

# **Module Manual**

Bachelor of Science (B.Sc.)

# General Engineering Science (German program, 7 semester)

Cohort: Winter Term 2020 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 1<sup>st</sup> and the 2<sup>nd</sup> 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
<b>Recommended Previous</b>	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 <b>teaching architecture</b> , in its <b>teaching and learning arrangements</b> , in <b>teach</b> <b>areas</b> and by means of teaching offerings in which students can qualify by opting for <b>specific competences</b> and a <b>compete</b> <b>level</b> 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 groriented 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
	<ul> <li>locate selected specialized areas with the relevant non-technical mother discipline,</li> <li>outline basic theories, categories, terminology, models, concepts or artistic techniques in the disciplines represented in learning area,</li> <li>different specialist disciplines relate to their own discipline and differentiate it as well as make connections,</li> <li>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,</li> <li>Can communicate in a foreign language in a manner appropriate to the subject.</li> </ul>
Skills	Professional Competence (Skills)
JKIII3	
	In selected sub-areas students can
	<ul> <li>apply basic methods of the said scientific disciplines,</li> <li>auestion a specific technical phenomena, models, theories from the viewpoint of another, aforementioned special discipline,</li> </ul>
	<ul> <li>to handle simple questions in aforementioned scientific disciplines in a sucsessful manner,</li> <li>justify their decisions on forms of organization and application in practical questions in contexts that go beyond technical relationship to the subject.</li> </ul>

Social Competence	Personal Competences (Social Skills)
	Students will be able
	<ul> <li>to learn to collaborate in different manner,</li> <li>to present and analyze problems in the abovementioned fields in a partner or group situation in a manner appropriate to the addressees,</li> <li>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),</li> <li>to explain nontechnical items to auditorium with technical background knowledge.</li> </ul>
Autonomy	Personal Competences (Self-reliance) Students are able in selected areas
	<ul> <li>to reflect on their own profession and professionalism in the context of real-life fields of application</li> <li>to organize themselves and their own learning processes</li> <li>to reflect and decide questions in front of a broad education background</li> <li>to communicate a nontechnical item in a competent way in writen form or verbaly</li> <li>to organize themselves as an entrepreneurial subject country (as far as this study-focus would be chosen)</li> </ul>
Workload in Hours	Depends on choice of courses
Credit points	6

### Courses

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

Module M0743: Electrical Engineering I: Direct Current Networks and Electromagnetic Fields						
Courses						
Title				Тур	Hrs/wk	СР
Electrical Engineering I: Direct Curr		5		Lecture	3	5
Electrical Engineering I: Direct Curr	rent Networks and Electi	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 suce	cessfully, students	have reached the follow	ing learning results		
Professional Competence						
Knowledge						
Skills						
Personal Competence						
Social Competence						
Autonomy						
Workload in Hours	Independent Study T	ime 110, Study Tir	ne in Lecture 70			
Credit points	6					
Course achievement	Compulsory Bonus	Form	Description			
	No 10 %	Excercises				
Examination	Written exam					
Examination duration and	120 Minutes					
scale						
Assignment for the	General Engineering Science (German program, 7 semester): Core Qualification: Compulsory					
Following Curricula	Data Science: Specialisation Electrical Engineering: Compulsory					
	Electrical Engineering: Core Qualification: Compulsory					
		Computational Science and Engineering: Core Qualification: Compulsory				
	Mechatronics: Core Qualification: Compulsory					
	Orientierungsstudiun	n: Core Qualificatio	n: 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	Prof. Matthias Kuhl		
Language	E		
Cycle	ViSe		
Content			
Literature	<ol> <li>M. Kasper, Skript zur Vorlesung Elektrotechnik 1, 2013</li> <li>M. Albach: Grundlagen der Elektrotechnik 1, Pearson Education, 2004</li> <li>F. Moeller, H. Frohne, K.H. Löcherer, H. Müller: Grundlagen der Elektrotechnik, Teubner, 2005</li> <li>A. R. Hambley: Electrical Engineering, Principles and Applications, Pearson Education, 2008</li> </ol>		

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	rof. Matthias Kuhl		
Language	DE		
Cycle	ViSe		
Content			
Literature	<ol> <li>Übungsaufgaben zur Elektrotechnik 1, TUHH, 2013</li> <li>Ch. Kautz: Tutorien zur Elektrotechnik, Pearson Studium, 2010</li> </ol>		

Module M0889: Mech	anics I (Statics)			
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	Prof. Robert Seifried			
Admission Requirements	None			
<b>Recommended Previous</b>	Solid school knowledge in mathematics and	physics.		
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 desi	-		
	<ul> <li>present technical knowledge in stered</li> </ul>	ostatics.		
Skills	The students can			
		athematical / mechanical analysis and model fo	rmation, and appl	y it to the contex
	their own problems;			
	<ul> <li>apply basic statical methods to engine</li> </ul>			
	<ul> <li>estimate the reach and boundaries of</li> </ul>	statical methods and extend them to be applica	ble to wider probl	em sets.
Personal Competence				
	The students can work in groups and suppor	t each other to overcome difficulties.		
···· ,···	5			
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 progra	am, 7 semester): Core Qualification: Compulsory	1	
Following Curricula	Civil- and Environmental Engineering: Core C	Qualification: Compulsory		
	Data Science: Specialisation Mechanics: Com	npulsory		
	Digital Mechanical Engineering: Core Qualific	cation: Compulsory		
	Logistics and Mobility: Core Qualification: Co	mpulsory		
	Mechanical Engineering: Core Qualification:			
	Mechatronics: Core Qualification: Compulsor			
	Orientierungsstudium: Core Qualification: Ele			
	Naval Architecture: Core Qualification: Comp			

Course L1001: Mechanics I (S	Statics)		
Тур	ture		
Hrs/wk	2		
CP	3		
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28		
Lecturer	Prof. Robert Seifried		
Language	DE		
Cycle	WiSe		
Content	<ul> <li>Tasks in Mechanics</li> <li>Modelling and model elements</li> <li>Vector calculus for forces and torques</li> <li>Forces and equilibrium in space</li> <li>Constraints and reactions, characterization of constraint systems</li> <li>Planar and spatial truss structures</li> <li>Internal forces and moments for beams and frames</li> <li>Center of mass, volumn, area and line</li> <li>Computation of center of mass by intergals, joint bodies</li> <li>Friction (sliding and sticking)</li> <li>Friction of ropes</li> </ul>		
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	
СР	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: Math	ematics I			
Courses				
Title		Tree	Line (suls	60
		<b>Typ</b> Lecture	Hrs/wk 2	СР
Analysis I (L1010)			2	2
Analysis I (L1012)		Recitation Section (small)	1	1
Analysis I (L1013) Linear Algebra I (L0912)		Recitation Section (large) Lecture	2	2
Linear Algebra I (L0912)		Recitation Section (small)	1	1
Linear Algebra I (L0914)		Recitation Section (large)	1	1
Module Responsible	Prof Anusch Taraz			_
Admission Requirements	None			
Recommended Previous				
Knowledge	School mattematics			
Educational Objectives	After taking part successfully, students have reach	ed the following learning results		
Professional Competence	······ ,, ······			
Knowledge				
Kilowieuge	Students can name the basic concepts in	analysis and linear algebra. They are able	e to explain the	em using appropriat
	examples.			
	<ul> <li>Students can discuss logical connections be</li> </ul>	tween these concepts. They are capable	of illustrating th	ese connections wit
	the help of examples.		-	
	<ul> <li>They know proof strategies and can reprodu</li> </ul>	ce them.		
	.,			
Skills				
	<ul> <li>Students can model problems in analysis ar</li> </ul>	d linear algebra with the help of the conce	pts studied in th	nis course. Moreover
	they are capable of solving them by applying	g established methods.		
	<ul> <li>Students are able to discover and verify furt</li> </ul>	her logical connections between the concep	ts studied in the	e course.
	<ul> <li>For a given problem, the students can deviate</li> </ul>	elop and execute a suitable approach, ar	nd are able to c	ritically evaluate th
	results.			
Personal Competence				
Social Competence	• Students are able to work together in teams. They are capable to use mathematics as a common language.			
	<ul> <li>In doing so, they can communicate new con</li> </ul>	cepts according to the needs of their coop	erating partners	. Moreover, they ca
	design examples to check and deepen the u		51	
	g			
Autonomy				
Autonomy	Students are capable of checking their under	erstanding of complex concepts on their or	vn. They can sp	ecify open question
	precisely and know where to get help in solv	ing them.		
	<ul> <li>Students have developed sufficient persister</li> </ul>		; in a goal-orien	ted manner on har
	problems.		-	
	P			
Workload in Hours	Independent Study Time 128, Study Time in Lectur	e 112		
Credit points	8			
Course achievement	None			
Examination	Written exam			
Examination duration and	60 min (Analysis I) + 60 min (Linear Algebra I)			
scale				
Assignment for the	General Engineering Science (German program, 7 s	semester): Core Qualification: Compulsory		
Following Curricula	Civil- and Environmental Engineering: Core Qualific	ation: Compulsory		
	Bioprocess Engineering: Core Qualification: Compu	lsory		
	Digital Mechanical Engineering: Core Qualification:	Compulsory		
	Electrical Engineering: Core Qualification: Compuls	ory		
	Energy and Environmental Engineering: Core Quali	fication: Compulsory		
	Computational Science and Engineering: Core Qual			
	Logistics and Mobility: Core Qualification: Compulse			
	Mechanical Engineering: Core Qualification: Compu			
	Mechatronics: Core Qualification: Compulsory			
		Compulsory		
	Orientierungsstudium: Core Qualification: Elective			
	Naval Architecture: Core Qualification: Compulsory			
	Process Engineering: Core Qualification: Compulsor			

Course L1010: Analysis I	Course L1010: Analysis I		
Тур	Lecture		
Hrs/wk	2		
СР	2		
Workload in Hours	ndependent 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		
	<ul> <li>statements, sets and functions</li> <li>natural and real numbers</li> <li>convergence of sequences and series</li> <li>continuous and differentiable functions</li> <li>mean value theorems</li> <li>Taylor series</li> <li>calculus</li> <li>error analysis</li> <li>fixpoint iteration</li> </ul>		
Literature	<ul> <li>http://www.math.uni-hamburg.de/teaching/export/tuhh/index.html</li> </ul>		

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	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	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, Prof. Marko Lindner
Language	DE
Cycle	WiSe
Content	<ul> <li>vectors: intuition, rules, inner and cross product, lines and planes</li> <li>systems of linear equations: Gauß elimination, matrix product, inverse matrices, transformations, block matrices, determinants</li> <li>orthogonal projection in R^n, Gram-Schmidt-Orthonormalization</li> </ul>
Literature	<ul> <li>T. Arens u.a. : Mathematik, Spektrum Akademischer Verlag, Heidelberg 2009</li> <li>W. Mackens, H. Voß: Mathematik I für Studierende der Ingenieurwissenschaften, HECO-Verlag, Alsdorf 1994</li> <li>W. Mackens, H. Voß: Aufgaben und Lösungen zur Mathematik I für Studierende der Ingenieurwissenschaften, HECO-Verlag, Alsdorf 1994</li> <li>G. Strang: Lineare Algebra, Springer-Verlag, 2003</li> <li>G. und S. Teschl: Mathematik für Informatiker, Band 1, Springer-Verlag, 2013</li> </ul>

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

Course L0914: Linear Algebra	ourse L0914: Linear Algebra I	
Тур	Recitation 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	

Courses				
Title		Тур	Hrs/wk	СР
Physics for Engineers (L0367)		Lecture	2	3
Physics for Engineers (Problem Solv	ing Course) (L0368)	Recitation Section (small)	1	1
Module Responsible	Prof. Manfred Eich			
Admission Requirements	None			
Recommended Previous Knowledge	<ul> <li>Calculus and linear algebra on high so</li> <li>Physics on high school level</li> </ul>	thool level		
Educational Objectives	After taking part successfully, students have	reached the following learning results		
Professional Competence				
Knowledge	Students can explain fundamental topics and laws of physics such as in the areas of mechanics, oscillations, waves, and optics.			
	Students can relate physics topics to technical problems.			
Skills	s Students can describe physical problems mathematically and solve such problems within the framework of their acquire mathematical expertise.			
Personal Competence				
Social Competence	Students can jointly solve subject related pro problem solving courses.	oblems in groups. They can present their results	effectively within	the framework of t
Autonomy	the lecture. They can reflect their acquired	ormation from the provided references and to rud level of expertise with the help of lecture action of connect their knowledge with that acquired from	companying mea	
Workload in Hours	Independent Study Time 78, Study Time in L	ecture 42		
Credit points	4			
Course achievement	None			
Examination	Written exam			
Examination duration and scale	120 min			
Assignment for the Following Curricula	General Engineering Science (German progr	am, 7 semester): Core Qualification: Compulsory	1	

Course L0367: Physics for En	Course L0367: Physics for Engineers		
Тур	Lecture		
Hrs/wk	2		
CP			
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28		
Lecturer	Prof. Manfred Eich		
Language	DE		
Cycle	WiSe		
Content	<ul> <li>Introduction</li> <li>Kinematics and dynamics</li> <li>Work, Energy, momentum</li> <li>Rotatory Motion, moments of inertia</li> <li>Gravitation</li> <li>Special Theory of Relativity</li> <li>Oscillations</li> <li>Waves</li> <li>Geometrical optics</li> <li>Wave optics</li> <li>Matter waves</li> <li>Fundamentals of quantum mechanics</li> </ul>		
Literature	<ul> <li>Giancoli, Physics for Scientists &amp; Engineers Vol. 1, 2, Pearson</li> <li>Halliday/Resnik/Walker, <i>Fundamentals of physics</i>, Wiley</li> <li>K. Cummings, P. Laws, E. Redish, and P. Cooney ("CLRC"), <i>Understanding Physics</i>, Wiley</li> <li>Gerthsen/Vogel, <i>Physik</i>, Springer Verlag</li> <li>Hering/Martin/Stohrer, <i>Physik für Ingenieure</i>, VDI-Verlag</li> </ul>		

Course L0368: Physics for En	ourse L0368: Physics for Engineers (Problem Solving Course)	
Тур	Recitation Section (small)	
Hrs/wk	1	
CP	1	
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14	
Lecturer	Prof. Manfred Eich	
Language	DE	
Cycle	WiSe	
Content	see lecture Physics for Engineers	
Literature	see lecture Physics for Engineers	

