Independent Study Time 62, Study Time in Lecture 28	
	Prof. Tobias Lange, PD Thorsten Frenzel	
Language	DE SoSe	
	General Anatomy	
content	1 st week: The Eucaryote Cell	
	2 nd week: The Tissues 3 rd week: Cell Cycle, Basics in Development	
	4 th week: Musculoskeletal System	
	5 th week: Cardiovascular System 6 th week: Respiratory System	
	6 th week: Respiratory System 7 th week: Genito-urinary System	
	8 th week: Immune system	
	9 th week: Digestive System I	
	10 th week: Digestive System II	
	11 th week: Endocrine System 12 th week: Nervous System	
	13 th week: Exam	
Literature	Adolf Faller/Michael Schünke, Der Körper des Menschen, 17. Auflage, Thieme Verlag Stuttgart, 2016	

Courses				
Courses Title		Tura		CD.
ntroduction to Radiology and Radi	ation Therapy (L0383)	Typ Lecture	Hrs/wk 2	CP 3
Module Responsible				
Admission Requirements	None	-		
Recommended Previous	None			
Knowledge				
	After taking part successfully, students ha	ave reached the following learning results		
Professional Competence Knowledge	Thorson			
Knowledge		es of currently used equipment with respect	to its use in radiation th	erapy.
	The students can explain treatment plans	s used in radiation therapy in interdisciplinary	/ contexts (e.g. surgery,	internal medicine).
	The students can describe the patien	its' passage from their initial admittanc	e through to follow-up	o care.
	Diagnostics			
	The students can illustrate the technical	base concepts of projection radiography, in	ncluding angiography an	d mammography
	well as sectional imaging techniques (CT,		icidaling anglography and	a manning apriy, e
	The students can explain the diagnestic a	as well as therapeutic use of imaging techni	iques as well as the tech	prical basis for thos
	techniques.	as well as therapeutic use of imaging technic	ques, as well as the tech	
	The students can choose the right treatme	ent method depending on the patient's clinic	cal history and needs.	
	The student can explain the influence of t	echnical errors on the imaging techniques.		
	The student can draw the right conclusion	ns based on the images' diagnostic findings o	or the error protocol.	
Skille	Therapy			
JKIIIJ		I palliative situations and motivate why they	came to that conclusion.	
	The students can develop adamusts there			
	The students can develop adequate thera	apy concepts and relate it to the radiation bio	logical aspects.	
	The students can use the therapeutic prin	ciple (effects vs adverse effects)		
	The students can distinguish different ki	inds of radiation, can choose the best one	depending on the situa	tion (location of th
	tumor) and choose the energy needed in	that situation (irradiation planning).		
	The student can assess what an individ	lual psychosocial service should look like (e.g. follow-up treatment	, sports, social he
	groups, self-help groups, social services, p	psycho-oncology).		
	Diagnostics			
	The students can suggest solutions for rea	pairs of imaging instrumontation after bavin	a dana arrar analysas	
	The students can suggest solutions for rep	pairs of imaging instrumentation after having	g done error analyses.	
		ging techniques according to different grou	ps of diseases based or	n their knowledge o
	anatomy, pathology and pathophysiology			
Personal Competence				
Social Competence		I situation of tumor patients and interact with		-
	The students are aware of the special, measures and can meet them appropriate	often fear-dominated behavior of sick pe	ople caused by diagnos	stic and therapeut
		-19.		
Autonomy	The students can apply their new knowled			
	The students can introduce younger stude	ants to the clinical daily routine.		
		cal knowledge by themselves, can participat	te competently in conve	rsations on the top
	and acquire the relevant knowledge them	iselves.		
Workload in Hours	Independent Study Time 62, Study Time i	n Lecture 28		
Credit points	3			
Course achievement				
Examination				
Examination duration and scale	90 minutes			
	General Engineering Science (German pro	ogram, 7 semester): Specialisation Biomedica	al Engineering: Compulso	ory
Following Curricula	General Engineering Science (German	program, 7 semester): Specialisation Me	chanical Engineering, F	ocus Biomechanic
	Compulsory			
	Data Science: Specialisation II. Application			
	Electrical Engineering: Specialisation Med Engineering Science: Specialisation Biome			
		gram, 7 semester): Specialisation Biomedica	I Engineering: Compulso	ry
	Mechanical Engineering: Specialisation Bi			
		edical Technology and Control Theory: Electiv		
		anagement and Business Administration: Electricity Administration Electricity Administration Electricity Administration Electric Administration and Administration Electric Administration and Admi		
		tificial Organs and Regenerative Medicine: El plants and Endoprostheses: Elective Compul		

Technomathematics: Specialisation III. Engineering Science: Elective Compulsory

course have heard the word "X-ray" at best. It will be distinguished between the two arms of diagnostic (Prof. Dr. med	Course L0383: Introduction t	o Radiology and Radiation Therapy		
cr 3 Workload in Nours Independent Study Time 62, Study Time in Lecture 28 Lecturer Prof. Ulrich Carl, Prof. Thomas Vestring Language DE Cycte SoSe Content The students will be given an understanding of the technological possibilities in the field of medical imagin interventional radiology and radiation therapytradiation oncology. It is assumed, that students in the beginning of the course have heard the word "X-ray" at best. It will be distinguished between the two arms of diagnostic (Prof. Dr. med. Thomas Vestring) and therapeutic (Prof. Dr. med. Ulrich Carl) use of X-rays. Both arms depend on special big units which determine a predefined sequence in their respective departments Literature • "Technik der medizinischen Radiologie" von T. + J. Laubenberg - 7. Auflage - Deutscher Ärzteverlag - erschienen 1999 • "Klinische Strahlenbiologie" von Th. Herrmann, M. Baumann und W. Dörr - 4. Auflage - Verlag Urban & Fischer - erschienen 02.03.2006 ISBN: 978-3-437-23960-1 • "Strahlentherapie und Onkologie für MTA-R" von R. Sauer - 5. Auflage 2003 - Verlag Urban & Schwarzenberg - erschienen 08.12.2009 ISBN: 978-3-437-47501-6 • "Taschenatlas der Physiologie" von S. Silbernagel und A. Despopoulus- 8. Auflage - Georg Thieme Verlag - erschienen 19.09.2012 ISBN: 978-3-13-567708-8 • "Der Körper des Menschen " von A. Faller u. M. Schünke - 16. Auflage 2004 - Georg Thieme Verlag - erschienen 18.07.2012 ISBN: 978-3-13-329716-5 • "Praxismanual Strahlentherapie" von Stöver / Feyer -	Тур	Lecture		
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		ISBN: 978-3-13-329716-5		
1. Auflage - Springer-Verlag GmbH – erschienen 02.06.2000		"Praxismanual Strahlentherapie" von Stöver / Feyer –		
		1. Auflage - Springer-Verlag GmbH - erschienen 02.06.2000		

Module M0684: Heat	Transfer
Courses	
Title	Typ Hrs/wk CP
Heat Transfer (L0458)	Lecture 3 4
Heat Transfer (L0459)	Recitation Section (large) 2 2
Module Responsible	Dr. Andreas Moschallski
Admission Requirements	None
Recommended Previous	Technical Thermodynamics I, II and Fluid Dynamics
Knowledge	
Educational Objectives	After taking part successfully, students have reached the following learning results
Professional Competence	
Knowledge	The students can
	- explain the technical terms,
	- classify the various physical processes of heat transfer in terms of conduction-based and radiation-based mechanisms,
	- simplify and critically analyze complex heat transfer processes using models,
	- methodically develop solutions to tasks.
Skills	The students are able to
	- describe the physics of the different Heat Transfer mechanism,
	- simplifywith models, calculate and evaluate complex Heat Transfer processes,
	- critically question and answer statements on heat transfer,
	- solve excersises self-consistent and in small groups.
Personal Competence	
Social Competence	In lectures and exercises, the students can use many examples and experiments to discuss in small groups in a goal-orie manner, develop a solution and present it. Within the exercises, the students can independently develop further questions work out targeted solutions.
Autonomy	The students can check their level of knowledge by means of repetition questions at the beginning of the lectures and describe discuss answers in exchange with the other students. In the exercises, the students work in small groups on the methods tauge the lectures in complex tasks and critically analyze the results in the auditorium.
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	
Assignment for the	General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Energy Syste
Following Curricula	Compulsory
	General Engineering Science (German program, 7 semester): Specialisation Biomedical Engineering: Compulsory
	General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Theoretical Mechan
	Engineering: Compulsory
	Energy Systems: Technical Complementary Course Core Studies: Elective Compulsory
	Integrated Building Technology: Core Qualification: Compulsory
	Mechanical Engineering: Specialisation Energy Systems: Compulsory
	Mechanical Engineering: Specialisation Theoretical Mechanical Engineering: Elective Compulsory

Course L0458: Heat Transfer	
Тур	Lecture
Hrs/wk	3
СР	4
Workload in Hours	Independent Study Time 78, Study Time in Lecture 42
Lecturer	Dr. Andreas Moschallski
Language	DE
Cycle	WiSe
Content	Dimensional analysis, Heat Conduction (steady and unsteady) , Convective Heat Transfer (natural convection, forced convection), Two-phase Heat Transfer (evaporation, condensation), Thermal Radiation, Heat Transfer on a thermodynamic view, thermotechnical devices, measures of temperature and heat flux
Literature	 Herwig, H.; Moschallski, A.: Wärmeübertragung, 4. Auflage, Springer Vieweg Verlag, Wiesbaden, 2019 Herwig, H.: Wärmeübertragung von A-Z, Springer- Verlag, Berlin, Heidelberg, 2000 Baehr, H.D.; Stephan, K.: Wärme- und Stoffübertragung, 2. Auflage, Springer Verlag, Berlin, Heidelberg, 1996

Course L0459: Heat Transfer	urse L0459: Heat Transfer	
Тур	Recitation Section (large)	
Hrs/wk	2	
CP	2	
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28	
Lecturer	Dr. Andreas Moschallski	
Language	DE	
Cycle	WiSe	
Content	See interlocking course	
Literature	See interlocking course	

Courses					
Title		Тур	Hrs/wk	CP	
Practical Course: Measurement and Control Systems (L1119)		Practical Course Lecture	2	2 2	
Measurement Technology for Mechanical Engineering (L1116) Measurement Technology for Mechanical Engineering (L1118)		Practical Course	2	2	
		Tractical Course	Z	2	
Module Responsible					
Admission Requirements		electrical engineering			
Recommended Previous Knowledge	Basic knowledge of physics, chemistry and	electrical engineering			
	After taking part support fully, students by	a reached the following learning results			
Educational Objectives Professional Competence	After taking part successfully, students hav	reached the following learning results			
•	Charlente and able to anno the most impo	where the second s	(Q	al the line of the second state	
Knowleage	Calibration, Static and Dynamic Properties	rtant fundmentals of the Measurement Techr of Sensors and Systems).	lology (Quantities ar	id Units, Uncertain	
	They can outline the most important mea	suring methods for different kinds of quantit	ies to be maesured	(Electrical Quantit	
	Temperature, mechanical quantities, Flow,	Time, Frequency).			
	They can describe important methods of ch	nemical Analysis (Gas Sensors, Spectroscopy,	Gas Chromatography	')	
Skills	Students can select suitable measuring me	thods to given problems and can use refering	measurement device	es in practice.	
	The students are able to orally explain issu	ies in the subject area of measurement tech	nology and solution a	annroaches as well	
	The students are able to orally explain issues in the subject area of measurement technology and solution approaches a place the issues into the right context and application area.				
Personal Competence					
Social Competence	Students can arrive at work results in group	os and document them in a common report.			
,					
Autonomy	Students are able to familiarize themselves	with new measurement technologies.			
Workload in Hours	Independent Study Time 96, Study Time in	Lecture 84			
Credit points					
Course achievement	Compulsory Bonus Form Yes None Subject theoretics	Description			
	practical work				
Frankland and					
	Subject theoretical and practical work				
Examination duration and		xperiments on measurements technology an	id sucessfull particip	ation in the pract	
scale					
Assignment for the	5 5	ram, 7 semester): Specialisation Mechanical E			
Following Curricula		ram, 7 semester): Specialisation Biomedical E			
		ram, 7 semester): Specialisation Advanced Ma	aterials: Elective Com	npulsory	
	Digital Mechanical Engineering: Core Qualif	fication: Compulsory			
	Engineering Science: Specialisation Mechat	ronics: Compulsory			
	Engineering Science: Specialisation Mechar	nical Engineering: Compulsory			
	Engineering Science: Specialisation Biomedical Engineering: Elective Compulsory				
	Engineering Science: Specialisation Advance	ed Materials: Elective Compulsory			
	General Engineering Science (English progr	am, 7 semester): Specialisation Mechatronics	: Compulsory		
	General Engineering Science (English program, 7 semester): Specialisation Mechanical Engineering: Compulsory				
	General Engineering Science (English program, 7 semester): Specialisation Biomedical Engineering: Elective Compulsory				
	Logistics and Mobility: Specialisation Production Management and Processes: Elective Compulsory				
	Mechanical Engineering: Core Qualification:	: Compulsory			
	Mechatronics: Specialisation Naval Enginee	ring: Compulsory			
	Mechatronics: Specialisation Electrical System	ems: Compulsory			
	Mechatronics: Specialisation Dynamic Syste	ems and AI: Compulsory			
	Mechatronics: Core Qualification: Compulso	bry			
	1	abian Contanan Contanan			
	Mechatronics: Specialisation Robot- and Ma	icnine-Systems: Compulsory			
	Mechatronics: Specialisation Robot- and Ma Mechatronics: Specialisation Medical Engine				
	Mechatronics: Specialisation Medical Engine		ion Management an	d Processes: Elect	