Module M0687: Chem	istry			
	listi y			
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			
<b>Recommended Previous</b>	none			
Knowledge				
Educational Objectives	After taking part successfully, students have reached the	ollowing learning results		
Professional Competence				
	The students are able to name and to describe basic principles and applications of general chemistry (structure of matter, periodic table, chemical bonds), physical chemistry (aggregate states, separating processes, thermodynamics, kinetics), inorganic chemistry (acid/base, pH-value, salts, solubility, redox, metals) and organic chemistry (aliphatic hydrocarbons, functional groups carbonyl compounds, aromates, reaction mechanisms, natural products, synthetic polymers). Furthermore students are able to explain basic chemical terms.			
Skills	After successful completion of this module students are able to describe substance groups and chemical compounds. On this basi they are capable of explaining, choosing and applying specific methods and various reaction mechanisms.			
Personal Competence				
	Students are able to take part in discussions on chemical	issues and problems as a member	of an interdiscipli	nary team. They c
	contribute to those discussion by their own statements.			
Autonomy	After successful completion of this module students are approaches with arguments. They can also document thei		ndependently by	defending propos
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 semeste	er): Core Qualification: Compulsory		
Following Curricula	Civil- and Environmental Engineering: Core Qualification: C	Compulsory		
	Technomathematics: Specialisation III. Engineering Scienc	e: 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	

Programming in C (11488)         Practi           Module Responsible         Prof. Siegfried Rump           Admission Requirements         None           Recommended Previous Knowledge         Elementary PC handling skills           Educational Objectives         After taking part successfully, students have reached the following lease Professional Competence Knowledge           Professional Competence Knowledge         The students know by heart the basic syntax of C programming as well purpose.           They know the fundamental components and principles of elementary based on C programming and can explain them:           • basic data types (pointers, arrays, strings, composed data types • operators (arithmetical operations, logical operations, bit operations) • control flow (choice, loops, jumps, conditional compilation) • functions and macros • important standard libraries and functions • recursion • linked lists           The students know how to use an integrated development environment so that they can write, store, compile and execute C programs on it.           Using their knowledge they are able to read and understand given C Pr They can solve simple algorithmic problems on their own and can mod in C language.           Personal Competence Social Competence         The students are able to solve selected exercises from other areas of t mechanics, electrical engineering or physics with the aid of small C prog- programming errors and to present their results.           They are able to explain simple phenomena to each other directly at th mechanics, electrical engineering or physics with the aid of small C prog- gin a certain programming	ire ical Course	Hrs/wk 1 1	<b>CP</b>
Programming in C (L0083)       Lectu         Programming in C (L1088)       Prof.         Module Responsible       Prof. Siegfried Rump         Admission Requirements       None         Recommended Previous       Elementary PC handling skills         Educational Objectives       After taking part successfully, students have reached the following lear         Professional Competence       Knowledge         Knowledge       The students know by heart the basic syntax of C programming as well purpose.         They know the fundamental components and principles of elementary based on C programming and can explain them:         • basic data types (integers, floating point numbers, characters)         • advanced data types (pointers, arrays, strings, composed data types (pointers, logical operations, bit operations)         • control flow (choice, loops, jumps, conditional compilation)         • functions and macros         • important standard libraries and functions         • recursion         • linked lists         The students know how to use an integrated development environments so that they can write, store, compile and execute C programs on it.         Using their knowledge they are able to read and understand given C Pr         They can solve simple algorithmic problems on their own and can mod in C language.         The students are able to solve selected exercises from other areas of t mechanics, electrical engineering or		1	
Programming in C (11488)         Practi           Module Responsible         Prof. Siegfried Rump           Admission Requirements         None           Recommended Previous Knowledge         Elementary PC handling skills           Educational Objectives         After taking part successfully, students have reached the following lease Professional Competence Knowledge           Professional Competence Knowledge         The students know by heart the basic syntax of C programming as well purpose.           They know the fundamental components and principles of elementary based on C programming and can explain them:           • basic data types (pointers, arrays, strings, composed data types • operators (arithmetical operations, logical operations, bit operations) • control flow (choice, loops, jumps, conditional compilation) • functions and macros • important standard libraries and functions • recursion • linked lists           The students know how to use an integrated development environment so that they can write, store, compile and execute C programs on it.           Using their knowledge they are able to read and understand given C Pr They can solve simple algorithmic problems on their own and can mod in C language.           Personal Competence Social Competence         The students are able to solve selected exercises from other areas of t mechanics, electrical engineering or physics with the aid of small C prog- programming errors and to present their results.           They are able to explain simple phenomena to each other directly at th mechanics, electrical engineering or physics with the aid of small C prog- gin a certain programming	ical Course	1	1
Admission Requirements         None           Recommended Previous Knowledge         Elementary PC handling skills           Educational Objectives         After taking part successfully, students have reached the following leal Professional Competence Knowledge           Professional Competence Knowledge         The students know by heart the basic syntax of C programming as well purpose.           They know the fundamental components and principles of elementary based on C programming and can explain them:           • basic data types (integers, floating point numbers, characters)           • advanced data types (pointers, arrays, strings, composed data types • operators (arithmetical operations, logical operations, bit operations)           • control flow (choice, loops, jumps, conditional compilation)           • functions and macros           • important standard libraries and functions           • recursion           • linked lists           The students know how to use an integrated development environmen so that they can write, store, compile and execute C programs on it.           Using their knowledge they are able to read and understand given C Pr They can solve simple algorithmic problems on their own and can mod in C language.           Personal Competence Social Competence           Autonomy           The students are able to solve selected exercises from other areas of t mechanics, electrical engineering or physics with the aid of small C proc programming errors and to present their results.           The			1
Recommended Previous Knowledge         Elementary PC handling skills           Educational Objectives         After taking part successfully, students have reached the following lear Professional Competence Knowledge           Professional Competence Knowledge         The students know by heart the basic syntax of C programming as well purpose.           They know the fundamental components and principles of elementary based on C programming and can explain them:         • basic data types (integers, floating point numbers, characters)           • advanced data types (pointers, arrays, strings, composed data types • operators (arithmetical operations, logical operations, bit operations)         • control flow (choice, loops, jumps, conditional compilation)           • functions and macros         • important standard libraries and functions           • recursion         • linked lists           The students know how to use an integrated development environment so that they can write, store, compile and execute C programs on it.           Using their knowledge they are able to read and understand given C Pr           They can solve simple algorithmic problems on their own and can mod in C language.           Personal Competence           Social Competence           Autonomy           The students are able to solve selected exercises from other areas of t mechanics, electrical engineering or physics with the aid of small C programming errors and to present their results.           The students prepare themselves using the given teaching material an programming exercises o			
Knowledge         Elementary mathematical skills           Educational Objectives         After taking part successfully, students have reached the following lear           Professional Competence         The students know by heart the basic syntax of C programming as well purpose.           They know the fundamental components and principles of elementary based on C programming and can explain them:              • basic data types (integers, floating point numbers, characters)             • advanced data types (pointers, arrays, strings, composed data types             • operators (arithmetical operations, loig cal operations, bit operations)             • control flow (choice, loops, jumps, conditional compilation)             • functions and macros             • important standard libraries and functions             • recursion             • linked lists             The students are prepared for continuing programming lectures like of             Skills             The students are prepared for continuing programming lectures like of             recursion             • Linguage.             The students are able to read and understand given C Pr             The y can solve simple algorithmic problems on their own and can mod             in C language.             The students are able to solve selected exercises from other areas of t             mechanics, electrical engineering or physics with the aid of small C pro             Personal Competence             Social Competence             Social Competence             For students are able to work in small teams to solve given weekly tas             programming errors and to present their results.             The students prepare themselves using the given teaching material an             programming exercises on their own.             Adutonommy             The students prepare themselves using the given teaching			
Elementary mathematical skills           Educational Objectives         After taking part successfully, students have reached the following lead           Professional Competence         The students know by heart the basic syntax of C programming as well purpose.           They know the fundamental components and principles of elementary based on C programming and can explain them:           • basic data types (integers, floating point numbers, characters)         • advanced data types (pointers, arrays, strings, composed data types operators (arithmetical operations, logical operations, bit operations)           • control flow (choice, loops, jumps, conditional compilation)         • functions and macros           • important standard libraries and functions         • recursion           • linked lists         The students know how to use an integrated development environments so that they can write, store, compile and execute C programs on it.           Using their knowledge they are able to read and understand given C Protey can solve simple algorithmic problems on their own and can mod in C language.           The students are able to solve selected exercises from other areas of t mechanics, electrical engineering or physics with the aid of small C programming errors and to present their results.           The students are able to work in small teams to solve given weekly tas programming errors and to present their results.           The students prepare themselves using the given teaching material an programming exercises on their own.           Additionally, they write small C programs to understand and check add gain a ce			
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based on C programming and can explain them:         • basic data types (integers, floating point numbers, characters)         • advanced data types (pointers, arrays, strings, composed data types         • operators (arithmetical operations, logical operations, bit operations)         • control flow (choice, loops, jumps, conditional compilation)         • functions and macros         • important standard libraries and functions         • recursion         • linked lists         The students are prepared for continuing programming lectures like ob         Skills         The students know how to use an integrated development environmen         so that they can write, store, compile and execute C programs on it.         Using their knowledge they are able to read and understand given C Pr         They can solve simple algorithmic problems on their own and can mod         in C language.         The students are able to solve selected exercises from other areas of t         mechanics, electrical engineering or physics with the aid of small C programming errors and to present their results.         They are able to explain simple phenomena to each other directly at th         Autonomy       The students prepare themselves using the given teaching material an programming exercises on their own.         Additionally, they write small C programs to understand and check add gain a certain programming experience.         For details beyond the s	ll as its meaning, intent a	and	
<ul> <li>advanced data types (pointers, arrays, strings, composed data types operators (arithmetical operations, logical operations, bit operations)</li> <li>control flow (choice, loops, jumps, conditional compilation)</li> <li>functions and macros</li> <li>important standard libraries and functions</li> <li>recursion</li> <li>linked lists</li> <li>The students are prepared for continuing programming lectures like ob</li> <li><i>Skills</i></li> <li>The students know how to use an integrated development environment so that they can write, store, compile and execute C programs on it.</li> <li>Using their knowledge they are able to read and understand given C Pri They can solve simple algorithmic problems on their own and can mod in C language.</li> <li>Personal Competence</li> <li>Social Competence</li> <li>The students are able to solve selected exercises from other areas of t mechanics, electrical engineering or physics with the aid of small C programming errors and to present their results.</li> <li>They are able to explain simple phenomena to each other directly at the Autonomy</li> <li>The students prepare themselves using the given teaching material an programming exercises on their own.</li> <li>Additionally, they write small C programs to understand and check ado gain a certain programming experience.</li> <li>For details beyond the scope of the lecture the students inform themse literature and / or by supplementary own research.</li> </ul>	procedural programmin	Ig	
<ul> <li>important standard libraries and functions</li> <li>recursion</li> <li>linked lists</li> <li>The students are prepared for continuing programming lectures like ob <i>Skills</i></li> <li>The students know how to use an integrated development environments on that they can write, store, compile and execute C programs on it.</li> <li>Using their knowledge they are able to read and understand given C Pritary Can solve simple algorithmic problems on their own and can modin C language.</li> <li>The students are able to solve selected exercises from other areas of timechanics, electrical engineering or physics with the aid of small C programming errors and to present their results.</li> <li>They are able to explain simple phenomena to each other directly at the <i>Autonomy</i></li> <li>The students prepare themselves using the given teaching material an programming exercises on their own.</li> <li>Additionally, they write small C programs to understand and check ador gain a certain programming experience.</li> <li>For details beyond the scope of the lecture the students inform themser literature and / or by supplementary own research.</li> </ul>			
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They can solve simple algorithmic problems on their own and can modin C language.         The students are able to solve selected exercises from other areas of t mechanics, electrical engineering or physics with the aid of small C programming errors and to present their results.         Personal Competence       The students are able to work in small teams to solve given weekly tas programming errors and to present their results.         Autonomy       They are able to explain simple phenomena to each other directly at the programming exercises on their own.         Autionally, they write small C programs to understand and check add gain a certain programming experience.       For details beyond the scope of the lecture the students inform themse literature and / or by supplementary own research.         Workload in Hours       Independent Study Time 32, Study Time in Lecture 28	nt for C programming on	a PC	
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Social Competence       The students are able to work in small teams to solve given weekly tas programming errors and to present their results.         They are able to explain simple phenomena to each other directly at the Autonomy       The students prepare themselves using the given teaching material an programming exercises on their own.         Additionally, they write small C programs to understand and check add gain a certain programming experience.       For details beyond the scope of the lecture the students inform themse literature and / or by supplementary own research.         Workload in Hours       Independent Study Time 32, Study Time in Lecture 28			
programming errors and to present their results.         They are able to explain simple phenomena to each other directly at the additionality of the students prepare themselves using the given teaching material and programming exercises on their own.         Additionally, they write small C programs to understand and check additionality, they write small C programs to understand and check additionality are certain programming experience.         For details beyond the scope of the lecture the students inform themses literature and / or by supplementary own research.         Workload in Hours       Independent Study Time 32, Study Time in Lecture 28			
Autonomy       The students prepare themselves using the given teaching material an programming exercises on their own.         Additionally, they write small C programs to understand and check add gain a certain programming experience.         For details beyond the scope of the lecture the students inform themseliterature and / or by supplementary own research.         Workload in Hours       Independent Study Time 32, Study Time in Lecture 28	sks, to identify and analy	yze	
programming exercises on their own.         Additionally, they write small C programs to understand and check add gain a certain programming experience.         For details beyond the scope of the lecture the students inform themse literature and / or by supplementary own research.         Workload in Hours       Independent Study Time 32, Study Time in Lecture 28	he PC.		
gain a certain programming experience.         For details beyond the scope of the lecture the students inform themse literature and / or by supplementary own research.         Workload in Hours       Independent Study Time 32, Study Time in Lecture 28	nd solve the given		
Workload in Hours         Independent Study Time 32, Study Time in Lecture 28	dressed issues and also t	to	
	elves using the stated		
Credit points 2			
Course achievement None			
Examination Written elaboration			
Examination duration and 1-2 coding tasks weekly			
scale			
Assignment for the General Engineering Science (German program, 7 semester): Core Qua	alification: Compulson		