Тур	Practical Course
Hrs/wk	
CP	2
	Independent Study Time 32, Study Time in Lecture 28
	Prof. Thorsten Kern
Language	
-	WiSe/SoSe
Content	The content of experiment 1:
	Accuracy testing of a delta robot: In the course of the experiment, the accuracy of a delta robot is tested through 3 tasks. The f task focuses on the online/offline programming of the robot. The second task deals with sensor calibration. In the third task, radius of a sphere is determined using three different measurement methods (manual measurement, manual measurement will sensor, automatic data acquisition and data processing).
	The content of experiment 3:
	The aim of the task is to enable the parallel kinematics to find objects, grasp them and place them on a static target position this purpose, the end effector of the kinematics is equipped with an optical sensor (camera), whose characteristics are to defined. The measuring range of the sensor is to be identified and, based on this, a movement strategy for finding the objects is be developed and implemented. Once the objects have been found, they are to be picked up with a magnetic gripper transported to their destination.
	The content of experiment 4:
	The aim of the task is to enable the parallel kinematics to find objects, grab them and deposit them on a moving platform. For purpose, the end effector of the kinematics is equipped with an optical sensor (camera), the properties of which were worked in experiment 3. Based on this, the parallel kinematics should now be able to follow the moving platform. For this purpose position control must be developed and implemented. Once the controller has been appropriately configured, the objects car placed on the moving platform.
Literature	Versuch 1:
	 1)Weck, Manfred; Brecher, Christian. Maschinenarten und Anwendungsbereiche. Springer (Werkzeugmaschinen, 1, Ed. 2005 2)Weck, Manfred; Brecher, Christian. Automatisierung von Maschinen und Anlagen. Springer (Werkzeugmaschinen, 4, 6). 2006 3)Siciliano, Bruno; Khatib, Oussama. Springer handbook of robotics. Springer. 2008
	• 4)Schüppstuhl, Thorsten. VL Grundlagen der Handhabungs- und Montagetechnik. 2017
	Versuch 3:
	 1)Hompel, Michael, Hubert Büchter, and Ulrich Franzke. Identifikationssysteme und Automatisierung. Springer-Verlag, 20 ArUco Library Documentation, https://docs.google.com/document/d/1QU9KoBtjSM2kF6ITOjQ76xqL7H0TEtXrijX5kwi9Kgc/stand 10/21 Demant, Christian, Bernd Streicher-Abel, and Axel Springhoff. Industrielle Bildverarbeitung: wie optische Qualitätskontrwirklich funktioniert. Springer-Verlag, 2011.
	Versuch 4:
	 1)Will, Thorsten T. C++ Das umfassende Handbuch, Rheinwerk Computing, 2020 2)Hildebrand, Walter. Grundkurs Regelungstechnik : Grundlagen für Bachelorstudiengänge aller technisch Fachrichtungen und Wirtschaftsingenieure, Springer Vieweg, 2013. 3)Erlenkötter, Helmut. C++: Objektorientiertes Programmieren von Anfang an, rororo, 2016
	Pibliography
	Bibliography:
	Experiment 1
	 1)Weck, Manfred; Brecher, Christian. Maschinenarten und Anwendungsbereiche. Springer (Werkzeugmaschinen, 1, Ed. 2005 2005
	 2)Weck, Manfred; Brecher, Christian. Automatisierung von Maschinen und Anlagen. Springer (Werkzeugmaschinen, 4, 6). 2006 3)Siciliano, Bruno; Khatib, Oussama. Springer handbook of robotics. Springer. 2008 4)Schüppstuhl, Thorsten. VL Grundlagen der Handhabungs- und Montagetechnik. 2017
	Experiment 3:
	 1)Hompel, Michael, Hubert Büchter, and Ulrich Franzke. Identifikationssysteme und Automatisierung. Springer-Verlag, 20 ArUco Library Documentation, https://docs.google.com/document/d/1QU9KoBtjSM2kF6ITOjQ76xqL7H0TEtXrijX5kwi9Kgc/ Stand 10/21 Demant, Christian, Bernd Streicher-Abel, and Axel Springhoff. Industrielle Bildverarbeitung: wie optische Qualitätskontr wirklich funktioniert. Springer-Verlag, 2011.
	Experiment 4:
	 1)Will, Thorsten T. C++ Das umfassende Handbuch, Rheinwerk Computing, 2020 2)Hildebrand, Walter. Grundkurs Regelungstechnik : Grundlagen für Bachelorstudiengänge aller technisch Fachrichtungen und Wirtschaftsingenieure, Springer Vieweg, 2013.

Course L1116: Measurement	Technology for Mechanical Engineering				
Тур	Lecture				
Hrs/wk	2				
СР	2				
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28				
	Prof. Thorsten Kern, Dennis Kähler				
Language					
Cycle					
Content	1 Fundamentals				
	1.1 Quantities and Units				
	1.2 Uncertainty				
	1.3 Calibration				
	1.4 Static and Dynamic Properties of Sensors and Systems				
	2 Measurement of Electrical Quantities				
	1 Current and Voltage				
	.2 Impedance				
	3 Amplification				
	2.4 Oscilloscope				
	.5 Analog-to-Digital Conversion				
	.6 Data Transmission				
	3 Measurement of Nonelectric Quantities				
	3.1 Temperature				
	3.2 Length, Displacement, Angle				
	3.3 Strain, Force, Pressure				
	3.4 Flow				
	3.5 Time, Frequency				
Literature	Lerch, R.: "Elektrische Messtechnik; Analoge, digitale und computergestützte Verfahren", Springer, 2006, ISBN: 978-3-540-34055- 3.				
	Profos, P. Pfeifer, T.: "Handbuch der industriellen Messtechnik", Oldenbourg, 2002, ISBN: 978-3486217940.				

Course L1118: Measurement Technology for Mechanical Engineering			
Тур	actical Course		
Hrs/wk	2		
СР			
Workload in Hours	dependent Study Time 32, Study Time in Lecture 28		
Lecturer	of. Thorsten Kern		
Language	N		
Cycle	WiSe/SoSe		
Content	See interlocking course		
Literature	See interlocking course		

Courses			
Title	Typ Hrs/w		
Numerical Mathematics I (L0417)	Lecture 2 Recitation Section (small) 2	3	
Numerical Mathematics I (L0418)		3	
Module Responsible			
Admission Requirements			
Recommended Previous	 Mathematik I + II for Engineering Students (german or english) or Analysis & Linear Algebra I + II 	for Technomathematic	
Knowledge	basic MATLAB/Python knowledge		
Educational Objectives	After taking part successfully, students have reached the following learning results		
Professional Competence	e		
Knowledge	e Students are able to		
	 name numerical methods for interpolation, integration, least squares problems, eigenvalue problems 	ems, nonlinear root fin	
	problems and to explain their core ideas,		
	repeat convergence statements for the numerical methods,		
	explain aspects for the practical execution of numerical methods with respect to computational and	id storage complexitx.	
Skills	s Students are able to		
	 implement, apply and compare numerical methods using MATLAB/Python, 		
	 justify the convergence behaviour of numerical methods with respect to the problem and solution 	algorithm	
	 select and execute a suitable solution approach for a given problem. 	algoritini,	
	• select and execute a suitable solution approach for a given problem.		
Personal Competence	a		
Social Competence	Students are able to		
	 work together in heterogeneously composed teams (i.e., teams from different study programs an our lait the autient foundations and any set of the work to any study of the involu- 		
	explain theoretical foundations and support each other with practical aspects regarding the imple	mentation of algorithm	
Autonomy	Students are capable		
	 to assess whether the supporting theoretical and practical excercises are better solved individual 	y or in a team,	
	 to assess their individual progess and, if necessary, to ask questions and seek help. 		
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56		
Credit points			
Course achievement			
	N Written exam		
Examination duration and			
scale			
Assignment for the			
Following Curricula	General Engineering Science (German program, 7 semester): Specialisation Biomedical Engineering: Cor		
	General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineer	ing, Focus Biomechar	
	Compulsory		
	General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, For	cus Theoretical Mechar	
Engineering: Compulsory			
	General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering	g, Focus Aircraft Syst	
	Engineering: Elective Compulsory		
	General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Fo	cus Mechatronics: Elec	
	Compulsory		
	General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering	, Focus Energy Syste	
	Elective Compulsory		
	General Engineering Science (German program, 7 semester): Specialisation Advanced Materials: Computer	sory	
	General Engineering Science (German program, 7 semester): Specialisation Data Science: Compulsory		
	Bioprocess Engineering: Specialisation A - General Bioprocess Engineering: Elective Compulsory		
	Data Science: Core Qualification: Compulsory		
	Electrical Engineering: Core Qualification: Elective Compulsory		
	Engineering Science: Core Qualification: Compulsory		
	Green Technologies: Energy, Water, Climate: Specialisation Energy Technology: Elective Compulsory		
	Green Technologies: Energy, Water, Climate: Specialisation Energy Technology: Elective Compulsory Computer Science in Engineering: Core Qualification: Compulsory		
	Computer Science in Engineering: Core Qualification: Compulsory		
	Computer Science in Engineering: Core Qualification: Compulsory Mechanical Engineering: Specialisation Theoretical Mechanical Engineering: Compulsory	ý	

Course L0417: Numerical Ma	thematics I			
Тур	Lecture			
Hrs/wk	2			
CP	3			
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28			
Lecturer	Prof. Sabine Le Borne			
Language	EN			
Cycle	WiSe			
Content	 Finite precision arithmetic, error analysis, conditioning and stability Linear systems of equations: LU and Cholesky factorization, condition Interpolation: polynomial, spline and trigonometric interpolation Nonlinear equations: fixed point iteration, root finding algorithms, Newton's method Linear and nonlinear least squares problems: normal equations, Gram Schmidt and Householder orthogonalization, singular value decomposition, regularizatio, Gauss-Newton and Levenberg-Marquardt methods Eigenvalue problems: power iteration, inverse iteration, QR algorithm Numerical differentiation Numerical integration: Newton-Cotes rules, error estimates, Gauss quadrature, adaptive quadrature 			
Literature	 Gander/Gander/Kwok: Scientific Computing: An introduction using Maple and MATLAB, Springer (2014) Stoer/Bulirsch: Numerische Mathematik 1, Springer Dahmen, Reusken: Numerik f ür Ingenieure und Naturwissenschaftler, Springer 			

Course L0418: Numerical Mathematics I			
Тур	citation Section (small)		
Hrs/wk	2		
CP	3		
Workload in Hours	dependent Study Time 62, Study Time in Lecture 28		
Lecturer	of. Sabine Le Borne, Dr. Jens-Peter Zemke		
Language	EN		
Cycle	WiSe		
Content	See interlocking course		
Literature	See interlocking course		

Courses				
Title		Тур	Hrs/wk	СР
ntroduction to Biochemistry and M	olecular Biology (L0386)	Lecture	2	3
Module Responsible	Prof. Hans-Jürgen Kreienkamp			
Admission Requirements	, , , ,			
Recommended Previous				
Knowledge				
-	After taking part successfully, students	have reached the following learning results		
Professional Competence		5 5		
	The students can			
	 describe basic biomolecules; 			
	 explain how genetic information 	is coded in the DNA;		
	 explain the connection between 	DNA and proteins;		
Skills	The students can			
SKIIS				
	 recognize the importance of mol 	ecular parameters for the course of a disease;		
	 describe selected molecular-diag 			
	 explain the relevance of these p 	rocedures for some diseases		
Personal Competence				
Social Competence	The students can participate in discuss	ions in research and medicine on a technical le	vel.	
	Students will have an improved understanding of current modical problems (e.g. Carena pandemic)and will be able to eval			
	Students will have an improved understanding of current medical problems (e.g. Corona pandemic) and will be able to explait these issues to others.			
Autonomy	The students can develop an understar	nding of topics from the course, using technical	literature, by themselves	5.
	Students will be better equipped to rec	ognize fake news in the media regarding medio	cal research topics.	
Workload in Hours	Independent Study Time 62, Study Tim	e in Lecture 28		
Credit points				
Course achievement				
Examination	Written exam			
Examination duration and	60 minutes			
scale				
Assignment for the	General Engineering Science (German	program, 7 semester): Specialisation Biomedic	al Engineering: Compulso	ry
Following Curricula	General Engineering Science (Germa	n program, 7 semester): Specialisation Me	chanical Engineering, F	ocus Biomechar
	Compulsory			
	Electrical Engineering: Specialisation M	edical Technology: Elective Compulsory		
	Engineering Science: Specialisation Bio			
	General Engineering Science (English p	rogram, 7 semester): Specialisation Biomedica	I Engineering: Compulsor	У
	Mechanical Engineering: Specialisation			
	Mechatronics: Specialisation Medical En			
		Management and Business Administration: Ele		
		Artificial Organs and Regenerative Medicine: E		
	Diamodical Engineering: Createlist			
	Biomedical Engineering: Specialisation	Medical Technology and Control Theory: Electri Implants and Endoprostheses: Elective Compu		

Course L0386: Introduction to Biochemistry and Molecular Biology					
Тур	cture				
Hrs/wk	2				
CP	3				
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28				
Lecturer	Prof. Hans-Jürgen Kreienkamp				
Language	DE				
Cycle	iSe				
Content					
Literature	Müller-Esterl, Biochemie, Spektrum Verlag, 2010; 2. Auflage				
	Löffler, Basiswissen Biochemie, 7. Auflage, Springer, 2008				

Module M1333: BIO I:	Implants and Fracture Heali	ng			
Courses					
Title		Тур	Hrs/wk	СР	
Implants and Fracture Healing (L03	76)	Lecture	2	3	
Module Responsible	Prof. Michael Morlock				
Admission Requirements	None				
Recommended Previous	It is recommended to participate in "Introc	duction into Anatomie" before attending "Impla	ants and Fracture Heal	ing".	
Knowledge					
Educational Objectives	After taking part successfully, students ha	ve reached the following learning results			
Professional Competence					
Knowledge	The students can describe the different ways how bones heal, and the requirements for their existence.				
	The students can name different treatmen	nts for the spine and hollow bones under given	fracture morphologies	5.	
Skills	The students can determine the forces acting within the human body under quasi-static situations under specific assumptions.				
Personal Competence					
•	The students can, in groups, solve basic numerical modeling tasks for the calculation of internal forces.				
Autonomy	The students can, in groups, solve basic numerical modeling tasks for the calculation of internal forces.				
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28				
Credit points	3				
Course achievement	None				
Examination	Written exam				
Examination duration and	90 min				
scale					
Assignment for the	General Engineering Science (German	program, 7 semester): Specialisation Mech	anical Engineering, F	ocus Biomechanio	
Following Curricula	Compulsory				
	General Engineering Science (German pro	gram, 7 semester): Specialisation Biomedical	Engineering: Compulso	ory	
	Engineering Science: Specialisation Biome	edical Engineering: Compulsory			
	General Engineering Science (English program, 7 semester): Specialisation Biomedical Engineering: Compulsory				
	Mechanical Engineering: Specialisation Biomechanics: Compulsory				
	Biomedical Engineering: Specialisation Implants and Endoprostheses: Elective Compulsory				
	Biomedical Engineering: Specialisation Artificial Organs and Regenerative Medicine: Elective Compulsory				
	Biomedical Engineering: Specialisation Management and Business Administration: Elective Compulsory				
	Biomedical Engineering: Specialisation Me	edical Technology and Control Theory: Elective	Compulsory		
	Orientation Studies: Core Qualification: Ele		· -		
	Technomathematics: Specialisation III. Eng				