Course L0083: Programming	in C
Тур	Lecture
Hrs/wk	1
CP	1
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14
Lecturer	Prof. Siegfried Rump, Weitere Mitarbeiter
Language	DE/EN
Cycle	WiSe
Content	C-Programming:
	1. basic data types (integers, floating point numbers, characters, boolean values)
	<ol> <li>advanced data types (pointers, arrays, strings, composed data types, type conversion)</li> </ol>
	3. operators (arithmetical operations, logical operations, bit operations)
	4. control flow (choice, loops, jumps, conditional compilation)
	5. functions and macros (basic function definitions and calls, program parameters, "call by value" versus "call by reference",
	storage classes, functions with variable many arguments, macros, inline functions, modular design, function pointers)
	6. important standard libraries and functions (stdio.h, stdlib.h, math.h, string.h, ctype.h, time.h)
	7. example programs for technical and mathematical applications
Literature	Kernighan, Brian W (Ritchie, Dennis M.;)
	The C programming language
	ISBN: 9780131103702
	Upper Saddle River, NJ [u.a.] : Prentice Hall PTR, 2009
	Sedgewick, Robert
	Algorithms in C
	ISBN: 0201316633
	Reading, Mass. [u.a.] : Addison-Wesley, 2007
	Kaiser, Ulrich (Kecher, Christoph.;)
	C/C++: Von den Grundlagen zur professionellen Programmierung
	ISBN: 9783898428392
	Bonn : Galileo Press, 2010
	Wolf, Jürgen
	C von A bis Z : das umfassende Handbuch
	ISBN: 3836214113
	Bonn : Galileo Press, 2009

Course L1488: Programming in C	
Тур	Practical Course
Hrs/wk	1
CP	1
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14
Lecturer	Prof. Siegfried Rump, Weitere Mitarbeiter
Language	DE/EN
Cycle	WiSe
Content	See interlocking course
Literature	See interlocking course

Courses				
		<b>T</b>	Hara faala	<b>CD</b>
<b>Title</b> Electrical Engineering II: Alternatin	g Current Networks and Basic Devices (L0178)	<b>Typ</b> Lecture	Hrs/wk 3	<b>CP</b> 5
	g Current Networks and Basic Devices (L0178)	Recitation Section (small)	2	1
	Prof. Christian Becker			
Admission Requirements				
Recommended Previous				
Knowledge				
	Mathematics I			
	Direct current networks, complex numbers			
Educational Objectives	After taking part successfully, students have reached	the following learning results		
Professional Competence	After taking part successfully, students have reached	the following learning results		
-	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 eleme			
	an overview of applications for the theory of alterna			
	explaining the behavior of fundamental passive and a			
Skills	Students are capable of calculating parameters withi	n simple electrical networks at alterna	ting currents by	means of a comp
Skiils	notation for voltages and currents. They can appra			
	alternating currents. Students are able to analyze			
	quantitatively and dimension elements by means of			-
	electrical power supply (transformer, transmission lin			
	dimension their main features.			
Personal Competence				
Social Competence	Students are able to work together on subject related	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 k	nowledge by means of activities that a	company the led	ture, such as onlir
	tests and exercises that are related to the exam. Bas	sed on respective feedback, students a	re expected to a	djust their individ
	learning process. They are able to draw connections	between their knowledge obtained in	this lecture and	the content of oth
	lectures (e.g. Electrical Engineering I, Linear Algebra,	and Analysis).		
	Independent Study Time 110, Study Time in Lecture 7	0		
Credit points				
Course achievement		scription		
	No 10 % Midterm			
Examination	Written exam			
Examination duration and				
scale				
Assignment for the	General Engineering Science (German program, 7 sen	nester): Core Qualification: Compulsory		
Following Curricula				
-	Electrical Engineering: Core Qualification: Compulsory			
	Computational Science and Engineering: Core Qualific	ation: Compulsory		
	Mechatronics: Core Qualification: Compulsory			
	Orientierungsstudium: Core Qualification: Elective Cor	npulsory		

Course L0178: Electrical Engineering 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 Engineering 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	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)	

Courses				
Title		Тур	Hrs/wk	СР
Fundamentals of Mechanical Engine		Lecture	2	3
Fundamentals of Mechanical Engine	eering Design (L0259)	Recitation Section (large)	2	3
Module Responsible	Prof. Dieter Krause			
Admission Requirements	None			
Recommended Previous Knowledge	<ul> <li>Basic knowledge about mechanics ar</li> <li>Internship (Stage I Practical)</li> </ul>	d production engineering		
Educational Objectives	After taking part successfully, students have	e reached the following learning results		
Professional Competence				
Knowledge	After passing the module, students are able	to:		
Skille	<ul> <li>explain basic working principles and functions of machine elements,</li> <li>explain requirements, selection criteria, application scenarios and practical examples of basic machine elements, indi the background of dimensioning calculations.</li> </ul> After passing the module, students are able to:			ne elements, indica
	<ul> <li>accomplish dimensioning calculations</li> <li>transfer knowledge learned in the mo</li> <li>recognize the content of technical dra</li> <li>technically evaluate basic designs.</li> </ul>	dule to new requirements and tasks (problem	solving skills),	
Personal Competence Social Competence	• Students are able to discuss technica	l information in the lecture supported by activ	ating methods.	
Autonomy		eepen their acquired knowledge in exercises. nal knowledge and to recapitulate poorly unc	erstood content e.	g. by using the vide
Workload in Hours	Independent Study Time 124, Study Time in	Lecture 56		
Credit points	6			
Course achievement	None			
Examination	Written exam			
Examination duration and scale	120			
Assignment for the	General Engineering Science (German progr	am, 7 semester): Core Qualification: Compulse	ory	
Following Curricula	Digital Mechanical Engineering: Core Qualifi			
	Energy and Environmental Engineering: Cor			
	Logistics and Mobility: Core Qualification: Co			
	Mechanical Engineering: Core Qualification:			
	Mechatronics: Core Qualification: Compulso Orientierungsstudium: Core Qualification: El	-		
	Naval Architecture: Core Qualification: Com			
	Technomathematics: Specialisation III. Engli			

	Lecture
	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
	<ul> <li>Introduction to the following machine elements</li> </ul>
	Screws
	Shaft-hub joints
	<ul> <li>Rolling contact bearings</li> </ul>
	Welding / adhesive / solder joints
	<ul> <li>Springs</li> </ul>
	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	
Elterature	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.
	<ul> <li>Maschinenelemente - Gestaltung, Berechnung, Anwendung; Haberhauer, H., Bodenstein, F., Springer-Verlag, aktuelle Auflage.</li> </ul>
	<ul> <li>Roloff/Matek Maschinenelemente; Wittel, H., Muhs, D., Jannasch, D., Voßiek, J., Springer Vieweg, aktuelle Auflage.</li> <li>Sowie weitere Bücher zu speziellen Themen</li> </ul>

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

Module M0696: Mech				
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			
<b>Recommended Previous</b>	Mechanics I			
Knowledge				
Educational Objectives	After taking part successfully, students	have reached the following learning results		
Professional Competence				
Knowledge	The students name the fundamental concepts and laws of statics such as stresses, strains, Hooke's linear law.			
Skills	The students apply the mathematical/r	nechanical analysis and modeling.		
	The students apply the fundamental m	ethods of elasto statics to simply engineering prob	lems.	
	The students estimate the validity and	limitations of the introduced methods.		
Personal Competence				
Social Competence	-			
Autonomy	-			
,	Independent Study Time 96, Study Tim	ne in Lecture 84		
Credit points				
Course achievement				
Examination				
Examination duration and				
scale	50 mm			
	General Engineering Science (German	program, 7 semester): Core Qualification: Compuls	00/	
	Civil- and Environmental Engineering:		ory	
ronowing curricula	Data Science: Specialisation Mechanics			
	Digital Mechanical Engineering: Core Q			
	Logistics and Mobility: Core Qualification			
	Mechanical Engineering: Core Qualifica			
	Mechatronics: Core Qualification: Com			
	Orientierungsstudium: Core Qualificatio	•		
	Naval Architecture: Core Qualification:			

Course L0493: Mechanics II	
Тур	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	stresses and strains
	Hooke's law
	tension and compression
	torsion
	bending
	stability
	buckling
	energy methods
Literature	<ul> <li>Gross, D., Hauger, W., Schröder, J., Wall, W.A.: Technische Mechanik 1, Springer</li> <li>Gross, D., Hauger, W., Schröder, J., Wall, W.A.: Technische Mechanik 2 Elastostatik, Springer</li> </ul>

Course L0494: Mechanics II	
Тур	Recitation Section (small)
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	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: Techn	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. Gerhard Schmitz			
Admission Requirements	None			
<b>Recommended Previous</b>	Elementary knowledge in Mathematics and Me	chanics		
Knowledge				
Educational Objectives	After taking part successfully, students have re	ached the following learning results		
<b>Professional Competence</b>				
Knowledge	Students are familiar with the laws of Thermo	dynamics. They know the relation of the ki	nds of energy ac	cording to 1 <sup>st</sup> law o
	Thermodynamics and are aware about the lim			
	distinguish between state variables and proc		-	-
	enthalpy, entropy and also the meaning of e	-		
	related diagram. They know the physical diffe		-	-
	state. They know the meaning of a fundamenta	-		
	state. They know the meaning of a fundamenta	is state of equation and know the basics of th	to phase mermoo	lyndinics.
or ""				
Skills	Students are able to calculate the internal ene			
	simple change of states and to use this calcula		alculate state vari	ables for an ideal and
	for a real gas from measured thermal state van	lables.		
Personal Competence				
Social Competence	The students are able to discuss in small group	s and develop an approach.		
Autonomy	Students are able to define independently task	s, to get new knowledge from existing know	ledge as well as to	o find ways to use the
	knowledge in practice.			
Workload in Hours	Independent Study Time 124, Study Time in Le	cture 56		
Credit points				
Course achievement				
Examination				
Examination Examination duration and				
Examination duration and scale				
-	General Engineering Science (German program		У	
Following Curricula	Bioprocess Engineering: Core Qualification: Co			
	Digital Mechanical Engineering: Core Qualificat			
	Energy and Environmental Engineering: Core C			
	Mechanical Engineering: Core Qualification: Co	mpulsory		
	Mechatronics: Core Qualification: Compulsory			
	Orientierungsstudium: Core Qualification: Elect			
	Naval Architecture: Core Qualification: Compul	,		
	Technomathematics: Specialisation III. Enginee			
	Process Engineering: Core Qualification: Comp	ilsory		

Course L0437: Technical The	rmodynamics I
Тур	Lecture
Hrs/wk	2
CP	4
Workload in Hours	Independent Study Time 92, Study Time in Lecture 28
Lecturer	Prof. Gerhard Schmitz
Language	DE
Cycle	SoSe
Content	1. Introduction
	2. Fundamental terms
	3. Thermal Equilibrium and temperature
	3.1 Thermal equation of state
	4. First law
	4. First law 4.1 Heat and work
	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
	7.2 Calorific state variables for arbritary fluids
	7.4 state equations (van der Waals u.a.)
	7.4 state equations (van der waars u.a.)
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 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. Gerhard Schmitz	
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. Gerhard Schmitz	
Language	DE	
Cycle	SoSe	
Content	See interlocking course	
Literature	See interlocking course	

Module M0851: Mathe	ematics II			
Courses				
		_		
Title		Тур	Hrs/wk	СР
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			
Admission Requirements	None			
<b>Recommended Previous</b>	Mathematics I			
Knowledge				
Educational Objectives	After taking part successfully, students have reached	the following learning results		
Professional Competence				
Knowledge	<ul> <li>Students can name further concents in ana</li> </ul>	lysis and linear algebra. They are able	to ovalain the	m using appropriat
	<ul> <li>Students can name further concepts in ana</li> </ul>	nysis and inteal algebra. They are able	to explain the	in using appropriat
	examples.			
	<ul> <li>Students can discuss logical connections betw</li> </ul>	veen these concepts. They are capable	of illustrating th	ese connections wit
	the help of examples.			
	<ul> <li>They know proof strategies and can reproduce</li> </ul>	e them.		
Skills				
	<ul> <li>Students can model problems in analysis and</li> </ul>	linear algebra with the help of the conce	pts studied in th	nis course. Moreover
	they are capable of solving them by applying e	established methods.		
	<ul> <li>Students are able to discover and verify further</li> </ul>	er logical connections between the concep	ts studied in the	e course.
	<ul> <li>For a given problem, the students can devel</li> </ul>	lop and execute a suitable approach, ar	id are able to c	ritically evaluate th
	results.			2
Personal Competence				
Social Competence				
	<ul> <li>Students are able to work together in teams. 1</li> </ul>			
	<ul> <li>In doing so, they can communicate new conce</li> </ul>	epts according to the needs of their coop	erating partners	. Moreover, they ca
	design examples to check and deepen the unc	derstanding of their peers.		
Autonomy				
	<ul> <li>Students are capable of checking their understand</li> </ul>	standing of complex concepts on their ov	vn. They can sp	ecify open question
	precisely and know where to get help in solvin	g them.		
	<ul> <li>Students have developed sufficient persisten</li> </ul>	ce to be able to work for longer periods	in a goal-orien	ted manner on har
	problems.	5 1	5	
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 Algebra II)			
scale				
Assignment for the	General Engineering Science (German program, 7 se	mester): Core Qualification: Compulsory		
-	Civil- and Environmental Engineering: Core Qualificat			
. Showing curricula	5 5 .			
	Bioprocess Engineering: Core Qualification: Compulse	•		
	Digital Mechanical Engineering: Core Qualification: Co			
	Electrical Engineering: Core Qualification: Compulsor	У		
	Energy and Environmental Engineering: Core Qualific	cation: Compulsory		
	Computational Science and Engineering: Core Qualifi	cation: Compulsory		
	Logistics and Mobility: Core Qualification: Compulsor			
	Mechanical Engineering: Coro Qualification: Compute	1/1 V		
	Mechanical Engineering: Core Qualification: Compuls			
	Mechatronics: Core Qualification: Compulsory			
	Mechatronics: Core Qualification: Compulsory			