Course L0376: Implants and	Fracture Healing
Тур	Lecture
Hrs/wk	2
CP	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
	Prof. Michael Morlock
Language	
Cycle	
Content	Topics to be covered include: 1. Introduction (history, definitions, background importance)
	2. Bone (anatomy, properties, biology, adaptations in femur, tibia, humerus, radius)
	3. Spine (anatomy, biomechanics, function, vertebral bodies, intervertebral disc, ligaments)
	3.1 The spine in its entirety
	3.2 Cervical spine 3.3 Thoracic spine
	3.4 Lumbar spine
	3.5 Injuries and diseases
	4. Pelvis (anatomy, biomechanics, fracture treatment)
	5 Fracture Healing
	5.1 Basics and biology of fracture repair
	5.2 Clinical principals and terminology of fracture treatment
	5.3 Biomechanics of fracture treatment
	5.3.1 Screws 5.3.2 Plates
	5.3.3 Nails
	5.3.4 External fixation devices
	5.3.5 Spine implants
	6.0 New Implants
Literature	Cochran V.B.: Orthopädische Biomechanik
	Mow V.C., Hayes W.C.: Basic Orthopaedic Biomechanics
	White A.A., Panjabi M.M.: Clinical biomechanics of the spine Nigg, B.: Biomechanics of the musculo-skeletal system
	Schiebler T.H., Schmidt W.: Anatomie
	Platzer: dtv-Atlas der Anatomie, Band 1 Bewegungsapparat

Courses					
Title			Тур	Hrs/wk	СР
Introduction into Medical Technolo	y and Systems (L034	2)	Lecture	2	3
Introduction into Medical Technolo	gy and Systems (L034	3)	Project Seminar	2	2
Introduction into Medical Technolo	yy and Systems (L187	76)	Recitation Section (la	arge) 1	1
Module Responsible	Prof. Alexander Scl	hlaefer			
Admission Requirements	None				
Recommended Previous	principles of math	(algebra, analysis/calculus))		
Knowledge	principles of stoch	astics			
	principles of progra	amming, R/Matlab			
Educational Objectives	After taking part su	uccessfully, students have	reached the following learning results		
Professional Competence			· · · · · · · · · · · · · · · · · · ·		
-	The students can	explain principles of med	lical technology, including imaging sy	stems, computer aide	d surgery, and me
			n overview of regulatory affairs and star		
Skills	The students are a	ble to evaluate systems an	nd medical devices in the context of clir	nical applications.	
Personal Competence					
-	The students descr	ribe a problem in medical t	echnology as a project, and define task	s that are solved in a id	pint effort.
···· , · · ·			Its of other groups and make construct		
			5	55	
Autonomi	The students can	ecces their level of least			
Autonomy			wledge and document their work rest	ults. They can critica	lly evaluate the re
Autonomy		assess their level of know ent them in an appropriate	-	ults. They can critica	lly evaluate the re
	achieved and prese		manner.	ults. They can critica	lly evaluate the re
	achieved and prese Independent Study	ent them in an appropriate	manner.	ults. They can critica	lly evaluate the re
Workload in Hours	achieved and press Independent Study 6	ent them in an appropriate	manner.	ults. They can critica	lly evaluate the re
Workload in Hours Credit points	achieved and press Independent Study 6	ent them in an appropriate	manner. .ecture 70	ults. They can critica	lly evaluate the re
Workload in Hours Credit points	achieved and press Independent Study 6 Compulsory Bonus	ent them in an appropriate 7 Time 110, Study Time in I Form	manner. .ecture 70	ults. They can critica	lly evaluate the re
Workload in Hours Credit points Course achievement	achieved and press Independent Study 6 Compulsory Bonus Yes 10 %	ent them in an appropriate 7 Time 110, Study Time in I Form Written elaboration	manner. .ecture 70	ults. They can critica	lly evaluate the re
Workload in Hours Credit points Course achievement	achieved and press Independent Study 6 Compulsory Bonus Yes 10 % Written exam	ent them in an appropriate 7 Time 110, Study Time in I Form Written elaboration	manner. .ecture 70	ults. They can critica	lly evaluate the re
Workload in Hours Credit points Course achievement Examination	achieved and press Independent Study 6 Compulsory Bonus Yes 10 % Written exam	ent them in an appropriate 7 Time 110, Study Time in I Form Written elaboration	manner. .ecture 70	ults. They can critica	lly evaluate the re
Workload in Hours Credit points Course achievement Examination Examination duration and scale	achieved and press Independent Study 6 Compulsory Bonus Yes 10 % Yes 10 % Written exam 90 minutes	ent them in an appropriate / Time 110, Study Time in I Form Written elaboration Presentation	manner. .ecture 70		·
Workload in Hours Credit points Course achievement Examination Examination duration and scale	achieved and press Independent Study 6 Compulsory Bonus Yes 10 % Yes 10 % Written exam 90 minutes General Engineerin	ent them in an appropriate / Time 110, Study Time in I Form Written elaboration Presentation ng Science (German progra	manner. .ecture 70 Description	ical Engineering: Comp	·
Workload in Hours Credit points Course achievement Examination Examination duration and scale Assignment for the	achieved and press Independent Study 6 Compulsory Bonus Yes 10 % Yes 10 % Written exam 90 minutes General Engineerin Computer Science:	ent them in an appropriate / Time 110, Study Time in I Form Written elaboration Presentation ng Science (German progra	manner. ecture 70 	ical Engineering: Comp	·
Workload in Hours Credit points Course achievement Examination Examination duration and scale Assignment for the	achieved and press Independent Study 6 Compulsory Bonus Yes 10 % Yes 10 % Written exam 90 minutes General Engineerin Computer Science: Data Science: Spec	ent them in an appropriate / Time 110, Study Time in I Form Written elaboration Presentation ng Science (German progra : Specialisation II. Mathema	manner. ecture 70 	ical Engineering: Comp	·
Workload in Hours Credit points Course achievement Examination Examination duration and scale Assignment for the	achieved and press Independent Study 6 Compulsory Bonus Yes 10 % Yes 10 % Written exam 90 minutes General Engineerin Computer Science: Data Science: Spec Data Science: Core	ent them in an appropriate / Time 110, Study Time in I Form Written elaboration Presentation ng Science (German progra : Specialisation II. Mathema cialisation II. Application: El	manner. ecture 70 	ical Engineering: Comp	·
Workload in Hours Credit points Course achievement Examination Examination duration and scale Assignment for the	achieved and press Independent Study 6 Compulsory Bonus Yes 10 % Yes 10 % Written exam 90 minutes General Engineerin Computer Science: Data Science: Spec Data Science: Core Electrical Engineer	ent them in an appropriate / Time 110, Study Time in I Form Written elaboration Presentation ng Science (German progra : Specialisation II. Mathema cialisation II. Application: Ele e Qualification: Elective Cor ing: Core Qualification: Elective I	manner. ecture 70 	ical Engineering: Comp	·
Workload in Hours Credit points Course achievement Examination Examination duration and scale Assignment for the	achieved and press Independent Study 6 Compulsory Bonus Yes 10 % Yes 10 % Written exam 90 minutes General Engineerir Computer Science: Data Science: Spec Data Science: Core Electrical Engineer Engineering Science	ent them in an appropriate (Time 110, Study Time in I Form Written elaboration Presentation Presentation ag Science (German progra Specialisation II. Mathema cialisation II. Application: Ele Qualification: Elective Cor ing: Core Qualification: Elective Cor ing: Core Qualification: Elective Cor ing: Core Qualification: Elective Cor ing: Core Qualification: Elective Cor	manner. ecture 70 	ical Engineering: Comp Compulsory	ulsory
Workload in Hours Credit points Course achievement Examination Examination duration and scale Assignment for the	achieved and press Independent Study 6 Compulsory Bonus Yes 10 % Yes 10 % Written exam 90 minutes General Engineerir Computer Science: Data Science: Spec Data Science: Spec Data Science: Core Electrical Engineerir Engineering Science	ent them in an appropriate (Time 110, Study Time in I Form Written elaboration Presentation Presentation ag Science (German progra Specialisation II. Mathema cialisation II. Application: Ele Qualification: Elective Cor ing: Core Qualification: Elective cor gualification Biomedic ag Science (English program	manner. ecture 70 	ical Engineering: Comp Compulsory	ulsory
Workload in Hours Credit points Course achievement Examination Examination duration and scale Assignment for the	achieved and press Independent Study 6 Compulsory Bonus Yes 10 % Yes 10 % Written exam 90 minutes General Engineerir Computer Science: Spec Data Science: Spec Data Science: Spec Data Science: Corre Electrical Engineerir Engineering Science General Engineerir Computer Science	ent them in an appropriate (Time 110, Study Time in I Form Written elaboration Presentation Presentation ag Science (German progra Specialisation II. Mathema cialisation II. Application: Ele Qualification: Elective Cor ing: Core Qualification: Elective cor gualification Biomedic ag Science (English program	manner. ecture 70 	ical Engineering: Comp Compulsory	ulsory
Workload in Hours Credit points Course achievement Examination Examination duration and scale Assignment for the	achieved and press Independent Study 6 Compulsory Bonus Yes 10 % Yes 10 % Written exam 90 minutes General Engineerir Computer Science: Data Science: Spec Data Science: Spec Data Science: Corre Electrical Engineerir Engineering Science General Engineerir Computer Science Mechatronics: Spec	ent them in an appropriate (Time 110, Study Time in I Form Written elaboration Presentation Presentation ag Science (German progra Specialisation II. Mathema cialisation II. Application: Ele Qualification: Elective Cor ing: Core Qualification: Ele ce: Specialisation Biomedic ag Science (English prograr in Engineering: Specialisat cialisation Medical Enginee	manner. ecture 70 	ical Engineering: Comp Compulsory cal Engineering: Compulso	ulsory
Workload in Hours Credit points Course achievement Examination Examination duration and scale Assignment for the	achieved and press Independent Study 6 Compulsory Bonus Yes 10 % Yes 10 % Written exam 90 minutes General Engineerir Computer Science: Data Science: Spec Data Science: Spec Data Science: Spec Data Science: Spec Data Science: Spec Data Science: Spec Biomedical Engineerir Science Biomedical Engineeri	ent them in an appropriate (Time 110, Study Time in I Form Written elaboration Presentation Presentation ag Science (German progra Specialisation II. Mathema cialisation II. Application: Ele Qualification: Elective Cor ing: Core Qualification: Ele ce: Specialisation Biomedic ag Science (English prograr in Engineering: Specialisati cialisation Medical Enginee ering: Specialisation Artific	manner. 	ical Engineering: Comp Compulsory cal Engineering: Compulso nce: Elective Compulsory Elective Compulsory	ulsory
Workload in Hours Credit points Course achievement Examination Examination duration and scale Assignment for the	achieved and press Independent Study 6 Compulsory Bonus Yes 10 % Yes 10 % Written exam 90 minutes General Engineerir Computer Science: Data Science: Spec Data Science: Spec Bioneering Science Biomedical Engineering Biomedical Engineering	ent them in an appropriate (Time 110, Study Time in I Form Written elaboration Presentation Presentation ag Science (German progra Specialisation II. Mathema cialisation II. Application: Ele Qualification: Elective Cor ing: Core Qualification: Ele ce: Specialisation Biomedic ag Science (English prograr in Engineering: Specialisati cialisation Medical Enginee ering: Specialisation Artific ering: Specialisation Implantice (Specialisation Implantice) (Specialisation Implantice) (Speciali	manner. 	ical Engineering: Comp Compulsory cal Engineering: Compulso nce: Elective Compulsory pulsory	ulsory
Workload in Hours Credit points Course achievement Examination Examination duration and scale Assignment for the	achieved and press Independent Study 6 Compulsory Bonus Yes 10 % Yes 10 % Written exam 90 minutes General Engineerir Computer Science: Data Science: Spec Data Science: Spec Data Science: Core Electrical Engineerir Computer Science Bioneering Science Mechatronics: Spec Biomedical Engineerie Biomedical Engineerie	ent them in an appropriate (Time 110, Study Time in I Form Written elaboration Presentation Presentation ag Science (German progra Specialisation II. Mathema cialisation II. Application: Ele Qualification: Elective Cor ing: Core Qualification: Elective Cor ing: Core Qualification: Elective cor gualification Biomedic ag Science (English prograr in Engineering: Specialisati cialisation Medical Enginee ering: Specialisation Artific ering: Specialisation Implar ering: Specialisation Medica	manner. 	ical Engineering: Comp Compulsory cal Engineering: Compulso nce: Elective Compulsory pulsory tive Compulsory	ulsory

Course L0342: Introduction i	nto Medical Technology and Systems
Тур	Lecture
Hrs/wk	2
CP	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Prof. Alexander Schlaefer
Language	DE
Cycle	SoSe
Content	- imaging systems
	- computer aided surgery
	- medical sensor systems
	- medical information systems
	- regulatory affairs
	- standard in medical technology
	The students will work in groups to apply the methods introduced during the lecture using problem based learning.
Literature	Bernhard Priem, "Visual Computing for Medicine", 2014
	Heinz Handels, "Medizinische Bildverarbeitung", 2009 (https://katalog.tub.tuhh.de/Record/745558097)
	Valery Tuchin, "Tissue Optics - Light Scattering Methods and Instruments for Medical Diagnosis", 2015
	Olaf Drössel, "Biomedizinische Technik - Medizinische Bildgebung", 2014
	H. Gross, "Handbook of Optical Systems", 2008 (https://katalog.tub.tuhh.de/Record/856571687)
	Wolfgang Drexler, "Optical Coherence Tomography", 2008
	Kramme, "Medizintechnik", 2011
	Thorsten M. Buzug, "Computed Tomography", 2008
	Otmar Scherzer, "Handbook of Mathematical Methods in Imaging", 2015
	Weishaupt, "Wie funktioniert MRI?", 2014
	Paul Suetens, "Fundamentals of Medical Imaging", 2009
	Vorlesungsunterlagen

Course L0343: Introduction into Medical Technology and Systems		
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	DE	
Cycle	SoSe	
Content	See interlocking course	
Literature	See interlocking course	

Course L1876: Introduction into Medical Technology and Systems	
Тур	Recitation Section (large)
Hrs/wk	1
CP	1
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14
Lecturer	Prof. Alexander Schlaefer
Language	DE
Cycle	SoSe
Content	See interlocking course
Literature	See interlocking course

Courses	
Title	Typ Hrs/wk CP
Introduction to Physiology (L0385)	Lecture 2 3
Module Responsible	Dr. Roger Zimmermann
Admission Requirements	None
Recommended Previous	None
Knowledge	
Educational Objectives	After taking part successfully, students have reached the following learning results
Professional Competence	
Knowledge	The students can
	describe the basics of the energy metabolism;
	 describe the basics of the chergy inclubingin, describe physiological relations in selected fields of muscle, heart/circulation, neuro- and sensory physiology.
Skills	The students can describe the effects of basic bodily functions (sensory, transmission and processing of information, developm
	of forces and vital functions) and relate them to similar technical systems.
Personal Competence	
Social Competence	
	The students can find solutions to problems in the field of physiology, both analytical and metrological.
Autonomy	The students can derive answers to questions arising in the course and other physiological areas, using technical literature,
,	themselves.
	Independent Study Time 62, Study Time in Lecture 28
Credit points	3
Examination	Written exam
Examination duration and	60 minutes
scale	
-	
Following Curricula	General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Biomechan
	Compulsory
	Electrical Engineering: Specialisation Medical Technology: Elective Compulsory
	Engineering Science: Specialisation Biomedical Engineering: Elective Compulsory
	General Engineering Science (English program, 7 semester): Specialisation Biomedical Engineering: Elective Compulsory Mechanical Engineering: Specialisation Biomechanics: Compulsory
	Mechanical Engineering: Specialisation Biomechanics: Compulsory Mechatronics: Specialisation Medical Engineering: Compulsory
	Biomedical Engineering: Specialisation Medical Technology and Control Theory: Elective Compulsory
	Biomedical Engineering: Specialisation Management and Business Administration: Elective Compulsory
	Biomedical Engineering: Specialisation Artificial Organs and Regenerative Medicine: Elective Compulsory
	Biomedical Engineering: Specialisation Implants and Endoprostheses: Elective Compulsory
	Technomathematics: Specialisation III. Engineering Science: Elective Compulsory

Course L0385: Introduction to Physiology	
Тур	Lecture
Hrs/wk	2
CP	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Dr. Gerhard Engler
Language	DE
Cycle	SoSe
Content	
Literature	Taschenatlas der Physiologie, Silbernagl Despopoulos, ISBN 978-3-135-67707-1, Thieme
	Repetitorium Physiologie, Speckmann, ISBN 978-3-437-42321-5, Elsevier

Courses				
Fitle		Тур	Hrs/wk	СР
	rogramming Concepts, Data Handling & Communication (L2689)	Lecture	3	3
	Programming Concepts, Data Handling & Communication (L2690)	Recitation Section (small)	2	3
Module Responsible				
	None			
Recommended Previous				
Knowledge				
-	After taking part successfully, students have reached the foll	owing learning results		
Professional Competence	······································	······		
Knowledge				
Skills				
SKIIIS				
Personal Competence				
Social Competence				
Autonomy				
Workload in Hours	Independent Study Time 110, Study Time in Lecture 70			
Credit points	6			
Course achievement	Compulsory Bonus Form Description			
	No 10 % Attestation Testate fi	nden semesterbegleitend statt.		
Examination				
Examination duration and	120 min			
scale				
	General Engineering Science (German program, 7 seme	ster): Specialisation Mechanica	l Engineering, F	ocus Biomechan
Following Curricula				
	General Engineering Science (German program, 7 semester)			
	General Engineering Science (German program, 7 semester)	: Specialisation Green Technolog	ies, Focus Renew	able Energy: Elect
	Compulsory	() Constaliantian Machanian (E E E E E E E E E E E E E E E E E E E
	General Engineering Science (German program, 7 semesi	er): Specialisation Mechanical	Engineering, Foc	us Energy Syster
	Compulsory	tor), Enocialization Machanical	Engineering Eeg	us Aircraft Syste
	General Engineering Science (German program, 7 semes Engineering: Compulsory	ter): Specialisation Mechanical	Engineering, Foc	us Aircrait Syste
	General Engineering Science (German program, 7 seme	ester): Specialisation Mechanica	al Engineering I	-
	Compulsory		i Ligilecilig, i	
	General Engineering Science (German program, 7 semester): Specialisation Mechanical Eng	ineerina. Focus P	roduct Developm
	and Production: Elective Compulsory		5.	
	General Engineering Science (German program, 7 semester)	: Specialisation Mechanical Engi	neering, Focus Th	eoretical Mechan
	Engineering: Elective Compulsory			
	General Engineering Science (German program, 7 semester)	Specialisation Electrical Enginee	ering: Elective Co	mpulsory
	Bioprocess Engineering: Core Qualification: Compulsory			
	Chemical and Bioprocess Engineering: Core Qualification: Co	mpulsory		
	Electrical Engineering: Core Qualification: Compulsory			
	Green Technologies: Energy, Water, Climate: Specialisation E	Energy Systems / Renewable Ene	rgies: Elective Co	mpulsory
	Logistics and Mobility: Specialisation Information Technology			
	Mechatronics: Specialisation Robot- and Machine-Systems: C			
	Mechatronics: Specialisation Medical Engineering: Compulso			
	Mechatronics: Specialisation Dynamic Systems and AI: Comp			
	Mechatronics: Specialisation Electrical Systems: Elective Con	npulsory		
	Process Engineering: Core Qualification: Compulsory			

Course L2689: Computer Science for Engineers - Programming Concepts, Data Handling & Communication	
Тур	Lecture
Hrs/wk	3
CP	3
Workload in Hours	Independent Study Time 48, Study Time in Lecture 42
Lecturer	Prof. Sibylle Fröschle
Language	DE
Cycle	SoSe
Content	
Literature	John V. Guttag: Introduction to Computation and Programming Using Python.
	With Application to Understanding Data. 2nd Edition. The MIT Press, 2016.

Course L2690: Computer Science for Engineers - Programming Concepts, Data Handling & Communication	
Тур	Recitation Section (small)
Hrs/wk	2
CP	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Prof. Sibylle Fröschle
Language	DE
Cycle	SoSe
Content	See interlocking course
Literature	See interlocking course

Courses	
	Ture Hawkule CD
Title Experimental Methods in Biomecha	anics (L0377) Typ Hrs/wk CP 2 3
Module Responsible	
•	
Admission Requirements	
Kecommended Previous Knowledge	It is recommended to participate in "Implantate und Frakturheilung" before attending "Experimentelle Methoden".
	After taking part successfully, students have reached the following learning results
	After taking part successfully, students have reached the following learning results
Professional Competence	
Knowledge	The course deals with common experimental methods used in biomechanics. For each topic an overview and some basic practic knowledge is provided.
	1. Tribology
	2. Optical Methods
	3. Motion Analysis
	4. Pressure Distribution
	5. Strain Gauges
	6. Pre-clinical testing
	7. Specimen Preparation and Storage
	The students can describe the different ways how bones heal, and the requirements for their existence.
	The students can name different treatments for the spine and hollow bones under given fracture morphologies.
	The students can describe different measurement techniques for forces and movements, and choose the adequate technique for given task.
Skills	The students can describe the basic handling of several experimental techniques used in biomechanics.
Personal Competence	
Social Competence	Students are able to organize themselves as a group to solve simple experimental tasks together. On the one hand, the division tasks must be organized during the experiment as well as during the short written elaboration, but on the other hand, the knowledge acquired must be available to all participants of the group afterwards. The challenge here is that the topics chan quickly because fundamentally different measurement principles are taught. In addition, a strict time management is expected.
Autonomy	Students perform simple experimental tasks in small groups or create simple sensors (e.g. strain gauges). The preceding lectus serves as a basis for these experiments. As preparation or follow-up, the theoretical knowledge has to be worked up and related the experimental result. In particular, independent transfer performance is necessary to clarify why experimental observations of show deviations from the theoretical values and how these deviations can be compensated.
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Credit points	3
Course achievement	None
Examination	Written exam
Examination duration and	90 min
scale	
Assignment for the	General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Biomechani
Following Curricula	Compulsory
	General Engineering Science (German program, 7 semester): Specialisation Biomedical Engineering: Compulsory
	Engineering Science: Specialisation Biomedical Engineering: Elective Compulsory
	General Engineering Science (English program, 7 semester): Specialisation Biomedical Engineering: Elective Compulsory
	Mechanical Engineering: Specialisation Biomechanics: Compulsory
	Mechatronics: Specialisation Medical Engineering: Elective Compulsory
	Technomathematics: Specialisation III. Engineering Science: Elective Compulsory

Course L0377: Experimental	Methods in Biomechanics
Тур	Lecture
Hrs/wk	2
СР	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Prof. Michael Morlock, Dr. Gerd Huber
Language	DE
Cycle	SoSe
Content	The course deals with common experimental methods used in biomechanics. For each topic an overview and some basic practical
	knowledge is provided.
	1. Tribology
	2. Optical Methods
	3. Motion Analysis
	4. Pressure Distribution
	5. Strain Gauges
	6. Pre-clinical testing
	7. Specimen Preparation and Storage
Literature	Hoffmann K., Eine Einführung in die Technik des Messens mit Dehnmessstreifen
	White A.A., Panjabi M.M.: Clinical biomechanics of the spine
	Nigg, B.: Biomechanics of the musculo-skeletal system
	Online Hilfe van Mathuusela, https://de.mathuusela.com/hale/mathak/
	Online Hilfe von Mathworks: https://de.mathworks.com/help/matlab/

Specialization Naval Architecture

The Bachelor Course "Naval Architecture" prepares by the elective modules for scientific tasks in naval architecture, ocean engineering and related mechanical engineering disciplines. Thus, the occupational orientation can either related to the design of ships or offshore systems, or to more dedicated areas, such as hydrodynamics or strength of structures.

Module M1118: Hydro	ostatics and Body Plan			
Courses				
Title		Тур	Hrs/wk	СР
Hydrostatics (L1260)		Lecture	2	3
Hydrostatics (L1261)		Recitation Section (large)	2	1
Body Plan (L1452)		Project Seminar	2	2
Module Responsible	Prof. Stefan Krüger			
Admission Requirements	None			
Recommended Previous	Good knowledge in Mathemathics I-III and Mecha	nics I-III.		
Knowledge	It is recommended that the students are familiar	with typical design relevant drawings, e.g. B	ody Plan, GA- Pla	an, Tank Plan etc.
Educational Objectives	After taking part successfully, students have read	hed the following learning results		
Professional Competence				
Knowledge	The lecture enables the student to carry out all necessary theoretical calculations for ship design on a scientific level. The lecture			
	is basic requirement for all following lectures in the	ne subjects shipo design and safety of ships.		
Chille	The student is able to cover out budyostatic cale	whethere to ensure that the ship has sufficie	unt stability lla i	a abla ta daajaa bull
SKIIIS	The student is able to carry out hydrostatic calc forms that are safe against capsizing or sinking.	ulations to ensure that the ship has sufficie	ent stability. He i	s able to design hull
	forms that are sale against capsizing of sinking.			
Personal Competence				
Social Competence	The student gets access to hydrostatical problem	S.		
Autonomy		<u></u>		
	Independent Study Time 96, Study Time in Lectur	re 84		
Credit points				
Course achievement				
	Written exam			
Examination duration and	180 min			
scale				
	General Engineering Science (German program, 7		e: Compulsory	
Following Curricula	Naval Architecture: Core Qualification: Compulsor	Ŷ		

Course L1260: Hydrostatics	
Тур	Lecture
Hrs/wk	2
СР	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Prof. Stefan Krüger
Language	DE
Cycle	SoSe
Content	1. Numerical Integration, Diffrentation, Interpolation
	- Trapezoidal Rule, Simpson, Tschebyscheff, graphical Integration Methods
	- Determination of Areas, 1st and 2nd order Moments
	- Numerical Diffrentation, Spline Interpolation
	2. Buyoancy
	- Principle of Archimedes
	- Equlibrium Floating Condition
	- Equlibrium Computations
	- Hydrostatic Tables and Sounding Tables
	- Trim Tables
	3. Stability at large heeling angles
	- Stability Equation
	- Cross Curves of Stability and Righting Levers
	- Numerical and Graphical Determination of Cross Curves
	- Heeling Moments of Free Surfaces, Water on Deck, Water Ingress
	- Heeling Moments of Different Type

- Balance of Heeling and Righting Moments acc. to BV 1030	
- Intact Stability Code (General Critaria)	

- 4. Linearization of Stability Problems
- Linearization of Restoring Forces and Moments
- Correlation between Metacentric Height and Righting Lever at small heeling angles
- Computation of Path of Metacentric Height for Modern Hull Forms
- Correlation between Righting Lever and Path of Metacentric Height
- Hydrostatic Stiffness Matrix
- Definition of MCT
- Computation of Equilibrum Floating Conditions from Hydrostatic Tables
- Effect of Free Surfaces on Initial GM
- Roll Motions at Small Roll Angles

6. Stability in Waves

- Roll Motions at Large Amplitudes
- Pure Loss of Stability on the Wave Crest
- Principle of Parametric Excitation
- Principle of Direct Wave Moments
- Grim's Equivalent Wave Concept
- 6 Longitudinal Strength
- Longitudinal Mass Distribution, Shear Forces, Bending Moments
- Longitudinal Strength in Stability Booklet
- 7. Deadweight Survey and Inclining Experiment
- Deplacement Computations from Draft mark Readings
- Weights to go on /come from board
- Inclining Experiment with Heeling Moments from Weights and Heeling Tanks
- Residual Sounding Volumes
- Determination of COG from Metacentric height and from Cross Curves
- Roll Decay Test
- 8. Launching and Docking
 - Launching Plan, Arrangement of Launching Blocks
 - Rigid Body Launching: Tilting, Dumping, Equation of Techel
 - Computation of Launching Event
 - Bottom Pressure and Longitudinal Strength
 - Linear- Elastic Effects
 - Transversal Stability on Slipway and in Dock
- 9. Grounding
- Loss of Buoynacy when Grounded
- Pointwise Grounding
- Ship Grounds on Keel
- 10. Introduction into Damage Stability Problems
 - Added Mass Method
 - Loss of Buoyant Volume Method
 - Simple Equilibrium Computations
 - Intermediate Stages of Flooding (Addes Mass Method), Cross- and Downflooding
 - Water Ingress Through Openings
- 11. Special Problems (optional and agreed upon)
- e.g. Heavy Lift Operations
- e.g. Jacking of Jackup Vessels

	- e.g. Sinking After Water Ingress
Literature	1. Herner/Rusch: Die Theorie des Schiffes
	Fachbuchverlag Leipzig
	2. Henschke
	Schiffstechnisches Handbuch, Band 1
	VEB Technik Verlag Berlin
	3. Das Skript zur Vorlesung, Anwendungsbeispiele und Klausuren sind auf unserer Homepage abrufbar.