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	<ul> <li>power series and elementary functions</li> <li>interpolation</li> <li>integration (proper integrals, fundamental theorem, integration rules, improper integrals, parameter dependent integrals</li> <li>applications of integration (volume and surface of bodies of revolution, lines and arc length, line integrals</li> <li>numerical quadrature</li> <li>periodic functions</li> </ul>
Literature	<ul> <li>http://www.math.uni-hamburg.de/teaching/export/tuhh/index.html</li> </ul>

Course L1026: Analysis II	urse 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	
Language	DE	
Cycle	SoSe	
Content	See interlocking course	
Literature	See interlocking course	

Course L1027: Analysis II	ourse 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	

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

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

Course L0917: Linear Algebra	se 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, Prof. Marko Lindner		
Language	DE		
Cycle	SoSe		
Content	See interlocking course		
Literature	See interlocking course		

Courses				
Title		Тур	Hrs/wk	СР
Technical Thermodynamics II (L044		Lecture	2 1	4
Technical Thermodynamics II (L045 Technical Thermodynamics II (L045		Recitation Section (large) Recitation Section (small)	1	1
Module Responsible		Reclation Section (Small)	+	1
Admission Requirements	None			
		shering and Tashring Thermodynamics I		
Recommended Previous Knowledge	Elementary knowledge in Mathematics, Med	chanics and Technical Thermodynamics I		
-	After taking part successfully, students have	a reached the following learning results		
Educational Objectives	After taking part successfully, students have	e reached the following learning results		
Professional Competence			and Clausing Daul	in a Theorem also
Knowledge		ocesses like Joule, Otto, Diesel, Stirling, Seiliger		
		s and know the influence different factors. T		
		r cycle, cooling cycle). They have increased kno		
		nics related diagrams. They know the laws of		
		combustion calculations. They are provided wit	n basic knowledge	in gas dynamics a
	know the definition of the speed of sound a	nd know about a Laval nozzle.		
Skills	Students are able to use thermodynamic laws for the design of technical processes. Especially they are able to formulate energy,			
	exergy- and entropy balances and by this to optimise technical processes. They are able to perform simple safety calculations in			
	regard to an outflowing gas from a tank	. They are able to transform a verbal formul	ated message into	o an abstract form
	procedure.			
Personal Competence				
Social Competence	The students are able to discuss in small gr	oups and develop an approach.		
Autonomv	Students are able to define independently t	asks, to get new knowledge from existing know	ledge as well as to	find ways to use t
, laterierity	knowledge in practice.		leage as men as to	
	knowledge in practice.			
Workload in Hours	Independent Study Time 124, Study Time ir	n Lecture 56		
Credit points	6			
Course achievement	None			
Examination				
Examination duration and	90 min			
scale				
Assignment for the	General Engineering Science (German prog	ram, 7 semester): Core Qualification: Compulso	У	
Following Curricula	Bioprocess Engineering: Core Qualification:	Compulsory		
	Energy and Environmental Engineering: Cor	re Qualification: Compulsory		
	Energy Systems: Technical Complementary	Course Core Studies: Elective Compulsory		
	Engineering Science: Specialisation Mechan	ical Engineering: Elective Compulsory		
	General Engineering Science (English progr	am, 7 semester): Specialisation Mechanical Eng	ineering: Elective C	Compulsory
	Green Technologies: Energy, Water, Climate		-	
	Mechanical Engineering: Core Qualification:			
	Mechatronics: Core Qualification: Compulso			
		· ,		
	Technomathematics: Specialisation III. Engi	neering Science: Elective Compulsory		

Course L0449: Technical Thermodynamics II		
Тур	Lecture	
Hrs/wk	2	
CP	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
Mechanics III (Dynamics) (L1134)		Lecture	3	3
Mechanics III (Dynamics) (L1135)		Recitation Section (small)	2	2
Mechanics III (Dynamics) (L1136)		Recitation Section (large)	1	1
Module Responsible	Prof. Robert Seifried			
Admission Requirements	None			
<b>Recommended Previous</b>	Mathematics I, II, Mechanics I (Statics)			
Knowledge				
Educational Objectives	After taking part successfully, students have	reached the following learning results		
Professional Competence				
Knowledge	The students can			
	<ul> <li>describe the axiomatic procedure use</li> </ul>	d in mechanical contexts:		
	<ul> <li>explain important steps in model desi</li> </ul>			
	<ul> <li>present technical knowledge in stered</li> </ul>	-		
	- present teenned knowledge in steree			
Skills	The students can			
	<ul> <li>explain the important elements of ma</li> </ul>	athematical / mechanical analysis and model	formation and appl	v it to the context
	their own problems;	anematical / meenamear analysis and model		
		nd kinetic methods to engineering problems;		
		statical methods and extend them to be appli	cable to wider probl	em sets.
Personal Competence				
Social 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	their 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	120 min			
scale				
Assignment for the	General Engineering Science (German progra	am, 7 semester): Core Qualification: Compulso	ry	
Following Curricula	Data Science: Core Qualification: Elective Co	mpulsory		
	Digital Mechanical Engineering: Core Qualific	cation: Compulsory		
	Energy and Environmental Engineering: Core	e Qualification: Elective Compulsory		
	Green Technologies: Energy, Water, Climate	: Specialisation Energy Technology: Elective C	ompulsory	
	Mechanical Engineering: Core Qualification:	Compulsory		
	Mechatronics: Core Qualification: Compulsor	У		
	Naval Architecture: Core Qualification: Comp	oulsory		

Course L1134: Mechanics III (Dynamics)		
Тур	Lecture	
Hrs/wk	3	
СР	3	
Workload in Hours	Independent Study Time 48, Study Time in Lecture 42	
Lecturer	Prof. Robert Seifried	
Language	DE	
Cycle	WiSe	
Content	Kinematics	
	<ul> <li>Kinematics of points and relative motion</li> <li>Planar and spatial motion of point systems and rigid bodies</li> <li>Dynamics</li> <li>Terms <ul> <li>Fundamental equations</li> <li>Motion of the rigid body in 3D-space</li> <li>Dynamics of gyroscopes, rotors</li> <li>Realtive kinetics</li> <li>Systems with non-constant mass</li> </ul> </li> <li>Vibrations</li> </ul>	
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 3 und 4. 11. Auflage, Springer (2011).	

Typ     Recitation Section (small)       Hrs/wk     2       CP     2       Workload in Hours     Independent Study Time 32, Stu	ourse L1135: Mechanics III (Dynamics)		
CP 2 Workload in Hours Independent Study Time 32, Study Lecturer Prof. Robert Seifried			
Workload in Hours         Independent Study Time 32, Study Time			
Lecturer Prof. Robert Seifried			
	ime in Lecture 28		
Euliguage			
Cycle WiSe			
Content See interlocking course			
Literature See interlocking course			

Yeitation Section (large)         Restation Section (large)         Instruction         I         Yeitation Section (large)         Instruction         I         Yeitation Section (large)         Instruction         Instrest Instruction	Course L1136: Mechanics III	(Dynamics)
CP       1         Workload in Hours       Independent Study Time 16, Study Time in Lecture 14         Lecture       Prof. Robert Seifried         DE       Vise         Content       See interlocking course	Тур	Recitation Section (large)
Workload in Hours     Independent Study Time 16, Study Time in Lecture 14       Lecture     Prof. Robert Seifried       Language     DE       Cycle     Wise       Content     See interlocking course	Hrs/wk	1
Lecturer       Prof. Robert Seifried         Language       DE         Cycle       WiSe         Content       See interlocking course	СР	1
Language     DE       Cycle     WiSe       Content     See interlocking course	Workload in Hours	Independent Study Time 16, Study Time in Lecture 14
Cycle     WiSe       Content     See interlocking course	Lecturer	Prof. Robert Seifried
Content See interlocking course	Language	DE
5	Cycle	WiSe
Literature See interlocking course	Content	See interlocking course
	Literature	See interlocking course