Course L1261: Hydrostatics	ourse L1261: Hydrostatics	
Тур	Recitation Section (large)	
Hrs/wk	2	
CP	1	
Workload in Hours	Independent Study Time 2, Study Time in Lecture 28	
Lecturer	Prof. Stefan Krüger	
Language	DE	
Cycle	SoSe	
Content	See interlocking course	
Literature	See interlocking course	

Course L1452: Body Plan	
Тур	Project Seminar
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Prof. Stefan Krüger
Language	DE
Cycle	WiSe
Content	As preparation for the lecture "Hydrostatics", the students must develop a body plan of a modern twin screw vessel (cruise liner, RoPAx- feryy, RoRo) and perform elementary volumetric computations. The body plan is to be developed from a given GA or can be designed freely. All computations shall be based on graphical integration methods. The body plan consists of : - Grid - approx. 20 sections, 5 Waterlines, 5 Buttocks - Computation Volume and centre of buoyancy for several drafts - Computation of Righting Lever curve for a given displacement based on and graphical integration for several heeling angles.
Literature	 Herner/Rusch: Die Theorie des Schiffes Fachbuchverlag Leipzig Henschke Schiffstechnisches Handbuch, Band 1 VEB Technik Verlag Berlin Das Skript zur Vorlesung, Anwendungsbeispiele und Klausuren sind auf unserer Homepage abrufbar.

Courses				
Courses				
Title	1 (11005)	Typ	Hrs/wk	CP 2
Fundamentals of Materials Science Fundamentals of Materials Science	II (Advanced Ceramic Materials, Polymers and Composites) (L0506)	Lecture Lecture	2	2
Physical and Chemical Basics of Ma		Lecture	2	2
Module Responsible				
Admission Requirements	None			
-	Highschool-level physics, chemistry und mathematics			
Knowledge	inglischool-level physics, chemistry and mathematics			
Educational Objectives	After taking part successfully, students have reached the follow	ving learning results		
Professional Competence	Arter taking part successfully, students have reached the follow	ang learning results		
-	The students have acquired a fundamental knowledge on r	metals coramics an	d polymers and can descr	ribe this knowled
Knowledge	comprehensively. Fundamental knowledge here means specific			
	phase transformations, corrosion and mechanical properties. Th			
	for materials and can identify relevant approaches for cha			
	phenomena back to the underlying physical and chemical laws			
Skills	The students are able to trace materials phenomena back t			
	phenomena here refers to mechanical properties such as stre			
	resistance, and to phase transformations such as solidificatio			
	between processing conditions and the materials microstructu	ure, and they can ac	count for the impact of m	icrostructure on 1
	material's behavior.			
Personal Competence				
Social Competence	-			
Autonomy				
Workload in Hours				
Credit points				
Course achievement	None			
Examination Examination duration and	Written exam 180 min			
scale	180 mm			
	Constal Engineering Science (Corman program, 7 comester); S	nocialization Machan	ical Engineering, Compulse	
	General Engineering Science (German program, 7 semester): S General Engineering Science (German program, 7 semester): S			
Following curricula	General Engineering Science (German program, 7 semester): S General Engineering Science (German program, 7 semester): S			i y
	General Engineering Science (German program, 7 semester): S			
	Data Science: Specialisation II. Application: Elective Compulsor		ed Materials. Compulsory	
	Digital Mechanical Engineering: Core Qualification: Compulsory			
	Green Technologies: Energy, Water, Climate: Specialisation Ene		tive Compulsory	
	Logistics and Mobility: Specialisation Engineering Science: Elect			
	Logistics and Mobility: Specialisation Production Management a		e Compulsorv	
	Mechanical Engineering: Core Qualification: Compulsory		1. · · · · 2	
	Mechatronics: Core Qualification: Compulsory			
	Naval Architecture: Core Qualification: Compulsory			
		ative Commuleons		
	Technomathematics: Specialisation III. Engineering Science: Ele	ective Compulsory		
	Technomathematics: Specialisation III. Engineering Science: Ele Engineering and Management - Major in Logistics and Mobili		duction Management and	Processes: Elect

Course L1085: Fundamentals	s of Materials Science i
Тур	Lecture
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Prof. Jörg Weißmüller
Language	DE
Cycle	WiSe
Content	
Literature	Vorlesungsskript
	W.D. Callister: Materials Science and Engineering - An Introduction. 5th ed., John Wiley & Sons, Inc., New York, 2000, ISBN 0-471- 32013-7 P. Haasen: Physikalische Metallkunde. Springer 1994

Course L0506: Fundamentals of Materials Science II (Advanced Ceramic Materials, Polymers and Composites)	
Тур	Lecture
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Prof. Bodo Fiedler, Prof. Gerold Schneider
Language	DE
Cycle	SoSe
Content	Chemische Bindungen und Aufbau von Festkörpern; Kristallaufbau; Werkstoffprüfung; Schweißbarkeit; Herstellung von Keramiken;
	Aufbau und Eigenschaften der Keramik; Herstellung, Aufbau und Eigenschaften von Gläsern; Polymerwerkstoffe,
	Makromolekularer Aufbau; Struktur und Eigenschaften der Polymere; Polymerverarbeitung; Verbundwerkstoffe
Literature	Vorlesungsskript
	W.D. Callister: Materials Science and Engineering -An Introduction-5th ed., John Wiley & Sons, Inc., New York, 2000, ISBN 0-471- 32013-7

Course L1095: Physical and (Chemical Basics of Materials Science
Тур	Lecture
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Gregor Vonbun-Feldbauer
Language	DE
Cycle	WiSe
Content	 Motivation: "Atoms in Mechanical Engineering?" Basics: Force and Energy The electromagnetic Interaction "Detour": Mathematics (complex e-funktion etc.) The atom: Bohr's model of the atom Chemical bounds The multi part problem: Solutions and strategies Descriptions of using statistical thermodynamics Elastic theory of atoms Consequences of atomar properties on makroskopic Properties: Discussion of examples (metals, semiconductors, hybrid systems)
Literature	 Für den Elektromagnetismus: Bergmann-Schäfer: "Lehrbuch der Experimentalphysik", Band 2: "Elektromagnetismus", de Gruyter Für die Atomphysik: Haken, Wolf: "Atom- und Quantenphysik", Springer Für die Materialphysik und Elastizität: Hornbogen, Warlimont: "Metallkunde", Springer

Module M0854: Mathe	ematics IV			
Courses				
Title		Тур	Hrs/wk	СР
Differential Equations 2 (Partial Diff	erential Equations) (L1043)	Lecture	2	1
Differential Equations 2 (Partial Diff	erential Equations) (L1044)	Recitation Section (small)	1	1
Differential Equations 2 (Partial Diff	erential Equations) (L1045)	Recitation Section (large)	1	1
Complex Functions (L1038)		Lecture	2	1
Complex Functions (L1041)		Recitation Section (small)	1	1
Complex Functions (L1042)		Recitation Section (large)	1	1
		Neclation Section (large)	I	1
Module Responsible				
Admission Requirements	None			
Recommended Previous Knowledge	Mathematics I - III			
-	After taking part successfully, students have read	thed the following learning results		
Professional Competence	······································			
Knowledge	 Students can name the basic concepts in N 	Asthematics IV. They are able to explain the	m using appropri	ate examples
	Students can discuss logical connections I	between these concepts. They are capable	or mustrating th	ese connections w
	the help of examples.			
	 They know proof strategies and can reproce 	duce them.		
Skills				
	 Students can model problems in Mathema 	atics IV with the help of the concepts studi	ed in this course	. Moreover, they a
	capable of solving them by applying estab	lished methods.		
	 Students are able to discover and verify full 	rther logical connections between the conce	pts studied in the	e course.
	 For a given problem, the students can dependent of the student of th	evelop and execute a suitable approach a	nd are able to c	ritically evaluate t
		evelop and execute a suitable approach, e		including evaluate i
	results.			
Borsonal Competence				
Personal Competence				
Social Competence	• Chudente ere able te work tegether in tean	They are conclude to use mothermatics as		
	 Students are able to work together in team 			
	 In doing so, they can communicate new communicate 	oncepts according to the needs of their coo	perating partners	. Moreover, they o
	design examples to check and deepen the	understanding of their peers.		
Autonomy				
	 Students are capable of checking their un 	derstanding of complex concepts on their of	own. They can sp	ecify open questic
	precisely and know where to get help in so	lving them.		
	 Students have developed sufficient persis 	stence to be able to work for longer period	ls in a goal-orien	ted manner on ha
		j		
	problems.			
	Independent Study Time 68, Study Time in Lectu	re 112		
Credit points				
Course achievement				
	Written exam			
Examination duration and	60 min (Complex Functions) + 60 min (Differentia	al Equations 2)		
scale				
Assignment for the	General Engineering Science (German program,	7 semester): Specialisation Electrical Engine	ering: Compulsor	у
Following Curricula	General Engineering Science (German progra	m, 7 semester): Specialisation Mechanica	al Engineering	Focus Mechatroni
			537	
	Compulsory			
	General Engineering Science (German program,	7 semester): Specialisation Naval Architectu	re: Compulsory	
	General Engineering Science (German program,	7 semester): Specialisation Mechanical Engi	neering, Focus Th	neoretical Mechani
	Engineering: Elective Compulsory	-		
		loon		
	Electrical Engineering: Core Qualification: Compu	•		
	General Engineering Science (English program, 7	semester): Specialisation Electrical Enginee	ring: Compulsory	
	Computer Science in Engineering: Specialisation	II. Mathematics & Engineering Science: Elect	ive Compulsorv	
	Mechanical Engineering: Specialisation Mechatro		1	
	Mechanical Engineering: Specialisation Theoretic	al Mechanical Engineering: Elective Compuls	sory	
	Mechatronics: Core Qualification: Compulsory			
	Naval Architecture: Core Qualification: Compulso	rv		
	Naval Architecture: Core Qualification: Compulso Theoretical Mechanical Engineering: Technical Co	-	Compulsors	

Course L1043: Differential Equations 2 (Partial Differential Equations)	
Тур	Lecture
Hrs/wk	2
CP	1
Workload in Hours	Independent Study Time 2, Study Time in Lecture 28
Lecturer	Dozenten des Fachbereiches Mathematik der UHH
Language	DE
Cycle	SoSe
Content	Main features of the theory and numerical treatment of partial differential equations
Literature	 Examples of partial differential equations First order quasilinear differential equations Normal forms of second order differential equations Harmonic functions and maximum principle Maximum principle for the heat equation Wave equation Liouville's formula Special functions Difference methods Finite elements http://www.math.uni-hamburg.de/teaching/export/tuhh/index.html

Course L1044: Differential Equations 2 (Partial Differential Equations)	
Тур	Recitation Section (small)
Hrs/wk	1
СР	1
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14
Lecturer	Dozenten des Fachbereiches Mathematik der UHH
Language	DE
Cycle	SoSe
Content	See interlocking course
Literature	See interlocking course

Course L1045: Differential Equations 2 (Partial Differential Equations)	
Тур	Recitation Section (large)
Hrs/wk	1
СР	1
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14
Lecturer	Dozenten des Fachbereiches Mathematik der UHH
Language	DE
Cycle	SoSe
Content	See interlocking course
Literature	See interlocking course

Course L1038: Complex Functions		
Тур	Lecture	
Hrs/wk	2	
CP	1	
Workload in Hours	Independent Study Time 2, Study Time in Lecture 28	
Lecturer	Dozenten des Fachbereiches Mathematik der UHH	
Language	DE	
Cycle	SoSe	
Content	Main features of complex analysis	
	 Functions of one complex variable Complex differentiation Conformal mappings Complex integration Cauchy's integral theorem Cauchy's integral formula Taylor and Laurent series expansion Singularities and residuals Integral transformations: Fourier and Laplace transformation 	
Literature	http://www.math.uni-hamburg.de/teaching/export/tuhh/index.html	

Course L1041: Complex Functions	
Тур	Recitation Section (small)
Hrs/wk	1
CP	1
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14
Lecturer	Dozenten des Fachbereiches Mathematik der UHH
Language	DE
Cycle	SoSe
Content	See interlocking course
Literature	See interlocking course