Module M0853: Math	ematics III			
Courses				
Title		Тур	Hrs/wk	CP
Analysis III (L1028)		Lecture	2	2
Analysis III (L1029)		Recitation Section (small)	1	1
Analysis III (L1030)		Recitation Section (large)	1	1
Differential Equations 1 (Ordinary I		Lecture	2	2
Differential Equations 1 (Ordinary		Recitation Section (small)	1	1
Differential Equations 1 (Ordinary	Differential Equations) (L1033)	Recitation Section (large)	1	1
Module Responsible	Prof. Anusch Taraz			
Admission Requirements	None			
•				
Recommended Previous	Mathematics I + II			
Knowledge				
Educational Objectives	After taking part successfully, students have reached t	he following learning results		
Professional Competence				
-				
Knowledge	Students can name the basic concepts in the are	ea of analysis and differential equations	. They are able t	o explain them usi
	appropriate examples.	, , , , , , , , , , , , , , , , , , ,		
		an three concepts. They are conclude	of illustration th	eee eennediene wi
	<ul> <li>Students can discuss logical connections between the students can discuss logical connections between the students of the student</li></ul>	en these concepts. They are capable	or illustrating th	ese connections wi
	the help of examples.			
	<ul> <li>They know proof strategies and can reproduce t</li> </ul>	hem.		
CL:U-				
Skills	Students can model problems in the area of ana	alvsis and differential equations with th	e help of the cor	ncepts studied in th
	course. Moreover, they are capable of solving th			
	Students are able to discover and verify further			
	<ul> <li>For a given problem, the students can develop</li> </ul>	p and execute a suitable approach, a	nd are able to c	ritically evaluate t
	results.			
Personal Competence				
Social Competence				
	<ul> <li>Students are able to work together in teams. Th</li> </ul>	ey are capable to use mathematics as a	a common langu	age.
	<ul> <li>In doing so, they can communicate new conception</li> </ul>	ts according to the needs of their coop	erating partners	. Moreover, they ca
	design examples to check and deepen the unde			
	acsign examples to encert and acceptin the anac	istantanig of their peersi		
Autonomy				
	<ul> <li>Students are capable of checking their understand</li> </ul>	anding of complex concepts on their o	wn. They can sp	ecify 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.			
Workload in Hours	Independent Study Time 128, Study Time in Lecture 12	12		
Credit points	8			
Course achievement				
Examination	Written exam			
Examination duration and	60 min (Analysis III) + 60 min (Differential Equations 1	)		
-				
scale				
	Conoral Engineering Science (Correspondence 7	octor). Coro Qualification. Computer		
Assignment for the	5 5			
	Civil- and Environmental Engineering: Core Qualification	on: Compulsory		
Assignment for the	5 5	on: Compulsory		
Assignment for the	Civil- and Environmental Engineering: Core Qualification	n: Compulsory y		
Assignment for the	Civil- and Environmental Engineering: Core Qualificatio Bioprocess Engineering: Core Qualification: Compulsor Digital Mechanical Engineering: Core Qualification: Cor	n: Compulsory y		
Assignment for the	Civil- and Environmental Engineering: Core Qualificatio Bioprocess Engineering: Core Qualification: Compulsor Digital Mechanical Engineering: Core Qualification: Cor Electrical Engineering: Core Qualification: Compulsory	n: Compulsory y mpulsory		
Assignment for the	Civil- and Environmental Engineering: Core Qualificatio Bioprocess Engineering: Core Qualification: Compulsor Digital Mechanical Engineering: Core Qualification: Cor Electrical Engineering: Core Qualification: Compulsory Energy and Environmental Engineering: Core Qualificat	n: Compulsory y mpulsory tion: Compulsory		
Assignment for the	Civil- and Environmental Engineering: Core Qualificatio Bioprocess Engineering: Core Qualification: Compulsor Digital Mechanical Engineering: Core Qualification: Cor Electrical Engineering: Core Qualification: Compulsory	n: Compulsory y mpulsory tion: Compulsory		
Assignment for the	Civil- and Environmental Engineering: Core Qualificatio Bioprocess Engineering: Core Qualification: Compulsor Digital Mechanical Engineering: Core Qualification: Cor Electrical Engineering: Core Qualification: Compulsory Energy and Environmental Engineering: Core Qualificat	n: Compulsory y mpulsory tion: Compulsory lification: Compulsory		
Assignment for the	Civil- and Environmental Engineering: Core Qualificatio Bioprocess Engineering: Core Qualification: Compulsor Digital Mechanical Engineering: Core Qualification: Cor Electrical Engineering: Core Qualification: Compulsory Energy and Environmental Engineering: Core Qualifical Green Technologies: Energy, Water, Climate: Core Qua Computational Science and Engineering: Core Qualifica	n: Compulsory y npulsory tion: Compulsory alification: Compulsory ation: Compulsory		
Assignment for the	Civil- and Environmental Engineering: Core Qualificatio Bioprocess Engineering: Core Qualification: Compulsor Digital Mechanical Engineering: Core Qualification: Cor Electrical Engineering: Core Qualification: Compulsory Energy and Environmental Engineering: Core Qualifical Green Technologies: Energy, Water, Climate: Core Qua Computational Science and Engineering: Core Qualifica Logistics and Mobility: Specialisation Traffic Planning a	n: Compulsory y npulsory tion: Compulsory alification: Compulsory ation: Compulsory nd Systems: Elective Compulsory	SOLY	
Assignment for the	Civil- and Environmental Engineering: Core Qualificatio Bioprocess Engineering: Core Qualification: Compulsor Digital Mechanical Engineering: Core Qualification: Cor Electrical Engineering: Core Qualification: Compulsory Energy and Environmental Engineering: Core Qualifical Green Technologies: Energy, Water, Climate: Core Qua Computational Science and Engineering: Core Qualifica Logistics and Mobility: Specialisation Traffic Planning a Logistics and Mobility: Specialisation Production Manage	n: Compulsory y mpulsory tion: Compulsory alification: Compulsory ation: Compulsory nd Systems: Elective Compulsory gement and Processes: Elective Compul	sory	
Assignment for the	Civil- and Environmental Engineering: Core Qualificatio Bioprocess Engineering: Core Qualification: Compulsor Digital Mechanical Engineering: Core Qualification: Cor Electrical Engineering: Core Qualification: Compulsory Energy and Environmental Engineering: Core Qualifical Green Technologies: Energy, Water, Climate: Core Qua Computational Science and Engineering: Core Qualifica Logistics and Mobility: Specialisation Traffic Planning a	n: Compulsory y mpulsory tion: Compulsory alification: Compulsory ation: Compulsory nd Systems: Elective Compulsory gement and Processes: Elective Compul	sory	
Assignment for the	Civil- and Environmental Engineering: Core Qualificatio Bioprocess Engineering: Core Qualification: Compulsor Digital Mechanical Engineering: Core Qualification: Cor Electrical Engineering: Core Qualification: Compulsory Energy and Environmental Engineering: Core Qualifical Green Technologies: Energy, Water, Climate: Core Qua Computational Science and Engineering: Core Qualifica Logistics and Mobility: Specialisation Traffic Planning a Logistics and Mobility: Specialisation Production Manage	n: Compulsory y mpulsory tion: Compulsory ation: Compulsory ation: Compulsory nd Systems: Elective Compulsory gement and Processes: Elective Compul nology: Compulsory	sory	
Assignment for the	Civil- and Environmental Engineering: Core Qualificatio Bioprocess Engineering: Core Qualification: Compulsor Digital Mechanical Engineering: Core Qualification: Cor Electrical Engineering: Core Qualification: Compulsory Energy and Environmental Engineering: Core Qualificat Green Technologies: Energy, Water, Climate: Core Qua Computational Science and Engineering: Core Qualificat Logistics and Mobility: Specialisation Traffic Planning a Logistics and Mobility: Specialisation Information Techno Logistics and Mobility: Specialisation Information Techno Logistics and Mobility: Specialisation Information Techno	n: Compulsory y mpulsory tion: Compulsory ation: Compulsory ation: Compulsory nd Systems: Elective Compulsory gement and Processes: Elective Compul nology: Compulsory	sory	
Assignment for the	Civil- and Environmental Engineering: Core Qualificatio Bioprocess Engineering: Core Qualification: Compulsor Digital Mechanical Engineering: Core Qualification: Cor Electrical Engineering: Core Qualification: Compulsory Energy and Environmental Engineering: Core Qualificat Green Technologies: Energy, Water, Climate: Core Qua Computational Science and Engineering: Core Qualificat Logistics and Mobility: Specialisation Traffic Planning a Logistics and Mobility: Specialisation Information Techn Mechanical Engineering: Core Qualification: Compulsor Mechatronics: Core Qualification: Compulsor	n: Compulsory y mpulsory tion: Compulsory ation: Compulsory ation: Compulsory nd Systems: Elective Compulsory gement and Processes: Elective Compul nology: Compulsory	Sory	
Assignment for the	Civil- and Environmental Engineering: Core Qualificatio Bioprocess Engineering: Core Qualification: Compulsor Digital Mechanical Engineering: Core Qualification: Cor Electrical Engineering: Core Qualification: Compulsory Energy and Environmental Engineering: Core Qualificat Green Technologies: Energy, Water, Climate: Core Qua Computational Science and Engineering: Core Qualificat Logistics and Mobility: Specialisation Traffic Planning a Logistics and Mobility: Specialisation Information Techn Mechanical Engineering: Core Qualification: Compulsor Mechatronics: Core Qualification: Compulsory Naval Architecture: Core Qualification: Compulsory	n: Compulsory y mpulsory tion: Compulsory ation: Compulsory ation: Compulsory nd Systems: Elective Compulsory gement and Processes: Elective Compul nology: Compulsory	sory	
Assignment for the	Civil- and Environmental Engineering: Core Qualificatio Bioprocess Engineering: Core Qualification: Compulsor Digital Mechanical Engineering: Core Qualification: Cor Electrical Engineering: Core Qualification: Compulsory Energy and Environmental Engineering: Core Qualificat Green Technologies: Energy, Water, Climate: Core Qua Computational Science and Engineering: Core Qualificat Logistics and Mobility: Specialisation Traffic Planning a Logistics and Mobility: Specialisation Information Techn Mechanical Engineering: Core Qualification: Compulsor Mechatronics: Core Qualification: Compulsory Naval Architecture: Core Qualification: Compulsory Process Engineering: Core Qualification: Compulsory	n: Compulsory y mpulsory tion: Compulsory ation: Compulsory ation: Compulsory nd Systems: Elective Compulsory gement and Processes: Elective Compul hology: Compulsory y		
Assignment for the	Civil- and Environmental Engineering: Core Qualificatio Bioprocess Engineering: Core Qualification: Compulsor Digital Mechanical Engineering: Core Qualification: Cor Electrical Engineering: Core Qualification: Compulsory Energy and Environmental Engineering: Core Qualificat Green Technologies: Energy, Water, Climate: Core Qua Computational Science and Engineering: Core Qualificat Logistics and Mobility: Specialisation Traffic Planning a Logistics and Mobility: Specialisation Information Techn Mechanical Engineering: Core Qualification: Compulsor Mechatronics: Core Qualification: Compulsory Naval Architecture: Core Qualification: Compulsory	n: Compulsory y mpulsory tion: Compulsory ation: Compulsory ation: Compulsory nd Systems: Elective Compulsory gement and Processes: Elective Compul hology: Compulsory y		ective Compulsory
Assignment for the	Civil- and Environmental Engineering: Core Qualificatio Bioprocess Engineering: Core Qualification: Compulsor Digital Mechanical Engineering: Core Qualification: Cor Electrical Engineering: Core Qualification: Compulsory Energy and Environmental Engineering: Core Qualificat Green Technologies: Energy, Water, Climate: Core Qua Computational Science and Engineering: Core Qualificat Logistics and Mobility: Specialisation Traffic Planning a Logistics and Mobility: Specialisation Information Techn Mechanical Engineering: Core Qualification: Compulsor Mechatronics: Core Qualification: Compulsory Naval Architecture: Core Qualification: Compulsory Process Engineering: Core Qualification: Compulsory	n: Compulsory y mpulsory tion: Compulsory alification: Compulsory ation: Compulsory nd Systems: Elective Compulsory gement and Processes: Elective Compul nology: Compulsory y Mobility: Specialisation Traffic Planning	and Systems: Eld	
Assignment for the	Civil- and Environmental Engineering: Core Qualificatio Bioprocess Engineering: Core Qualification: Compulsor Digital Mechanical Engineering: Core Qualification: Cor Electrical Engineering: Core Qualification: Compulsory Energy and Environmental Engineering: Core Qualificat Green Technologies: Energy, Water, Climate: Core Qua Computational Science and Engineering: Core Qualificat Logistics and Mobility: Specialisation Traffic Planning a Logistics and Mobility: Specialisation Information Techn Mechanical Engineering: Core Qualification: Compulsory Naval Architecture: Core Qualification: Compulsory Process Engineering: Core Qualification: Compulsory Engineering and Management - Major in Logistics and Engineering and Management - Major in Logistics and	n: Compulsory y mpulsory tion: Compulsory alification: Compulsory ation: Compulsory nd Systems: Elective Compulsory gement and Processes: Elective Compul nology: Compulsory y Mobility: Specialisation Traffic Planning	and Systems: Eld	
Assignment for the	Civil- and Environmental Engineering: Core Qualificatio Bioprocess Engineering: Core Qualification: Compulsor Digital Mechanical Engineering: Core Qualification: Cor Electrical Engineering: Core Qualification: Compulsory Energy and Environmental Engineering: Core Qualificat Green Technologies: Energy, Water, Climate: Core Qua Computational Science and Engineering: Core Qualificat Logistics and Mobility: Specialisation Traffic Planning a Logistics and Mobility: Specialisation Information Techn Mechanical Engineering: Core Qualification: Compulsor Mechatronics: Core Qualification: Compulsory Naval Architecture: Core Qualification: Compulsory Process Engineering: Core Qualification: Compulsory Engineering and Management - Major in Logistics and Management - Major in Logistics and Management	n: Compulsory y mpulsory tion: Compulsory alification: Compulsory ation: Compulsory nd Systems: Elective Compulsory gement and Processes: Elective Compul nology: Compulsory y Mobility: Specialisation Traffic Planning id Mobility: Specialisation Production N	and Systems: El lanagement and	Processes: Election

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
	<ul> <li>Differential calculus for several variables</li> <li>Mean value theorems and Taylor's theorem</li> <li>Maximum and minimum values</li> <li>Implicit functions</li> <li>Minimization under equality constraints</li> <li>Newton's method for multiple variables</li> <li>Double integrals over general regions</li> <li>Line and surface integrals</li> <li>Theorems of Gauß and Stokes</li> </ul>
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	
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 L1031: Differential E	Course L1031: Differential Equations 1 (Ordinary Differential Equations)	
Тур	Lecture	
Hrs/wk	2	
CP		
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	
	<ul> <li>Introduction and elementary methods</li> <li>Exsitence and uniqueness of initial value problems</li> <li>Linear differential equations</li> <li>Stability and qualitative behaviour of the solution</li> <li>Boundary value problems and basic concepts of calculus of variations</li> <li>Eigenvalue problems</li> <li>Numerical methods for the integration of initial and boundary value problems</li> <li>Classification of partial differential equations</li> </ul>	
Literature	<ul> <li>http://www.math.uni-hamburg.de/teaching/export/tuhh/index.html</li> </ul>	

ourse 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

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	and systems. Cool in pulledge in mathe		o moodulo Mothemetil
	The modul is an introduction to the theory of signals 1-3 is expected. Further experience with spectral tra		-	
	but not required.		пізіонії, саріасе	transionn) is useful
	but not required.			
Educational Objectives	After taking part successfully, students have reached	the following learning results		
Professional Competence				
Knowledge	The students are able to classify and describe signal	Is and linear time-invariant (LTI) systems	using methods	of signal and system
	theory. They are able to apply the fundamental tran	nsformations of continuous-time and disc	rete-time signals	and systems. They
	can describe and analyse deterministic signals and	systems mathematically in both time an	nd image domai	n. In particular, they
	understand the effects in time domain and image	domain which are caused by the transit	ion of a continu	ous-time signal to a
	discrete-time signal.			
Skills	The students are able to describe and analyse determ	ministic signals and linear time-invariant	systems using m	nethods of signal and
	system theory. They can analyse and design basic systems regarding important properties such as magnitude and phase			agnitude and phase
	response, stability, linearity etc They can assess the	e impact of LTI systems on the signal prop	perties in time ar	nd frequency domain.
Personal Competence				
Social Competence	The students can jointly solve specific problems.			
Autonomy	The students are able to acquire relevant inform	ation from appropriate literature sourc	es. They can c	ontrol their level of
	knowledge during the lecture period by solving tutori	ial problems, software tools, clicker syste	m.	
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	Computer Science: Core Qualification: Compulsory			
	Computer Science: Specialisation II. Mathematics and	d Engineering Science: Elective Compulso	ry	
	Data Science: Core Qualification: Compulsory			
	Electrical Engineering: Core Qualification: Compulsor	У		
	Computational Science and Engineering: Core Qualifi			
	Mechanical Engineering: Specialisation Mechatronics	: Elective Compulsory		
	Mechatronics: Core Qualification: Compulsory			
	Technomathematics: Specialisation III. Engineering S	cience: Elective Compulsory		

Course L0432: Signals and Systems	
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	SoSe
Content	Introduction to signal and system theory
	Signals
	Classification of signals
	<ul> <li>Continuous-time and discrete-time signals</li> </ul>
	<ul> <li>Analog and digital signals</li> </ul>
	Deterministic and random signals
	<ul> <li>Description of LTI systems by differential equations or difference equations, respectively</li> </ul>
	<ul> <li>Basic properties of signals and operations on signals</li> </ul>
	Elementary signals
	Distributions (Generalized Functions)
	<ul> <li>Power and energy of signals</li> </ul>
	<ul> <li>Correlation functions of deterministic signals</li> </ul>
	<ul> <li>Autocorrelation function</li> </ul>
	<ul> <li>Crosscorrelation function</li> </ul>
	Orthogonal signals
	Applications of correlation
	Linear time-invariant (LTI) systems
	• Linearity
	Time-invariance
1	1

- 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

Literature

- Allpass filters
- Minimum-phase, maximum-phase and mixed-phase filters
- Linear phase filters
- 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.

ourse 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
Introduction to Control Systems (L		Lecture	2	4
Introduction to Control Systems (L		Recitation Section (small)	2	2
Module Responsible				
Admission Requirements				
Recommended Previous Knowledge	Representation of signals and systems in time	e and frequency domain, Laplace transform		
Educational Objectives	After taking part successfully, students have	reached the following learning results		
Professional Competence				
Knowledge	- Chudanta con represent dunamia quata	ne helpsuist in time and frequency density and	oon in norticular	avalain areastics
	<ul> <li>Students can represent dynamic system</li> <li>first and second order systems</li> </ul>	m behavior in time and frequency domain, and	can în particular	explain properties
		ble control loops and interpret dynamic propertion	es in terms of free	quency response a
	root locus			4
	• They can explain the Nyquist stability	criterion and the stability margins derived from	it.	
	• They can explain the role of the phase	margin in analysis and synthesis of control loop	S	
	• They can explain the way a PID control	ler affects a control loop in terms of its frequent	cy response	
	They can explain issues arising when c	ontrollers designed in continuous time domain a	are implemented	digitally
Skills				
	Students can transform models of linea	ar dynamic systems from time to frequency dom	nain and vice vers	a
	They can simulate and assess the behavior			
		e help of heuristic (Ziegler-Nichols) tuning rules		a taabaiguaa
		le control loops with the help of root locus and fi		
	• They can calculate discrete-time ap	pproximations of controllers designed in cor	iunuous-ume an	a use it for alg
		Matlab Control Toolbox, Simulink) for carrying o	ut these tasks	
	,	· · · · · · · · · · · · · · · · · · ·		
Personal Competence				
		olve technical problems, and experimentally va		
Autonomy		ded sources (lecture notes, software document	tation, experimen	nt guides) and use
	when solving given problems.			
	They can assess their knowledge in weekly of	n-line tests and thereby control their learning pr	ogress.	
Workload in Hours	Independent Study Time 124, Study Time in I	Lecture 56		
Workload in Hours Credit points		Lecture 56		
	6	Lecture 56		
Credit points Course achievement	6	ecture 56		
Credit points Course achievement	6 None Written exam	.ecture 56		
Credit points Course achievement Examination	6 None Written exam	.ecture 56		
Credit points Course achievement Examination Examination duration and scale	6 None Written exam 120 min			
Credit points Course achievement Examination Examination duration and scale	6 None Written exam 120 min General Engineering Science (German progra	m, 7 semester): Core Qualification: Compulsory		
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Course L0654: Introduction t	o Control Systems
Тур	Lecture
Hrs/wk	2
CP	4
Workload in Hours	Independent Study Time 92, Study Time in Lecture 28
Lecturer	Prof. Herbert Werner
Language	DE
Cycle	WiSe
Content	Signals and systems
	Linear systems, differential equations and transfer functions
	<ul> <li>First and second order systems, poles and zeros, impulse and step response</li> </ul>
	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
	<ul> <li>Nyquist plot, Nyquist stability criterion, phase and gain margin</li> </ul>
	Loop shaping, lead lag compensation
	Frequency response interpretation of PID control
	Time delay systems
	Dest land and for warming of the scalar such as
	<ul> <li>Root locus and frequency response of time delay systems</li> <li>Smith predictor</li> </ul>
	• Smith predictor
	Digital control
	<ul> <li>Sampled-data systems, difference equations</li> <li>Tustin approximation, digital implementation of PID controllers</li> </ul>
	Software tools
	Introduction to Matlab, Simulink, Control toolbox
	Computer-based exercises throughout the course
	··· ··· ····
Literature	Werner, H., Lecture Notes "Introduction to Control Systems"
	<ul> <li>G.F. Franklin, J.D. Powell and A. Emami-Naeini "Feedback Control of Dynamic Systems", Addison Wesley, Reading, MA, 2009</li> </ul>
	<ul> <li>K. Ogata "Modern Control Engineering", Fourth Edition, Prentice Hall, Upper Saddle River, NJ, 2010</li> </ul>
	<ul> <li>R.C. Dorf and R.H. Bishop, "Modern Control Systems", Addison Wesley, Reading, MA 2010</li> </ul>

Course L0655: Introduction t	ourse 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	Prof. Herbert Werner	
Language	DE	
Cycle	WiSe	
Content	See interlocking course	
Literature	See interlocking course	

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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 business
	knowledge from the lecture should come to practical use. The group projects are guided by a mentor.