Course L1042: Complex Functions	
Тур	Recitation Section (large)
Hrs/wk	1
CP	1
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14
Lecturer	Dozenten des Fachbereiches Mathematik der UHH
Language	DE
Cycle	SoSe
Content	See interlocking course
Literature	See interlocking course

Module M0680: Fluid	Dynamics			
	-			
Courses				
Title		Тур	Hrs/wk	СР
Fluid Mechanics (L0454)		Lecture	3	4
Fluid Mechanics (L0455)		Recitation Section (large)	2	2
Module Responsible	Prof. Thomas Rung			
Admission Requirements	None			
Recommended Previous	Students should have sound knowledge of engineering mat	hematics, engineering mechanics	and thermodyna	nics.
Knowledge				
Educational Objectives	After taking part successfully, students have reached the fo	llowing learning results		
Professional Competence				
Skills	Students will have the required sound knowledge to explain the general principles of fluid engineering and physics of fluids. The are familiar with the similarities and differences between fluid mechanics and neighbouring subjects (thermodynamics, structura mechanics). Students can scientifically outline the rationale of flow physics using mathematical models. They are familiar with most performance analysis methods -in particular their realms and limitations- and the prediction of fluid engineering devices. Students are able to apply fluid-engineering principles and flow-physics models for the analysis of technical systems. They are able			
Personal Competence	to explain physical relationships used to design fluid en necessary theoretical calculations for the fluid dynamic des	ign of engineering devices on a sc	ientific level.	
Social Competence	The students are able to discuss problems, present the re- address given technical goals.	sults of their own analysis, and jc	intly develop sol	ution strategies th
Autonomy	The students are able to develop solution strategies for co results as well as external data with regards to the plausibil		ney are able to c	ritically analyse ov
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	General Engineering Science (German program, 7 semester): Specialisation Mechanical Engin	eering: Compulso	ory
Following Curricula	General Engineering Science (German program, 7 semester): Specialisation Biomedical Engin	eering: Compulso	ory
	General Engineering Science (German program, 7 semester): Specialisation Naval Architectur	e: Compulsory	
	Mechanical Engineering: Core Qualification: Compulsory			
	Naval Architecture: Core Qualification: Compulsory			
	Technomathematics: Specialisation III. Engineering Science	Elective Compulsory		

Course L0454: Fluid Mechani	ics
Тур	Lecture
Hrs/wk	3
CP	4
Workload in Hours	Independent Study Time 78, Study Time in Lecture 42
Lecturer	Prof. Thomas Rung
Language	DE/EN
Cycle	SoSe
Content	 continuum physics definition of fluids, difference to solids/structures and material properties of fluids dimensional analysis and similitude fluid forces and fluid statics transport and conservation of mass, momentum & energy fluid kinematics technically relevant flow models for incompressible fluids control volume & stream tube analysis vortical flow models potential flows boundary layer flows different types of conservation equations and their realm (Navier-Stokes/Euler/Bernoulli equations) analytical solutions for Navier-Stokes systems Analysis of internal flows (channels, pipes, open channels) and external flows, fundamentals of wing aerodynamics turbulent flows
Literature	 fundamentals of gas dynamics (1D compressible flows) the course primarily refers to / das Modul stütz sich bevorzugt auf : Munson, B.R.; Rothmayer, A.P.; Okiishi, T.H.; Huebsch, W.W.: Fundamentals of Fluid Mechanics, John Wiley & Sons. Spurk, J.; Aksel, N.: Strömungslehre, Springer. Schade, H.; Kunz, E., Kameier, F.; Paschereit, C.O.: Strömungslehere, De Gruyter. Herwig, H.: Strömungsmechanik, Springer. Herwig, H.: Strömungsmechanik von A-Z, Vieweg.

ourse L0455: Fluid Mechanics	
Тур	Recitation Section (large)
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Prof. Thomas Rung
Language	DE/EN
Cycle	SoSe
Content	See interlocking course
Literature	See interlocking course

Courses				
Title		Тур	Hrs/wk	СР
Computational Mechanics (Exercise	es) (L1138)	Recitation Section (small)	2	2
Computational Multibody Dynamics (L1137)		Integrated Lecture	2	2
Computational Stuctural Mechanics	s (L2475)	Integrated Lecture	2	2
Module Responsible	Prof. Robert Seifried			
Admission Requirements	None			
Recommended Previous	Mathematics I-III and Engineering Mechanics	1-111		
Knowledge				
Educational Objectives	After taking part successfully, students have	reached the following learning results		
Professional Competence				
Knowledge	The students can			
	describe the axiomatic procedure use			
	explain important steps in model desire	gn;		
	 present technical knowledge. 			
Skills	The students can			
		athematical / mechanical analysis and model for	mation, and appl	y it to the context
	their own problems;			
	 apply basic methods from numerical r 			
	 estimate the reach and boundaries of 	the methods and extend them to be applicable	o wider problem	sets.
Personal Competence				
	The students can work in groups and suppor	t each other to overcome difficulties.		
Autonomy	Students are capable of determining their ov	vn strengths and weaknesses and to organize th	eir time and learn	ing based on those
Workload in Hours	Independent Study Time 96, Study Time in L	ecture 84		
Credit points	6			
Course achievement	None			
Examination	Written exam			
Examination duration and				
scale				
Assignment for the	General Engineering Science (German progra	am, 7 semester): Specialisation Mechanical Engi	neering: Compuls	orv
Following Curricula		am, 7 semester): Specialisation Biomedical Engli		
		am, 7 semester): Specialisation Naval Architectu		
	Energy Systems: Technical Complementary		iei eeinpaisei j	
	Mechanical Engineering: Core Qualification:			
	Mechatronics: Core Qualification: Compulsor			
	Naval Architecture: Core Qualification: Comp	•		
	Technomathematics: Specialisation III. Engin			
		al Complementary Course Core Studies: Elective	Compulsory	

Course LI138: Computational Mechanics (Exercises)		
Тур	Recitation Section (small)	
Hrs/wk	2	
СР	2	
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28	
Lecturer	Prof. Robert Seifried, Prof. Christian Cyron	
Language	DE	
Cycle	SoSe	
Content		
Literature	K. Magnus, H.H. Müller-Slany: Grundlagen der Technischen Mechanik. 7. Auflage, Teubner (2009).	
	D. Gross, W. Hauger, J. Schröder, W. Wall: Technische Mechanik 1-4. 11. Auflage, Springer (2011).	

Course L1137: Computational Multibody Dynamics		
Тур	Integrated Lecture	
Hrs/wk	2	
CP	2	
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28	
Lecturer	Prof. Robert Seifried	
Language	DE	
Cycle	SoSe	
Content	 Linear versus nonlinear vibration Numerical methods for time integration Concepts from analytical mechanics Spatial multibody systems Linearization of multibody systems Vibrations with multiple degrees of freedom: free, damped, forced, modal transformation Impacts Introduction to Matlab 	
Literature	K. Magnus, H.H. Müller-Slany: Grundlagen der Technischen Mechanik. 7. Auflage, Teubner (2009). D. Gross, W. Hauger, J. Schröder, W. Wall: Technische Mechanik 1-4. 11. Auflage, Springer (2011). W. Schiehlen, P. Eberhard: Technische Dynamik, Springer (2012).	

ourse L2475: Computational Stuctural Mechanics		
Тур	Integrated Lecture	
Hrs/wk	2	
CP	2	
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28	
Lecturer	Prof. Christian Cyron	
Language	DE	
Cycle	SoSe	
Content	The lecture Computational Structural Mechanics extends the content of the lecture Engineering Mechanic II. It bridges the gap	
	between the manual calculation of mechanical stress and deformation in systems with a particularly simple geometry and the	
	efficent computer-based computation of general mechanical systems:	
	Basics of linear continuum mechanics	
	Planar structures: plate, membrane, slab	
	Linientragwerke: beam, cable, truss	
	Weak form and Galerkin's method	
	Finite element method: theory and application	
	Principles of mechanics: principle of virtual work, virtual displacements, virtual forces	
Literature	Gross, Hauger, Wriggers, "Technische Mechanik 4", Springer	

Module Responsible F Admission Requirements N Recommended Previous Knowledge Educational Objectives A Professional Competence Knowledge	n Naval Architecure and Ocean Engineering (L0364) Prof. Moustafa Abdel-Maksoud None • Technical mechanics • Linear algebra, analysis, complex numbers • Fluid mechanics After taking part successfully, students have reached the The students are able to give an overview over various procedure of the manoeuvres. The students are able to give an overview over varius i	s manoeuvres. They can name applica	Hrs/wk 2 1 2	CP 3 1 3			
ip Dynamics (L1620) atistics and Stochastic Processes in Module Responsible F Admission Requirements N Recommended Previous Knowledge Educational Objectives A Professional Competence Knowledge	Prof. Moustafa Abdel-Maksoud None • Technical mechanics • Linear algebra, analysis, complex numbers • Fluid mechanics After taking part successfully, students have reached the The students are able to give an overview over various procedure of the manoeuvres.	Recitation Section (small) Lecture e following learning results s manoeuvres. They can name applica	1 2	1 3			
atistics and Stochastic Processes in Module Responsible F Admission Requirements N Recommended Previous Knowledge F Educational Objectives A Professional Competence Knowledge F	Prof. Moustafa Abdel-Maksoud None • Technical mechanics • Linear algebra, analysis, complex numbers • Fluid mechanics After taking part successfully, students have reached the The students are able to give an overview over various procedure of the manoeuvres.	Lecture e following learning results s manoeuvres. They can name applica	2	3			
Module Responsible F Admission Requirements N Recommended Previous Knowledge Educational Objectives A Professional Competence Knowledge	Prof. Moustafa Abdel-Maksoud None • Technical mechanics • Linear algebra, analysis, complex numbers • Fluid mechanics After taking part successfully, students have reached the The students are able to give an overview over various procedure of the manoeuvres.	e following learning results s manoeuvres. They can name applica					
Admission Requirements A Recommended Previous Knowledge Educational Objectives A Professional Competence Knowledge	None Technical mechanics Linear algebra, analysis, complex numbers Fluid mechanics After taking part successfully, students have reached the The students are able to give an overview over various procedure of the manoeuvres.	s manoeuvres. They can name applica	ation goals and t	hey can describe			
Recommended Previous Knowledge Educational Objectives Professional Competence Knowledge From the second secon	 Technical mechanics Linear algebra, analysis, complex numbers Fluid mechanics After taking part successfully, students have reached the taking part able to give an overview over various procedure of the manoeuvres.	s manoeuvres. They can name applica	tion goals and t	hey can describe			
Knowledge # Educational Objectives # Professional Competence # Knowledge #	 Linear algebra, analysis, complex numbers Fluid mechanics After taking part successfully, students have reached the The students are able to give an overview over various procedure of the manoeuvres. 	s manoeuvres. They can name applica	ation goals and t	hey can describe			
Educational Objectives A Professional Competence Knowledge	Fluid mechanics After taking part successfully, students have reached the The students are able to give an overview over various procedure of the manoeuvres.	s manoeuvres. They can name applica	ation goals and t	hey can describe			
Professional Competence Knowledge -	After taking part successfully, students have reached the The students are able to give an overview over various procedure of the manoeuvres.	s manoeuvres. They can name applica	ation goals and t	hey can describe			
Professional Competence Knowledge -	The students are able to give an overview over various procedure of the manoeuvres.	s manoeuvres. They can name applica	ation goals and t	hey can describe			
Knowledge -	procedure of the manoeuvres.		ation goals and t	hey can describe			
7	procedure of the manoeuvres.		ation goals and t	hey can describe			
·		rudder types. They can name criteria i					
-	The students are able to give an overview over varius i	rudder types. They can name criteria i					
	5		- The students are able to give an overview over varius rudder types. They can name criteria in the rudder design.				
-	The students can name computation methods which ar	re used to determine forces and motio	ns in waves.				
Skills -	The students can come up with the equations of motion	ns which are used to discribe manoeu	vres. The can use	e and linearise the			
	The students are able to determine hydrodynamic coef						
-	- The students can explain how a rudder works and they can explain the physical effects which can occur.						
	- The students can mathematically describe waves.						
-	- The students can explain the mathematically description of harmoncial motions in waves and they can determine them.						
Personal Competence							
-	The students can arrive at work results in groups and c	document them.					
-	The students can discuss in groups and explain their po	oint of view.					
Autonomy -	The students can assess their own strengthes and wea	knesses and the define further work s	teps on this basi	s.			
Workload in Hours	ndependent Study Time 140, Study Time in Lecture 70						
Credit points 7	7						
Course achievement	None						
Examination V	Nritten exam						
Examination duration and 1	L80 min						
scale							

T	Lecture
Тур	
Hrs/wk	
СР	
Workload in Hours	
	Prof. Moustafa Abdel-Maksoud
Language	DE
Cycle	SoSe
Content	Maneuverability of ships
	Equations of motion
	Hydrodynamic forces and moments
	Linear equations and their solutions
	 Full-scale trials for evaluating the maneuvering performance
	Regulations for maneuverability
	Rudder
	Seakeeping
	Representation of harmonic processes
	Motions of a rigid ship in regular waves
	 Flow forces on ship cross sections
	Strip method
	Consequences induced by ship motion in regular waves
	Behavior of ships in a stationary sea state
	Long-term distribution of seaway influences
Literature	
	 Abdel-Maksoud, M., Schiffsdynamik, Vorlesungsskript, Institut f ür Fluiddynamik und Schiffstheorie, Technische Univers Hamburg-Harburg, 2014
	 Abdel-Maksoud, M., Ship Dynamics, Lecture notes, Institute for Fluid Dynamic and Ship Theory, Hamburg University Technology, 2014
	 Bertram, V., Practical Ship Design Hydrodynamics, Butterworth-Heinemann, Linacre House - Jordan Hill, Oxford, Un Kingdom, 2000
	Bhattacharyya, R., Dynamics of Marine Vehicles, John Wiley & Sons, Canada,1978
	Brix, J. (ed.), Manoeuvring Technical Manual, Seehafen-Verlag, Hamburg, 1993
	Claus, G., Lehmann, E., Östergaard, C). Offshore Structures, I+II, Springer-Verlag. Berlin Heidelberg, Deutschland, 1992
	Faltinsen, O. M., Sea Loads on Ships and Offshore Structures, Cambridge University Press, United Kingdom, 1990
	Handbuch der Werften, Deutschland, 1986
	Jensen, J. J., Load and Global Response of Ships, Elsevier Science, Oxford, United Kingdom, 2001
	 Lewis, Edward V. (ed.), Principles of Naval Architecture - Motion in Waves and Controllability, Society of Naval Architects - Marine Engineers, Jersey City, NJ, 1989
	 Lewandowski, E. M., The Dynamics of Marine Craft: Maneuvering and Seakeeping, World Scientific, USA, 2004
	 Lloyd, A., Ship Behaviour in Rough Weather, Gosport, Chichester, Sussex, United Kingdom, 1998

ourse L1620: Ship Dynamics		
Тур	Recitation Section (small)	
Hrs/wk	1	
CP	1	
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14	
Lecturer	Prof. Moustafa Abdel-Maksoud	
Language	DE	
Cycle	SoSe	
Content	See interlocking course	
Literature	See interlocking course	

	Stochastic Processes in Naval Architecure and Ocean Engineering Lecture		
Hrs/wk			
	3		
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28		
Lecturer	DrIng. Ulf Göttsche		
Language	DE		
Cycle	WiSe		
Content	 descriptive statistics, parameter, criteria for outliers sample, sample space, probability, probability space Bayes method, conditional probability, law of total probability Discrete and continuous random variables Probability distributions mixed and joint random variables and their distribution Characteristics of random variables (expectation, variance, skewness, kurtosis,) (central) limit theorem Stochastic processes Statistical description of seaway, harmonic analysis of seaway narrow-banded Gaussian process, seaway and its characteristics sea- and wind spectra transformation of spectra, transfer function 		
Literature	 V. Müller, Statistik und Stochastik in der Schiffs- und Meerestechnik, Vorlesungsskript, Institut für Fluiddynamik und Schiffstheorie, Technische Universität Hamburg-Harburg, 2014 W. Blendermann "Grundlagen der Wahrscheinlichkeitsrechnung", Vorlesungsskript, Arbeitsbereich Fluiddynamik und Schiffstheorie, Technische Universität Hamburg-Harburg, 2001 H. W. Coleman, W. G. Steele, Experimentation and Uncertainty Analysis for Engineers, 3 rd Edition, John Wiley & Sons, Inc., New York, NY, 2009 ITTC Recommended Procedures and Guidelines, In: Quality Systems Manual, International Towing Tank Conference (ITTC), 2011 F.M. Dekking, C. Kraaikamp, H.P. Lopuhaä, L.E. Meester, A Modern Introduction To Probability and Statistics, Springer, 2005 Springer Handbook of Engineering Statistics, H. Pham (Hrsg.), Springer, 2006 A. Klenke, Wahrscheinlichkeitstheorie, Springer, 2013 		

Courses					
Title		Turn	Hee /uule	СР	
Fundamentals of Ship Structural De	sign (10411)	Typ Lecture	Hrs/wk 2	2	
Fundamentals of Ship Structural De	5	Recitation Section (small)	1	2	
Fundamentals of Ship Structural Ar		Lecture	2	2	
Fundamentals of Ship Structural Ar	-	Recitation Section (small)	1	2	
Module Responsible					
Admission Requirements					
Recommended Previous					
	Knowledge Fundamentals of Materials Science I - III				
	Welding Technology I				
	Fundamentals of Mechanical Design I - III				
	rundamentals of Mechanical Design 1- In				
	After teling part successfully, students bays to	a check the following leavening years the			
	After taking part successfully, students have re	ached the following learning results			
Professional Competence	Chudanta and an and the basis and the state				
Knowledge	Students can reproduce the basic contents of t		y can explain the	e theory and meth	
	for the calculation of deformations and stresses	s in beam-like structures.			
	Furthermore, they can reproduce the basis co	ntents of codes (rules), materials, semi-finish	ed products, join	ing and principle	
	Furthermore, they can reproduce the basis contents of codes (rules), materials, semi-finished products, joining and principles structural design of components in the ship structure.				
Skills	Students are capable of applying the method	Is and tools for the calculation of linear det	ormations and st	tresses in the ah	
SKIIS	S Students are capable of applying the methods and tools for the calculation of linear deformations and stresses in the abc mentioned structures; they can choose calculation models of typical ship structures.				
	mentioned structures, they can choose calculation models of typical ship structures.				
	Furthermore, they are capable to apply the me	ethods of drawing and sizing the ship structu	re; they can sele	ct suitable materi	
	semi-finished products and joints.				
Personal Competence					
Social Competence	The students are able to communicate and co	poperate in a professional environment in th	e shipbuilding an	nd component su	
	industry.				
	<u>-</u>				
Autonomy	The students are capable to independently ide		ble methods for a	analysis of beam-	
	structures; they are capable to assess the results of structural analyses.				
	Furthermore, they are capable to assess drawings of complex ship structures and to design ship structures for vario				
	requirements and boundary conditions.				
Workload in Hours	Independent Study Time 156, Study Time in Le	cture 84			
Credit points					
Course achievement	None				
Examination	Written exam				
Eveningtion dynation and	2 haura				
Examination duration and	5 hours				
scale	Conoral Engineering Science (Cormon program	7 competer): Specialization Naval Architecture	ro: Compulson:		
-	General Engineering Science (German program				
Following Curricula	Green Technologies: Energy, Water, Climate: S		Lompuisory		
	Mechatronics: Specialisation Naval Engineering				
	Orientation Studies: Core Qualification: Elective Naval Architecture: Core Qualification: Compute				

Course L0411: Fundamentals	s of Ship Structural Design
Тур	Lecture
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Dr. Rüdiger Ulrich Franz von Bock und Polach
Language	DE
Cycle	WiSe
Content	Chapters:
	1. Introduction
	3. Class societies and their tasks
	4. Materials for steel shipbuilding
	5. Welding and Cutting
	6. Semi-finished products in steel shipbuilding
	7. Determining the scantlings for local loads
	8. Longitudinal strength of the hull girder
	9. Determining the scantlings of longitudinal structural members
	10. Determining the scantlings of bottom and side structures
	11. Decks and Hatch Openings
	12. Effective breadth
	13. Iterative determination of scantlings (POSEIDON)
Literature	Vorlesungsskript mit weiteren Literaturangaben wird über das Internet verfügbar gemacht

Course L0413: Fundamentals	s of Ship Structural Design
Тур	Recitation Section (small)
Hrs/wk	1
CP	2
Workload in Hours	Independent Study Time 46, Study Time in Lecture 14
Lecturer	Dr. Rüdiger Ulrich Franz von Bock und Polach
Language	DE
Cycle	WiSe
Content	Chapters:
	1. Introduction
	3. Class societies and their tasks
	4. Materials for steel shipbuilding
	5. Welding and Cutting
	6. Semi-finished products in steel shipbuilding
	7. Determining the scantlings for local loads
	8. Longitudinal strength of the hull girder
	9. Determining the scantlings of longitudinal structural members
	10. Determining the scantlings of bottom and side structures
	11. Decks and Hatch Openings
	12. Effective breadth
	13. Iterative determination of scantlings (POSEIDON)
Literature	Vorlesungsskript mit weiteren Literaturangaben wird über das Internet verfügbar gemacht

Course L0410: Fundamentals	Course L0410: Fundamentals of Ship Structural Analysis		
Тур	Lecture		
Hrs/wk	2		
CP	2		
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28		
Lecturer	Prof. Sören Ehlers		
Language	DE		
Cycle	WiSe		
Content	Contents:		
	1. Introduction		
	2. Finite element method (f.e. method) by the example of trussworks		
	3. Force methods for frameworks		
	4. F.e. method for frameworks		
	5. Shear and torsion in thin-walled beams		
	6. Beams subjected to longitudinal forces		
Literature	Vorlesungsskript mit weiteren Literaturangaben; div. Bücher über die Methode der finiten Elemente		

Course L0414: Fundamentals	urse L0414: Fundamentals of Ship Structural Analysis		
Тур	Recitation Section (small)		
Hrs/wk	1		
CP	2		
Workload in Hours	Independent Study Time 46, Study Time in Lecture 14		
Lecturer	Prof. Sören Ehlers		
Language	DE		
Cycle	WiSe		
Content	Contents:		
	1. Introduction		
	2. Finite element method (f.e. method) by the example of trussworks		
	3. Force methods for frameworks		
	4. F.e. method for frameworks		
	5. Shear and torsion in thin-walled beams		
	6. Beams subjected to longitudinal forces		
Literature	Vorlesungsskript mit weiteren Literaturangaben; div. Bücher über die Methode der finiten Elemente		

Courses					
Title		Тур	Hr	s/wk	СР
Ship Structural Design (L0412)		Lecture	2		3
Ship Structural Design (L0415)		Recitation Section (small) 2		3
Welding Technology (L1123)		Lecture	3		3
Module Responsible	Prof. Sören Ehlers				
Admission Requirements	None				
Recommended Previous	Mechanics I - III				
Knowledge	wledge Fundamentals of Materials Science I - III				
	Welding Technology I				
	Fundamentals of Mechanical Design I - III				
Educational Objectives	After taking part successfully, students ha	ve reached the following learning results			
Professional Competence					
Knowledge	Students can reproduce design and sizing	as well as fabrication of the different are	as of ship structu	res and of	different ship ty
	(incl. detail design); they can describe cald	ulation models for complex structures.			
Skills	Students are capable to specify the requi			define de	esign criteria for
Skills	Students are capable to specify the requi components, to select suitable calculation			define de	esign criteria for
Personal Competence	components, to select suitable calculation	models and to assess the chosen structu	re		esign criteria for
Personal Competence	components, to select suitable calculation	models and to assess the chosen structu	re		esign criteria for
Personal Competence Social Competence	components, to select suitable calculation	models and to assess the chosen structu	re constructively in a	group.	
Personal Competence Social Competence	components, to select suitable calculation Students are capable to present their struc	models and to assess the chosen structu	re constructively in a	group.	
Personal Competence Social Competence	components, to select suitable calculation Students are capable to present their struc Students are capable to design independ	models and to assess the chosen structu	re constructively in a	group.	
Personal Competence Social Competence	components, to select suitable calculation Students are capable to present their struc Students are capable to design independ	models and to assess the chosen structu	re constructively in a	group.	
Personal Competence Social Competence	components, to select suitable calculation Students are capable to present their struc Students are capable to design independ	models and to assess the chosen structu	re constructively in a	group.	
Personal Competence Social Competence Autonomy	components, to select suitable calculation Students are capable to present their struc Students are capable to design independ	models and to assess the chosen structu tural design and discuss their decisions o ently different structural areas of the st	re constructively in a	group.	
Personal Competence Social Competence Autonomy	components, to select suitable calculation Students are capable to present their struc Students are capable to design independ appropriate fabrication methods.	models and to assess the chosen structu tural design and discuss their decisions o ently different structural areas of the st	re constructively in a	group.	
Personal Competence Social Competence Autonomy Workload in Hours	components, to select suitable calculation Students are capable to present their struc Students are capable to design independ appropriate fabrication methods. Independent Study Time 172, Study Time 9	models and to assess the chosen structu tural design and discuss their decisions o ently different structural areas of the st	re constructively in a	group.	
Personal Competence Social Competence Autonomy Workload in Hours Credit points Course achievement	components, to select suitable calculation Students are capable to present their struc Students are capable to design independ appropriate fabrication methods. Independent Study Time 172, Study Time 9	models and to assess the chosen structu tural design and discuss their decisions o ently different structural areas of the st	re constructively in a	group.	
Personal Competence Social Competence Autonomy Workload in Hours Credit points Course achievement	components, to select suitable calculation Students are capable to present their struc Students are capable to design independ appropriate fabrication methods. Independent Study Time 172, Study Time 9 None Written exam	models and to assess the chosen structu tural design and discuss their decisions o ently different structural areas of the st	re constructively in a	group.	
Personal Competence Social Competence Autonomy Workload in Hours Credit points Course achievement Examination	components, to select suitable calculation Students are capable to present their struc Students are capable to design independ appropriate fabrication methods. Independent Study Time 172, Study Time 9 None Written exam	models and to assess the chosen structu tural design and discuss their decisions o ently different structural areas of the st	re constructively in a	group.	
Personal Competence Social Competence Autonomy Workload in Hours Credit points Course achievement Examination	components, to select suitable calculation Students are capable to present their struc Students are capable to design independ appropriate fabrication methods. Independent Study Time 172, Study Time 9 None Written exam 3 hours	n Lecture 98	re constructively in a hip hull and differ	group. rent ship f	

Course L0412: Ship Structura	al Design	
Тур	Lecture	
Hrs/wk	2	
CP	3	
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28	
Lecturer	r. Rüdiger Ulrich Franz von Bock und Polach	
Language	DE	
Cycle	SoSe	
Content	Chapters:	
	1. Bulkheads and tanks	
	2. Structural design of forebodies	
	3. Structures in engine rooms	
	4. Aft bodies and rudders	
	5. Detail structural design	
	6. Outfitting	
	7. Bulk carriers	
	8. Tankers	
	9. Container ships	
	10. Production-kind steel structural design	
	11. Buckling and ultimate strength	
	12. Safety factors and reliability of structures	
Literature	Vorlesungsskript mit weiteren Literaturangaben wird über das Internet verfügbar gemacht	

Course L0415: Ship Structura	al Design
Тур	Recitation Section (small)
Hrs/wk	2
CP	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Dr. Rüdiger Ulrich Franz von Bock und Polach
Language	DE
Cycle	SoSe
Content	Chapters:
	 Bulkheads and tanks Structural design of forebodies Structures in engine rooms Aft bodies and rudders Detail structural design Outfitting Bulk carriers Tankers Container ships Production-kind steel structural design Buckling and ultimate strength Safety factors and reliability of structures
Literature	Vorlesungsskript mit weiteren Literaturangaben wird über das Internet verfügbar gemacht

Course L1123: Welding Tech	nology
Тур	Lecture
Hrs/wk	3
CP	3
Workload in Hours	Independent Study Time 48, Study Time in Lecture 42
Lecturer	Prof. Claus Emmelmann, Prof. Karl-Ulrich Kainer
Language	DE
Cycle	WiSe
Content	- phase transitions, phase diagrams and thermal activated processes
	- fundamentals of steels, heat treatment applications for steels and time temperature transformation diagrams
	- properties of weldable carbon and fine grained steels
	- properties of weldable low- and high-alloy steels, corrosion resistant steels and high-strength steels
	- structure and properties of non-ferrite metals (aluminum, titanium)
	- NDT/DT Methods for materials and welds
	- gas fusion welding, fundamentals of electric arc welding technologies
	- structure and influence parameters for the welded joint
	- submerged arc welding/tungsten inert gas welding/inert gas metal arc welding (MIG)/active gas metal arc welding (MAG)/Plasma Welding
	- resistance welding/ polymer welding/ hybrid-welding
	- deposition welding
	- electron beam welding/ laser beam welding
	- weld joint designs and declarations
	- computation methods for weld joint dimensioning
Literature	Schulze, G.: Die Metallurgie des Schweißens, 4. Aufl., Berlin 2010 Strassburg, F.W. und Wehner H.: Schweißen nichtrostender Stähle, 4. Aufl. Düsseldorf, 2009 Dilthey, U.: Schweißtechnische Fertigungsverfahren, Bd. 1: Schweiß- und Schneidtechnologien, 3. Aufl., Berlin 2006.
	Dilthey, U.: Schweißtechnische Fertigungsverfahren, Bd. 2: Verhalten der Werkstoffe beim Schweißen, 3. Aufl., Berlin 2005.
	Dilthey, U.: Schweißtechnische Fertigungsverfahren, Bd. 3: Gestaltung und Festigkeit von Schweißkonstruktionen, 2. Aufl., Berlin 2002.