Literature Relevante Literatur aus der korrespondierenden Vorlesung.

	o Management
Тур	Lecture
Hrs/wk	3
СР	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	<ul> <li>Introduction to Business and Management, Business versus Economics, relevant areas in Business and Management</li> <li>Important definitions from Management,</li> <li>Developing Objectives for Business, and their relation to important Business functions</li> <li>Business Functions: Functions of the Value Chain, e.g. Production and Procurement, Supply Chain Management, Innovation Management, Marketing and Sales Cross-sectional Functions, e.g. Organisation, Human Ressource Management, Supply Chain Management, Information Management</li> <li>Definitions as information, information systems, aspects of data security and strategic information systems</li> <li>Definition and Relevance of innovations, e.g. innovation opporunities, risks etc.</li> <li>Relevance of marketing, B2B vs. B2C-Marketing</li> <li>different techniques from the field of marketing (e.g. scenario technique), pricing strategies</li> <li>important organizational structures</li> <li>basics of human ressource management</li> <li>Introduction to Business Planning and the steps of a planning process</li> <li>Decision Analysis: Elements of decision problems and methods for solving decision problems</li> <li>Selected Planning Tasks, e.g. Investment and Financial Decisions</li> <li>Introduction to Accounting: Accounting, Balance-Sheets, Costing</li> <li>Relevance of Controlling and selected Controlling methods</li> <li>Important aspects of Entrepreneurship projects</li> </ul>
	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. Aufl., Stuttgart 2005.
	Weber, J., Schäffer, U. : Einführung in das Controlling, 12. Auflage, Stuttgart 2008.

Courses				
Title		Түр	Hrs/wk	СР
	nship-accompanying Seminar (L2687)	Seminar	1	0
Advanced Internship AIW/ ES: Prep		Seminar	1	0
Module Responsible	Prof. Robert Seifried			
Admission Requirements	None			
<b>Recommended Previous</b>	150 Creditpoints in General Engineering Scien	ce		
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	periences in typical scope of duties of	engineers, who are worki	ng in a developme
	division, planning division or in the manage	ement of a company. In the framewo	rk of this environment	the knowledge fro
	university can used a first time for real engine	eering tasks.		
Skills	Students of the different specialisations show	5 ,1 ,	, ,	5 51
	functions of engineers. They are able to struct	ture and organize their working day and	to finish tasks in a certa	in 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.			
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	m. 7 semester): Core Oualification: Com	npulsory	
Assignment for the				

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

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-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 intensive exchange with fellow students, the students also gain insights into the internships of their peers. This gives them an impression of their professional opportunities far beyond their own internship. The concrete application example of the advanced internship thus promotes 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 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.

Courses				
Title		Тур	Hrs/wk	CP
Building Physics (L0217)		Lecture	2	2
Building Physics (L0219)		Recitation Section (large)	1	1
Building Physics (L0247) Principles of Building Materials (L02	215)	Recitation Section (small) Lecture	1 2	1
	Prof. Frank Schmidt-Döhl	Letture	2	Z
Admission Requirements				
	Knowledge of physics, chemistry and	mathematics from school		
Knowledge				
5	After taking part successfully, studen	ts have reached the following learning results		
Professional Competence				
Skills	materials and structures and their me The students are able to work with t	rosion processes and to describe the most important easurement in the field of protection against moisture, he most important standardized methods and regulari ving, fire protection and noise protection in the case of	coldness, fire and ities in the field of	noise.
Personal Competence				
Social Competence	The students are able to support each	h other to learn the very extensive specialist knowledg	e.	
Autonomy	The students are able to make the tin	ning and the operation steps to learn the specialist kno	wledge of a very e	extensive field.
Workload in Hours	Independent Study Time 96, Study Ti	me in Lecture 84		
Credit points	6			
Course achievement	None			
Examination	Written exam			
Examination duration and	2 h written exam			
scale				
Assignment for the	General Engineering Science (German	n program, 7 semester): Specialisation Civil Engineerin	g: Compulsory	
	Civil- and Environmental Engineering	· Coro Qualification: Compulsory		
Following Curricula	Civil- and Environmental Engineering	. Core Qualification. Compulsory		
Following Curricula	Orientation Studies: Core Qualificatio			

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	ics
Тур	Recitation Section (large)
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 L0247: Building Phys	ics
Тур	Recitation Section (small)
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 L0215: Principles of I	Ruilding Materials
	Lecture
Hrs/wk	
СР	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. Uwe Starossek				
Admission Requirements	None				
<b>Recommended Previous</b>	Mechanics I, Mathem	atics I			
Knowledge					
Educational Objectives	After taking part succ	cessfully, students have r	eached the following learning results		
Professional Competence					
Knowledge	After successfully cor	mpleting this module, stu	dents can express the basic aspects of linear	frame analysis of s	tatically determina
	systems.				
Skills	After successful com	pletion of this module th	e students are able to distinguish between s	statically determinat	e and indetermin
JKIIIS			ariables and to construct influence lines of	,	
	frame and truss struc				
Personal Competence					
Personal Competence Social Competence	Students can				
Personal Competence Social Competence	Students can				
-	participate in s	subject-specific and inter-			
-	<ul><li>participate in s</li><li>defend their or</li></ul>	wn work results in front o	fothers		
-	<ul><li>participate in s</li><li>defend their or</li><li>promote the so</li></ul>	wn work results in front o cientific development of o	f others colleagues		
-	<ul><li>participate in s</li><li>defend their or</li><li>promote the so</li></ul>	wn work results in front o cientific development of o	fothers		
-	<ul> <li>participate in s</li> <li>defend their or</li> <li>promote the so</li> <li>Furthermore, t</li> </ul>	wn work results in front o cientific development of hey can give and accept	f others colleagues professional constructive criticism	k, they are enabled	l to self-assess th
<i>Social Competence</i>	<ul> <li>participate in s</li> <li>defend their or</li> <li>promote the so</li> <li>Furthermore, t</li> </ul>	wn work results in front o cientific development of hey can give and accept	f others colleagues professional constructive criticism rk assignments. Due to the in-term feedbac	k, they are enabled	d to self-assess th
Social Competence Autonomy	<ul> <li>participate in s</li> <li>defend their or</li> <li>promote the sr</li> <li>Furthermore, t</li> </ul> The students are abl learning progress dur	wn work results in front of cientific development of of hey can give and accept le work in-term homewo ring the lecture period, al	f others colleagues professional constructive criticism rk assignments. Due to the in-term feedbac ready.	k, they are enabled	d to self-assess th
Social Competence Autonomy Workload in Hours	<ul> <li>participate in s</li> <li>defend their or</li> <li>promote the so</li> <li>Furthermore, t</li> </ul> The students are ablighted the students are ablighted by the students are ablighted by the student st	wn work results in front o cientific development of hey can give and accept le work in-term homewo	f others colleagues professional constructive criticism rk assignments. Due to the in-term feedbac ready.	k, they are enabled	d to self-assess th
Social Competence Autonomy Workload in Hours Credit points	<ul> <li>participate in s</li> <li>defend their or</li> <li>promote the sr</li> <li>Furthermore, t</li> </ul> The students are abl learning progress dur Independent Study Tr	wn work results in front o cientific development of o hey can give and accept le work in-term homewo ring the lecture period, al ime 124, Study Time in L	f others colleagues professional constructive criticism rk assignments. Due to the in-term feedbac ready. ecture 56	k, they are enabled	d to self-assess th
Social Competence Autonomy Workload in Hours	<ul> <li>participate in s</li> <li>defend their or</li> <li>promote the s</li> <li>Furthermore, t</li> </ul> The students are ablighted the students are ablighted by the student student student are ablighted by the student student student student are ablighted by the student student student student are ablighted by the student stu	wn work results in front of cientific development of of hey can give and accept le work in-term homewo ring the lecture period, al ime 124, Study Time in L Form	f others colleagues professional constructive criticism rk assignments. Due to the in-term feedbac ready. ecture 56 Description		
Social Competence Autonomy Workload in Hours Credit points Course achievement	<ul> <li>participate in s</li> <li>defend their or</li> <li>promote the s</li> <li>Furthermore, t</li> </ul> The students are ablighted the students are ablighted by t	wn work results in front o cientific development of o hey can give and accept le work in-term homewo ring the lecture period, al ime 124, Study Time in L	f others colleagues professional constructive criticism rk assignments. Due to the in-term feedbac ready. ecture 56		
Social Competence Autonomy Workload in Hours Credit points Course achievement Examination	<ul> <li>participate in s</li> <li>defend their or</li> <li>promote the sr</li> <li>Furthermore, t</li> </ul> The students are able learning progress during progress durin	wn work results in front of cientific development of of hey can give and accept le work in-term homewo ring the lecture period, al ime 124, Study Time in L Form	f others colleagues professional constructive criticism rk assignments. Due to the in-term feedbac ready. ecture 56 Description		
Social Competence Autonomy Workload in Hours Credit points Course achievement Examination duration and	<ul> <li>participate in s</li> <li>defend their or</li> <li>promote the sr</li> <li>Furthermore, t</li> </ul> The students are able learning progress during progress durin	wn work results in front of cientific development of of hey can give and accept le work in-term homewo ring the lecture period, al ime 124, Study Time in L Form	f others colleagues professional constructive criticism rk assignments. Due to the in-term feedbac ready. ecture 56 Description		
Social Competence Autonomy Workload in Hours Credit points Course achievement Examination Examination duration and scale	<ul> <li>participate in s</li> <li>defend their or</li> <li>promote the sr</li> <li>Furthermore, t</li> </ul> The students are able learning progress dures and the students are able learning progress dures and the students of the students of the students of the student students of the students of t	wn work results in front of cientific development of of hey can give and accept le work in-term homewo ring the lecture period, al ime 124, Study Time in L Form Written elaboration	f others colleagues professional constructive criticism rk assignments. Due to the in-term feedbac ready. ecture 56 Description Hausübungen mit Testat, betreut durch	Studentische Tutor	
Social Competence Autonomy Workload in Hours Credit points Course achievement Examination Examination duration and scale Assignment for the	participate in s     defend their or     promote the se     Furthermore, t  The students are abl learning progress dur Independent Study Tr 6 Compulsory Bonus No 10 % Written exam 90 Minuten General Engineering	wn work results in front of cientific development of of hey can give and accept le work in-term homewo ring the lecture period, al ime 124, Study Time in L Form Written elaboration Science (German program	f others colleagues professional constructive criticism rk assignments. Due to the in-term feedbac ready. ecture 56 Description Hausübungen mit Testat, betreut durch	Studentische Tutor	
Social Competence Autonomy Workload in Hours Credit points Course achievement Examination Examination duration and scale	<ul> <li>participate in s</li> <li>defend their or</li> <li>promote the sr</li> <li>Furthermore, t</li> </ul> The students are able learning progress during progress durin	wn work results in front of cientific development of of hey can give and accept le work in-term homewo ring the lecture period, al ime 124, Study Time in L Form Written elaboration Science (German program tal Engineering: Core Qu	f others colleagues professional constructive criticism rk assignments. Due to the in-term feedbac ready. ecture 56 Description Hausübungen mit Testat, betreut durch m, 7 semester): Specialisation Civil Engineeri ialification: Compulsory	Studentische Tutor	
Social Competence Autonomy Workload in Hours Credit points Course achievement Examination Examination duration and scale Assignment for the	<ul> <li>participate in s</li> <li>defend their or</li> <li>promote the sr</li> <li>Furthermore, t</li> </ul> The students are able learning progress during progress durin	wn work results in front of cientific development of of hey can give and accept le work in-term homewo ring the lecture period, al ime 124, Study Time in L Form Written elaboration Science (German program ttal Engineering: Core Qu r: Specialisation Traffic Pl	f others colleagues professional constructive criticism rk assignments. Due to the in-term feedbac ready. ecture 56 Description Hausübungen mit Testat, betreut durch m, 7 semester): Specialisation Civil Engineeri ialification: Compulsory anning and Systems: Elective Compulsory	Studentische Tutor	
Social Competence Autonomy Workload in Hours Credit points Course achievement Examination Examination duration and scale Assignment for the	<ul> <li>participate in s</li> <li>defend their or</li> <li>promote the sr</li> <li>Furthermore, t</li> </ul> The students are able learning progress during progress durin	wn work results in front of cientific development of of hey can give and accept le work in-term homewo ring the lecture period, al ime 124, Study Time in L Form Written elaboration Science (German program ttal Engineering: Core Qu 2: Specialisation Traffic PI Specialisation III. Engine	f others colleagues professional constructive criticism rk assignments. Due to the in-term feedbac ready. ecture 56 Description Hausübungen mit Testat, betreut durch m, 7 semester): Specialisation Civil Engineeri ialification: Compulsory	n Studentische Tutor	en (Tutorium)

Тур	Lecture				
Hrs/wk	2				
CP	3				
Workload in Hours	ndent Study Time 62, Study Time in Lecture 28				
Lecturer	Prof. Uwe Starossek				
Language	DE				
Cycle	WiSe				
Content	<ul> <li>Statically determinate structural systems</li> <li>basics: statically determinacy, equilibrium, method of sections</li> <li>forces: determination of support reactions and internal forces</li> <li>influence lines of forces</li> <li>displacements: calculation of discrete displacements and rotations, calculation of deflection curves</li> <li>principle of virtual displacements and virtual forces</li> <li>work-engergy theorem</li> <li>differential equation of beam</li> </ul>				
Literature	Krätzig, W.B., Harte, R., Meskouris, K., Wittek, U.: Tragwerke 1 - Theorie und Berechnungsmethoden statisch bestimmter Stabtragwerke. 4. Aufl., Springer, Berlin, 1999.				

Course L0667: Structural Ana	urse 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. Uwe Starossek				
Language	DE				
Cycle	WiSe				
Content	See interlocking course				
Literature	See interlocking course				

Second sets         Typ         Hrs/wk         CP           Building Materials and Building Chemistry (10.248)         Lecture         4         4           Building Materials and Building Chemistry (10.248)         Recitation Section (small)         1         2           Module Responsible         Prof. Frank Schmidt-Dohl         Recommended Previous         None	Courses						
Building Materials and Building Chemistry (L0248)       Lecture       4       4         Building Materials and Building Chemistry (L0249)       Recitation Section (small)       1       2         Module Responsible       Ford. Frank Schmidt-Döhl       Image: Section (small)       1       2         Admission Requirements       More       Image: Section (small)       1       2         Recommended Previous       Module Principles of Building Materials and Building Physics       Image: Section (small)       1       2         Professional Competence       Knowledge       If the students are able to explain the most important components, the manufacture, the structure, the most import characteristics of the mechanical behaviour and the corrosion behaviour, the material testing and the fields of utilization of relevant building materials.         Skills       The students are able to assess the usability of building materials for different applications and to select building materials and mixtures to avoid damage processes.         Personal Competence       Envirue able to select suitable materials and mixtures to avoid damage processes.         Social Competence       In estudents are able to support each other to learn the very extensive specialist knowledge of a very extensive field.         Workload in Hours       Independent Study Time 110, Study Time in Lecture 70       Image: Section         Course achievent       Independent Study Time 10, Study Time in Lecture 70       Image: Section <th></th> <th></th> <th></th> <th></th> <th>100</th> <th>Hrs /wk</th> <th>CB</th>					100	Hrs /wk	CB
Building Materials and Building Chemistry (L0249)       Recitation Section (small)       1       2         Module Responsible       Prof. Frank Schmidt-Doll							
Module Responsible         Prof. Frank Schmidt-Döhl           Admission Requirements         None           Recommended Previous         Module Principles of Building Materials and Building Physics           Knowledge         Educational Objectives           Educational Objectives         After taking part successfully, students have reached the following learning results           Professional Competence         Knowledge           Knowledge         The students are able to explain the most important components, the manufacture, the structure, the most import characteristics of the mechanical behaviour and the corrosion behaviour, the material testing and the fields of utilization of relevant building materials.           Skills         The students are able to assess the usability of building materials for different applications and to select building materials.           Skills         The students are able to assess the usability of building materials for different applications and to select building materials.           Personal Competence         Social Competence           Social Competence         The students are able to support each other to learn the very extensive specialist knowledge in learning groups and to carry exercises in small groups in the lab.           Autonomy         The students are able to make the timing and the operation steps to learn the specialist knowledge of a very extensive field.           Workload in Hours         Independent Study Time 110, Study Time in Lecture 70           Course achievement		-					
Admission Requirements         None           Recommended Previous Knowledge         Module Principles of Building Materials and Building Physics           Educational Objectives         After taking part successfully, students have reached the following learning results           Professional Competence Knowledge         The students are able to explain the most important components, the manufacture, the structure, the most import characteristics of the mechanical behaviour and the corrosion behaviour, the material testing and the fields of utilization of relevant building materials.           Skills         The students are able to assess the usability of building materials for different applications and to select building materials according to their specific advantages and disadvantages. The students are able to prepare the mixture of a normal type concr and to consider the mixture in respect to the actual rules and the connections between the characteristic concrete paramete. They are able to select suitable materials and mixtures to avoid damage processes.           Personal Competence Social Competence         The students are able to support each other to learn the very extensive specialist knowledge in learning groups and to carry exercises in small groups in the lab.           Autonomy         The students are able to make the timing and the operation steps to learn the specialist knowledge of a very extensive field.           Workload in Hours         Independent Study Time 110, Study Time in Lecture 70           Course achievement No         10 %           Computery Benus         Form         Description No           No		-	Döhl				
Knowledge         After taking part successfully, students have reached the following learning results           Professional Competence         After taking part successfully, students have reached the following learning results           Professional Competence         The students are able to explain the most important components, the manufacture, the structure, the most import characteristics of the mechanical behaviour and the corrosion behaviour, the material testing and the fields of utilization of relevant building materials.           Skills         The students are able to assess the usability of building materials for different applications and to select building materials according to their specific advantages and disadvantages. The students are able to prepare the mixture of a normal type conce and to consider the mixture in respect to the actual rules and the connections between the characteristic concrete paramete They are able to select suitable materials and mixtures to avoid damage processes.           Personal Competence         The students are able to support each other to learn the very extensive specialist knowledge in learning groups and to carry exercises in small groups in the lab.           Autonomy         The students are able to make the timing and the operation steps to learn the specialist knowledge of a very extensive field.           Workload in Hours         Independent Study Time 110, Study Time in Lecture 70           Course achievement         Form         Description           No         10 %         Presentation           Examination duration and a 1 hwitten exam         2 hwitten exam         Examination							
Educational Objectives       After taking part successfully, students have reached the following learning results         Professional Competence       Knowledge         The students are able to explain the most important components, the manufacture, the structure, the most import characteristics of the mechanical behaviour and the corrosion behaviour, the material testing and the fields of utilization of relevant building materials.         Skills       The students are able to assess the usability of building materials for different applications and to select building materials or or relevant building their specific advantages and disadvantages. The students are able to prepare the mixture of a normal type concrand to consider the mixture in respect to the actual rules and the connections between the characteristic concrete paramete. They are able to select suitable materials and mixtures to avoid damage processes.         Personal Competence       Social Competence         Social Competence       The students are able to make the timing and the operation steps to learn the specialist knowledge in learning groups and to carry exercises in small groups in the lab.         Workload in Hours       Independent Study Time 110, Study Time in Lecture 70         Credit points       6         Course achievement       Computory Bonus         No       10 %         Presentation       Viritien exam         Examination duration and scale       2 horititen exam         Scale       Assignment for the	<b>Recommended Previous</b>	Module Principles of	Building Materials and Bu	uilding Physics			
Professional Competence       Knowledge         Knowledge       The students are able to explain the most important components, the manufacture, the structure, the most import characteristics of the mechanical behaviour and the corrosion behaviour, the material testing and the fields of utilization of relevant building materials.         Skills       The students are able to assess the usability of building materials for different applications and to select building materials correlevant building the important connections between the mixture of a normal type concrete parameter in the mixture in respect to the actual rules and the connections between the characteristic concrete parameter They are able to select suitable materials and mixtures to avoid damage processes.         Personal Competence       The students are able to support each other to learn the very extensive specialist knowledge in learning groups and to carry exercises in small groups in the lab.         Autonomy       The students are able to make the timing and the operation steps to learn the specialist knowledge of a very extensive field.         Workload in Hours       Independent Study Time 110, Study Time in Lecture 70         Credit points       6         Course achievement       Compulsory Bonus Form Description No         No       10 % Presentation         Examination duration and 2 h written exam       2 h written exam         Examination duration and scale       2 h written exam	Knowledge						
Knowledge       The students are able to explain the most important components, the manufacture, the structure, the most import characteristics of the mechanical behaviour and the corrosion behaviour, the material testing and the fields of utilization of relevant building materials.         Skills       The students are able to assess the usability of building materials for different applications and to select building materials corroring to their specific advantages and disadvantages. The students are able to prepare the mixture of a normal type concrutering and to consider the mixture in respect to the actual rules and the connections between the characteristic concrete parameter They are able to select suitable materials and mixtures to avoid damage processes.         Personal Competence       The students are able to support each other to learn the very extensive specialist knowledge in learning groups and to carry exercises in small groups in the lab.         Autonomy       The students are able to make the timing and the operation steps to learn the specialist knowledge of a very extensive field.         Workload in Hours       Independent Study Time 110, Study Time in Lecture 70         Course achievement       form Description         No       10 %       Presentation         Examination       uritten exam         scale       formular exam         Assignment for the       General Engineering Science (German program, 7 semester): Specialisation Civil Engineering: Compulsory	Educational Objectives	After taking part suce	cessfully, students have	reached the following	learning results		
characteristics of the mechanical behaviour and the corrosion behaviour, the material testing and the fields of utilization of relevant building materials.         Skills       The students are able to assess the usability of building materials for different applications and to select building materials corroling to their specific advantages and disadvantages. The students are able to prepare the mixture of a normal type concrant to consider the mixture in respect to the actual rules and the connections between the characteristic concrete parameter. They are able to select suitable materials and mixtures to avoid damage processes.         Personal Competence       Social Competence         Social Competence       The students are able to support each other to learn the very extensive specialist knowledge in learning groups and to carry exercises in small groups in the lab.         Autonomy       The students are able to make the timing and the operation steps to learn the specialist knowledge of a very extensive field.         Workload in Hours       Independent Study Time 110, Study Time in Lecture 70         Course achievement       Compulsory Bonus       Form         No       10 %       Presentation         No       10 %       Presentation         Rexamination duration and scale       2 h written exam         Examination duration and scale       2 h written exam	Professional Competence						
Skills       relevant building materials.         Skills       The students are able to assess the usability of building materials for different applications and to select building materials according to their specific advantages and disadvantages. The students are able to prepare the mixture of a normal type concrand to consider the mixture in respect to the actual rules and the connections between the characteristic concrete parameter They are able to select suitable materials and mixtures to avoid damage processes.         Personal Competence       The students are able to support each other to learn the very extensive specialist knowledge in learning groups and to carry exercises in small groups in the lab.         Autonomy       The students are able to make the timing and the operation steps to learn the specialist knowledge of a very extensive field.         Workload in Houra       Independent Study Time 110, Study Time in Lecture 70         Course achievement       Computory ionus form form bescription No         No       10 %         Presentation       Viritten exam         Examination duration ana scale       2 h written exam         Assignment for the       General Engineering Science (German program, 7 semester): Specialisation Civil Engineering: Compulsory	Knowledge	The students are a	able to explain the mo	ost important compo	nents, the manufacture,	the structure, t	he most importa
Skills       The students are able to assess the usability of building materials for different applications and to select building materials according to their specific advantages and disadvantages. The students are able to prepare the mixture of a normal type concruteriant to consider the mixture in respect to the actual rules and the connections between the characteristic concrete parameterization to consider the mixture in respect to the actual rules and the connections between the characteristic concrete parameterization and to consider the mixture in respect to the actual rules and the connections between the characteristic concrete parameterization and to consider the mixture in respect to the actual rules and the connections between the characteristic concrete parameterization and to consider the mixture in respect to the actual rules and the connections between the characteristic concrete parameterization and to consider the mixture in respect to the actual rules and the connections between the characteristic concrete parameterization and the specialization to the construction of the students are able to support each other to learn the very extensive specialist knowledge in learning groups and to carry exercises in small groups in the lab.         Autonomy       The students are able to make the timing and the operation steps to learn the specialist knowledge of a very extensive field.         Workload in Hours       Independent Study Time 110, Study Time in Lecture 70         Course achievement       Form       Description         No       10 %       Presentation         Examination duration and       2 h written exam         scale       2 h written exam		characteristics of the	e mechanical behaviour	and the corrosion be	haviour, the material test	ing and the field	s of utilization of
According to their specific advantages and disadvantages. The students are able to prepare the mixture of a normal type concrutering and to consider the mixture in respect to the actual rules and the connections between the characteristic concrete parameters. They are able to select suitable materials and mixtures to avoid damage processes.         Personal Competence       The students are able to support each other to learn the very extensive specialist knowledge in learning groups and to carry exercises in small groups in the lab.         Autonomy       The students are able to make the timing and the operation steps to learn the specialist knowledge of a very extensive field.         Workload in Hours       Independent Study Time 110, Study Time in Lecture 70         Course achievement       Compulsory       Bonus         No       10 %       Presentation         Examination duration and scale       2 h written exam       Form       Description         Assignment for the       General Engineering Science (German program, 7 semester): Specialisation Civil Engineering: Compulsory       Social Compulsory		relevant building ma	terials.				
According to their specific advantages and disadvantages. The students are able to prepare the mixture of a normal type concrute and to consider the mixture in respect to the actual rules and the connections between the characteristic concrete parameter. They are able to select suitable materials and mixtures to avoid damage processes.         Personal Competence.       The students are able to support each other to learn the very extensive specialist knowledge in learning groups and to carry exercises in small groups in the lab.         Autonomy       The students are able to make the timing and the operation steps to learn the specialist knowledge of a very extensive field.         Workload in Hours       Independent Study Time 110, Study Time in Lecture 70         Course achievement       Compulsory       Bonus         No       10 %       Presentation         Examination duration and scale       2 h written exam       Seciel Compulsory         Assignment for the       General Engineering Science (German program, 7 semester): Specialisation Civil Engineering: Compulsory							
According to their specific advantages and disadvantages. The students are able to prepare the mixture of a normal type concrutering and to consider the mixture in respect to the actual rules and the connections between the characteristic concrete parameters. They are able to select suitable materials and mixtures to avoid damage processes.         Personal Competence       The students are able to support each other to learn the very extensive specialist knowledge in learning groups and to carry exercises in small groups in the lab.         Autonomy       The students are able to make the timing and the operation steps to learn the specialist knowledge of a very extensive field.         Workload in Hours       Independent Study Time 110, Study Time in Lecture 70         Course achievement       Compulsory       Bonus         No       10 %       Presentation         Examination duration and scale       2 h written exam       Form       Description         Assignment for the       General Engineering Science (German program, 7 semester): Specialisation Civil Engineering: Compulsory       Social Compulsory							
Autonomy       and to consider the mixture in respect to the actual rules and the connections between the characteristic concrete parameter They are able to select suitable materials and mixtures to avoid damage processes.         Personal Competence       The students are able to support each other to learn the very extensive specialist knowledge in learning groups and to carry exercises in small groups in the lab.         Autonomy       The students are able to make the timing and the operation steps to learn the specialist knowledge of a very extensive field.         Workload in Hours       Independent Study Time 110, Study Time in Lecture 70         Course achievement       Compulsory       Bonus       Form       Description         No       10 %       Presentation       Description         Examination duration and scale       2 h written exam       2 h written exam         Assignment for the       General Engineering Science (German program, 7 semester): Specialisation Civil Engineering: Compulsory	Skills	The students are at	ble to assess the usabil	ity of building mater	ials for different applicati	ons and to seled	t building materi
Personal Competence       The sure able to select suitable materials and mixtures to avoid damage processes.         Social Competence       The students are able to support each other to learn the very extensive specialist knowledge in learning groups and to carry exercises in small groups in the lab.         Autonomy       The students are able to make the timing and the operation steps to learn the specialist knowledge of a very extensive field.         Workload in Hours       Independent Study Time 110, Study Time in Lecture 70         Course achievement       Compulsory Bonus Form Description         No       10 %       Presentation         Written examination       Unitten exam         Examination duration and scale       2 h written exam         Scale       Scale         Assignment for the       General Engineering Science (German program, 7 semester): Specialisation Civil Engineering: Compulsory		according to their sp	ecific advantages and di	sadvantages. The stu	dents are able to prepare	the mixture of a r	ormal type concre
Personal Competence       Social Competence       The students are able to support each other to learn the very extensive specialist knowledge in learning groups and to carry exercises in small groups in the lab.         Autonomy       The students are able to make the timing and the operation steps to learn the specialist knowledge of a very extensive field.         Workload in Hours       Independent Study Time 110, Study Time in Lecture 70         Credit points       6         Course achievement       Compulsory Bonus Form Persentation       Description         Examination duration and scale       2 h written exam         Examination duration and scale       2 h written exam         Assignment for the       General Engineering Science (German program, 7 semester): Specialisation Civil Engineering: Compulsory		and to consider the	mixture in respect to th	e actual rules and the	e connections between th	e characteristic c	oncrete paramete
Social Competence       The students are able to support each other to learn the very extensive specialist knowledge in learning groups and to carry exercises in small groups in the lab.         Autonomy       The students are able to make the timing and the operation steps to learn the specialist knowledge of a very extensive field.         Workload in Hours       Independent Study Time 110, Study Time in Lecture 70         Credit points       6         Course achievement       Form       Description         No       10 %       Presentation         Examination duration and scale       2 h written exam         Scale       Scale       Scale		They are able to sele	ect suitable materials and	d mixtures to avoid da	mage processes.		
Social Competence       The students are able to support each other to learn the very extensive specialist knowledge in learning groups and to carry exercises in small groups in the lab.         Autonomy       The students are able to make the timing and the operation steps to learn the specialist knowledge of a very extensive field.         Workload in Hours       Independent Study Time 110, Study Time in Lecture 70         Credit points       6         Course achievement       Compulsory       Bonus       Form       Description         No       10 %       Presentation       Description         Examination duration and scale       2 h written exam       Scale       Scale         Assignment for the       General Engineering Science (German program, 7 semester): Specialisation Civil Engineering: Compulsory							
Autonomy       Rescrises in small groups in the lab.         Autonomy       The students are able to make the timing and the operation steps to learn the specialist knowledge of a very extensive field.         Workload in Hours       Independent Study Time 110, Study Time in Lecture 70         Credit points       6         Course achievement       Compulsory         No       10 %         Presentation         Kitten exam         Examination duration and scale         Scale         Assignment for the       General Engineering Science (German program, 7 semester): Specialisation Civil Engineering: Compulsory							
Autonomy       The students are able to make the timing and the operation steps to learn the specialist knowledge of a very extensive field.         Workload in Hours       Independent Study Time 110, Study Time in Lecture 70         Credit points       6         Course achievement       Compulsory Bonus       Form         No       10 %       Presentation         Examination duration and scale       2 h written exam         Scale       Scale	Social Competence			to learn the very ext	ensive specialist knowledg	je in learning gro	ups and to carry c
Workload in Hours       Independent Study Time 110, Study Time in Lecture 70         Credit points       6         Course achievement       Compulsory Bonus       Form       Description         No       10 %       Presentation       Description         Examination duration and scale       2 h written exam       Scale       Scale         Assignment for the       General Engineering Science (German program, 7 semester): Specialisation Civil Engineering: Compulsory		exercises in small gro	oups in the lab.				
Workload in Hours       Independent Study Time 110, Study Time in Lecture 70         Credit points       6         Course achievement       Compulsory Bonus       Form       Description         No       10 %       Presentation       Description         Examination duration and scale       2 h written exam       Scale       Scale         Assignment for the       General Engineering Science (German program, 7 semester): Specialisation Civil Engineering: Compulsory							
Workload in Hours       Independent Study Time 110, Study Time in Lecture 70         Credit points       6         Course achievement       Compulsory Bonus       Form       Description         No       10 %       Presentation       Description         Examination duration and scale       2 h written exam       Scale       Scale         Assignment for the       General Engineering Science (German program, 7 semester): Specialisation Civil Engineering: Compulsory							
Credit points       6         Course achievement       Compulsory Bonus       Form       Description         No       10 %       Presentation       Description         Examination duration and scale       2 h written exam       Examination       General Engineering Science (German program, 7 semester): Specialisation Civil Engineering: Compulsory	Autonomy	The students are able	e to make the timing and	the operation steps t	to learn the specialist know	ledge of a very e	xtensive field.
Course achievement         Compulsory         Bonus         Form         Description           No         10 %         Presentation         Presentation           Examination duration and scale         2 h written exam         Scale         Scale	Workload in Hours	Independent Study T	Time 110, Study Time in I	Lecture 70			
No     10 %     Presentation       Examination duration and scale     2 h written exam       Assignment for the     General Engineering Science (German program, 7 semester): Specialisation Civil Engineering: Compulsory	Credit points	6					
Examination       Written exam         Examination duration and scale       2 h written exam         Assignment for the       General Engineering Science (German program, 7 semester): Specialisation Civil Engineering: Compulsory	Course achievement	Compulsory Bonus	Form	Description			
Examination duration and scale       2 h written exam         scale		No 10 %	Presentation				
scale           Assignment for the         General Engineering Science (German program, 7 semester): Specialisation Civil Engineering: Compulsory	Examination	Written exam					
Assignment for the General Engineering Science (German program, 7 semester): Specialisation Civil Engineering: Compulsory	Examination duration and	2 h written exam					
	scale						
Following Curricula Civil- and Environmental Engineering: Core Qualification: Compulsory	Assignment for the	General Engineering	Science (German progra	im, 7 semester): Spec	ialisation Civil Engineering	Compulsory	
	Following Curricula	Civil- and Environme	ental Engineering: Core Q	ualification: Compulse	ry		