Courses				
Title		Тур	Hrs/wk	СР
Resistance and Propulsion (L1265)		Lecture	2	3
Resistance and Propulsion (L1266)		Recitation Section (large)	2	3
Module Responsible	Prof. Stefan Krüger			
Admission Requirements	None			
Recommended Previous	Mechanics			
Knowledge	Fluid Dynamics for Naval Architects			
	Hydrostratics			
	-			
Educational Objectives	After taking part successfully, students have reached	the following learning results		
Professional Competence				
Knowledge	The hydrodynamic basics that are relevant for re			
	phenomena and their practical applications to hullfor	-	-	-
	of the course. Furthermore, environmental additional			
	their application to full scale ships. This hold also for		-	
	Main Focus is how hull forms can be optimized for min	imum and sustainable fuel consumption	n. The following to	pics are dealt with
	- Stillwater/added resistance, Wave resistance, Mini	mization of wave resistance, numeric	al prediction me	thods, friction law
	laminar/turbulent flow separation, Hull form design	for redcude flow separation, Appenda	ige Design and i	esistance, Froude
	resistance law,form factor method, thrust deduction,	wake, model scaling laws, resistance t	ests, free running	propeller tests a
	propeller basics, propulsion tests, full scale speed po	ower predictions, additional resistances	(wind, steering,	current, sea state
	EEDI, speed trials, contractual matters concerning spe	ed/power, bunker claims		
Chille	The student shall leave to design severations built form	a with respect to find concuration by		al taabaigu aa aad
SKIIIS	The student shall learn to design competitive hull form			
	evaluate these hulls by several progosis methods minimize the required power including environmental		the student to ci	ean determine a
	minimize the required power including environmental	indences.		
Personal Competence				
Social Competence	The student learns to prepare technical matters in suc	h a way that he can compte with his bu	ilding suvervision	team.
Autonomy	The student learns to prepare technical matters in suc	h a way that he can compte with his bu	ilding suvervision	team.
Workload in Hours	Independent Study Time 124, Study Time in Lecture 5	e		
	Independent Study Time 124, Study Time in Lecture 5 6	0		
Credit points Course achievement				
Examination				
Examination duration and scale	180 min			
	Conoral Engineering Science (Corman program, 7 con	actor). Specialization Naval Architectur	o: Compulsor	
Assignment for the	General Engineering Science (German program, 7 sen Naval Architecture: Core Qualification: Compulsory	iester), specialisation Navai AfChitectur	e. compulsory	
ronowing curricula	wavar Architecture. Core Quantication. Compulsory			
Course L1265: Resistance an	d Propulsion			

Hrs/wk	2
CP	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Prof. Stefan Krüger
Language	DE
Cycle	WiSe
Content	
Literature	

ourse L1266: Resistance and Propulsion	
Тур	Recitation Section (large)
Hrs/wk	2
CP	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Prof. Stefan Krüger
Language	DE
Cycle	WiSe
Content	See interlocking course
Literature	See interlocking course

Courses				
Title		Тур	Hrs/wk	СР
Computational Fluid Dynamics I (LC)235)	Lecture	2	3
Computational Fluid Dynamics I (LO	0419)	Recitation Section (large)	2	3
Module Responsible	Prof. Thomas Rung			
Admission Requirements	None			
Recommended Previous	Students should have sound knowledge of engineering ma	thematics (series expansions, inter	nal & vector calcu	ulus), and be fami
Knowledge	with the foundations of partial/ordinary differential equat	ons. They should also be familiar v	vith engineering	fluid mechanics a
	thermodynamics.			
Educational Objectives	After taking part successfully, students have reached the	allowing loarning results		
	Arter taking part successiony, students have reached the	bilowing learning results		
Professional Competence	Students will have the required combined knowledge	f thormo (fluid dynamics and num		to translato gono
Knowledge	Students will have the required combined knowledge of principles of thermo-/fluid engineering into discrete alo		-	-
	(potential theory) ansatz functions. They are familiar wi			
	approximation concepts for investigating coupled syste			
	explain the motivation for applying them. Students have			
	numerical algorithms dedicated to the solution of thermof			
	to predict thermofluid dynamic fields, in particular their re			
Skills	The students are able choose and apply appropriate nume	rical procedures that integrate the	governing therm	ofluid dynamic PE
	in space and time. They can apply/optimise numerica			
	computational algorithms in a structured way, apply the	ese codes for parameter investigation	ations and suppl	ement interfaces
	extract simulation data for an engineering analysis.			
Personal Competence				
	The students are able to discuss problems, present the re	sults of their own analysis and join	tly develop imple	ement and report
boelar competence	solution strategies that address given technical reference		acterop, mp.	
Autonomy	The students can independently analyse numerical met	nods to solving fluid engineering i	problems. They a	are able to critic
Autonomy	analyse own results as well as external data with regards		stoblettis. They c	
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56			
Credit points	6			
Course achievement	None			
Examination	Written exam			
Examination duration and	2h			
scale				
Assignment for the	General Engineering Science (German program, 7 sem	ester): Specialisation Mechanical	Engineering, Foc	us Aircraft Syste
-	Engineering: Elective Compulsory		5 5.	2
	General Engineering Science (German program, 7 semest	r): Specialisation Naval Architectur	e: Compulsory	
	General Engineering Science (German program, 7 sem			us Energy Syster
	Elective Compulsory		-	
	Energy Systems: Technical Complementary Course Core S	udies: Elective Compulsory		
	Green Technologies: Energy, Water, Climate: Specialisatio		pulsory	
	Green Technologies: Energy, Water, Climate: Specialisatio	Maritime Technologies: Elective C	ompulsory	
	Mechanical Engineering: Specialisation Energy Systems: E	ective Compulsory	-	
	Naval Architecture: Core Qualification: Compulsory			
	Technomathematics: Specialisation III. Engineering Science			

Course L0235: Computationa	al Fluid Dynamics I
Тур	Lecture
Hrs/wk	2
CP	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Prof. Thomas Rung
Language	DE
Cycle	WiSe
Content	Fundamentals of computational modelling of thermofluid dynamic problems. Development of numerical algorithms.
	 Partial differential equations Foundations of finite numerical approximations Computation of potential flows Introduction of finite-differences Approximation of convective, diffusive and transient transport processes Formulation of boundary conditions and initial conditions Assembly and solution of algebraic equation systems Facets of weighted -residual approaches Finite volume methods Basics of grid generation
Literature	Ferziger and Peric: Computational Methods for Fluid Dynamics, Springer

Course L0419: Computationa	urse L0419: Computational Fluid Dynamics I	
Тур	Recitation Section (large)	
Hrs/wk	2	
СР	3	
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28	
Lecturer	Prof. Thomas Rung	
Language	DE	
Cycle	WiSe	
Content	See interlocking course	
Literature	See interlocking course	

Courses		
Title	Typ Hrs/wk CP	
Ship Design (L1262)	Lecture 2 3	
Ship Design (L1264)	Recitation Section (large) 2 3	
Module Responsible		
Admission Requirements		
Recommended Previous Knowledge	 Eluid Dynamics for Naval Architects, Resistance and Propulsion 	
Educational Objectives	After taking part successfully, students have reached the following learning results	
Professional Competence		
Kioweuge	The lecture starts with an overview about the importance and requirements of the aerly design phase. Competitive Elen Ship Designs are thoroughly discussed. Typical bulding contracts and the related technical risk are introduced. The most in main parameters of a ship are introduced and their influence on the competitiveness of a design. The lecture focusses influence of alternated main parameters on the total performance of a ship design and the consecutive process elements lecture, the design changes are dealt with by simple models or formulae. The student shall further learn to model of systems properly so that the relavent technical conclusions can be drawn. The lecture continues with an introduction into the different phases of design project, from the initial design phase to a contract. Further, methods are introduced to generate bulding specification relevant information at different levens of gra during the different design stages. In detail, the following topics are adressed: - Structure of a building specification - Determination of Light Ship Weight and Deadweight Components - Design of main section and hull form - Design of main propulsion plant - Design of subdivision - Determination of limiting GMrequ- Curves - Scantlings of most improtant structural members - Longitudinal strength - Outfitting Components - Relevant rules and regulations	nporta s on t s. In tl compl buildi
Skills	The student is made familiar with the basic design principles of seagoing mearchant ships. The goal of the lecture is student shall be able to carry out a concept design based on a vessel of comparison fulfilling typical contract requirement the Marine Environment. The lecture deals with the basic design methods to determine the fundamantal technical charact of a ship design with respect to fulfillment procedures of the contract values. Based on the lecture "Principles of Ship Des relevant methods to determine and judge uopn the performance of a ship design are treated.	s witl terist
Personal Competence		
Social Competence	The students learns to prepare technical matters in such a way the he can persuade his potantial customer aga	inst l
Autonomy	competitors. The students learns to prepare technical matters in such a way the he can persuade his potantial customer aga competitors.	inst
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	General Engineering Science (German program, 7 semester): Specialisation Naval Architecture: Compulsory	
Course L1262: Ship Design		
Тур		
Hrs/wk		
CP	3	

Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Prof. Stefan Krüger
Language	DE
Cycle	SoSe
Content	
Literature	

Course L1264: Ship Design	ourse L1264: Ship Design	
Тур	Recitation Section (large)	
Hrs/wk	2	
CP	3	
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28	
Lecturer	Prof. Stefan Krüger	
Language	DE	
Cycle	SoSe	
Content		
Literature		

	Thesis
Module M-001: Bache	lor Thesis
Courses	
Title	Typ Hrs/wk CP
Module Responsible	Professoren der TUHH
Admission Requirements	
	 According to General Regulations §21 (1): At least 126 ECTS credit points have to be achieved in study programme. The examinations board decides on exceptions.
Recommended Previous	
Knowledge Educational Objectives	After taking part successfully, students have reached the following learning results
Professional Competence	
Knowledge Skills Personal Competence Social Competence	 The students can select, outline and, if need be, critically discuss the most important scientific fundamentals of their course of study (facts, theories, and methods). On the basis of their fundamental knowledge of their subject the students are capable in relation to a specific issue of opening up and establishing links with extended specialized expertise. The students are able to outline the state of research on a selected issue in their subject area. The students can make targeted use of the basic knowledge of their subject that they have acquired in their studies to solve subject-related problems. With the aid of the methods they have learnt during their studies the students can analyze problems, make decisions on technical issues, and develop solutions. The students can take up a critical position on the findings of their own research work from a specialized perspective.
Autonomy	 Both in writing and orally the students can outline a scientific issue for an expert audience accurately, understandably and in a structured way. The students can deal with issues in an expert discussion and answer them in a manner that is appropriate to the addressees. In doing so they can uphold their own assessments and viewpoints convincingly. The students are capable of structuring an extensive work process in terms of time and of dealing with an issue within a specified time frame. The students are able to identify, open up, and connect knowledge and material necessary for working on a scientific problem. The students can apply the essential techniques of scientific work to research of their own.
Workload in Hours	Independent Study Time 360, Study Time in Lecture 0
Credit points	12
Course achievement	None
Examination	Thesis
Examination duration and	According to General Regulations
scale	
Assignment for the Following Curricula	
Pollowing Curricula	General Engineering Science (German program, 7 semester): Thesis: Compulsory Civil- and Environmental Engineering: Thesis: Compulsory
	Bioprocess Engineering: Thesis: Compulsory
	Chemical and Bioprocess Engineering: Thesis: Compulsory
	Computer Science: Thesis: Compulsory
	Data Science: Thesis: Compulsory Digital Mechanical Engineering: Thesis: Compulsory
	Electrical Engineering: Thesis: Compulsory
	Engineering Science: Thesis: Compulsory
	General Engineering Science (English program): Thesis: Compulsory
	General Engineering Science (English program, 7 semester): Thesis: Compulsory
	Green Technologies: Energy, Water, Climate: Thesis: Compulsory Computer Science in Engineering: Thesis: Compulsory
	Integrated Building Technology: Thesis: Compulsory
	Logistics and Mobility: Thesis: Compulsory
	Mechanical Engineering: Thesis: Compulsory
	Mechatronics: Thesis: Compulsory
	Naval Architecture: Thesis: Compulsory Technomathematics: Thesis: Compulsory
	Teilstudiengang Lehramt Metalltechnik: Thesis: Compulsory
	Process Engineering: Thesis: Compulsory
	Engineering and Management - Major in Logistics and Mobility: Thesis: Compulsory