Course L0248: Building Materials and Building Chemistry					
Тур	Lecture				
Hrs/wk	4				
СР	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	ourse L0249: Building Materials 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	03)			Lecture	2	3
Reinforced Concrete Design I (L030	05)			Recitation Section (large)	2	2
Module Responsible	Prof. Günter Romba	ch				
Admission Requirements	None					
<b>Recommended Previous</b>	Basic knowledge in	structural analysis and	d building materials.			
Knowledge	Madulaa Chuvahuural					
	Modules: Structural	Analysis I, Mechanics	1+11			
Educational Objectives	After taking part suc	ccessfully, students ha	ave 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	are able to draft and di	mension simple structures,	as well as to eval	uate and discuss t
	behaviour of the ma	terials and of structur	al members.			
Skills	The students are ab	le to apply basic proc	edures of the concepti	on and dimensioning to pra-	ctical cases. They	are capable to dr
51115	The students are able to apply basic procedures of the conception and dimensioning to practical cases. They are capable to dra simple concrete structures and to design them for bending and bending with axial force, and to plan their detailing ar					
				etches and draw up technica		then actuming a
	execution. Horeover	r, they can make desig		teries and araw up teerinica	r desemptions.	
Personal Competence						
-						
Social Competence	The shudents are als	1. h	to also in the second sublem	and dimensioning of should		U 61
Autonomy	The students are ab	le to carry out simple	tasks in the conception	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			
	Yes 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	: Compulsory	
Following Curricula	Civil- and Environme	ental Engineering: Cor	e Qualification: Compu	lsory		
	•					
Course L0896: Project Semir	nar Concrete I					
Тур	Seminar					
Hrs/wk	1					
	1					

HIS/WK	I
CP	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	<ul> <li>history of concrete construction</li> <li>building materials: mechanical and physical-chemical properties of concrete, steel, GFRP, CFRP</li> <li>Introduction in safety concepts, ultimate limit states and safety coefficients</li> <li>actions on structures</li> <li>design of linear concrete members with arbitrary cross section for tension and bending with/without axial force</li> <li>design of slender columns</li> </ul> Download der Unterlagen zur Vorlesung über Stud.IP! <ul> <li>Zilch K., Zehetmaier G.: Bemessung im konstruktiven Betonbau. Springer Verlag, 2010</li> <li>König G., Tue N.: Grundlagen des Stahlbetonbaus, 3. Auflage, Teubner-Verlag, 2008</li> <li>Deutscher Beton- und Bautechnikverein E.V.: Beispiele zur Bemessung von Betontragwerken nach Eurocode 2. Band 1: Hochbau, Bauverlag GmbH, Wiesbaden 2011 <ul> <li>Fingerlos F., Hegger J., Zilch K.: Eurocode 2 für Deutschland. Berlin 2016</li> </ul></li></ul>
	<ul> <li>Dahms KH.: Rohbauzeichnungen, Bewehrungszeichnungen. Bauverlag, Wiesbaden 1997</li> <li>Grasser E., Thielen G.: Hilfsmittel zur Berechnung der Schnittgrößen und Formänderungen von Stahlbetontragwerken Deutscher Ausschuss für Stahlbeton, Heft 240, Verlag Ernst &amp; Sohn, Berlin 1978</li> </ul>

Course L0305: Reinforced Co	ourse L0305: Reinforced Concrete 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				

Module M0744: Struc	tural Analysis II			
Courses				
Fitle		Тур	Hrs/wk	СР
Structural Analysis II (L0673)		Lecture	2	3
Structural Analysis II (L0674)		Recitation Section (large)	2	3
Module Responsible	Prof. Uwe Starossek			
Admission Requirements	None			
<b>Recommended Previous</b>				
Knowledge	Mechanics I/II     Mathematics I/II			
	Differential Equations I			
	Structural Analysis I			
Educational Objectives	After taking part successfully, students have reach	hed the following learning results		
Professional Competence				
Knowledge	-	udents can express the basic aspects o	f linear frame a	nalysis of statica
	indeterminate systems.			
Skills	After successful completion of this module, the		es and to constru	ct influence lines
	statically inderminate plane and spatial frame and	d truss structures.		
Personal Competence				
Social Competence	Students can			
	<ul> <li>participate in subject-specific and interdisci</li> </ul>	iplinary discussions.		
	defend their own work results in front of otl			
	promote the scientific development of colle	agues		
	Furthermore, they can give and accept prot	fessional constructive criticism		
Autonomy	The students are able to work in-term homework	assignments. Due to the in-term feedback	they are enable	d to colf-access th
Autonomy	learning progress during the lecture period, alread			
Workload in Hours	Independent Study Time 124, Study Time in Lectu	ıre 56		
Credit points	6			
Course achievement		Description		
	No 10 % Written elaboration	Hausübungen mit Testat, betreut durch St	udentische Tutor	en (Tutorium)
Examination	Written exam			
Examination duration and scale	90 Minuten			
	General Engineering Science (German program, 7	semester): Specialisation Civil Engineering	Compulsory	
Following Curricula	Civil- and Environmental Engineering: Core Qualifi			
<b>J</b>				
Course L0673: Structural An	alysis II			
Тур	Lecture			
Hrs/wk	2			
CP	3			
Workload in Hours	Independent Study Time 62, Study Time in Lectur	e 28		
Lecturer	Prof. Uwe Starossek			

 Language
 DE

 Cycle
 SoSe

 Content
 • Linear structural analysis: statically indeterminate systems<br/>• force method<br/>• slope-deflection method for sway and non-sway frames<br/>• general displacement method and finite element method

 Literature
 Krätzig, W. B.; Harte, R.; Meskouris, K.; Wittek, U.: Tragwerke 2 - Theorie und Berechnungsmethoden statisch unbestimmter<br/>Stabtragwerke, 4. Auflage, Berlin, 2004

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. Uwe Starossek				
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 I	Physics			
Educational Objectives	After taking part successfully, students have reache	ed the following learning results			
Professional Competence					
Knowledge	After passing this module students are able to				
	<ul> <li>give a summary of the security concept</li> </ul>				
	<ul> <li>explain the priciples of the design process</li> </ul>				
	describe and illustrate the bhaviour of meme	rs in tension, compression and bending			
Skills	Students can rate and apply the material steel appropiately with respect to its properties and usage.				
	They can use the security concept with respect to le	oads, forces and resistances.			
	They can check the ultimate limit state and the ser	viceability of simple members in tension, c	compression and	bending.	
Personal Competence					
Social Competence	After participation of an optional course (building o	of a simple truss) they are able to organiz	themselves in	groups. They will b	
	successful in guided building a truss with bolted con	nnections according to design drawings.			
Autonomy					
Workload in Hours	Independent Study Time 124, Study Time in Lecture	e 56			
Credit points	6				
Course achievement	None				
Examination	Written exam				
Examination duration and	120 minutes				
scale					
Assignment for the	General Engineering Science (German program, 7 semester): Specialisation Civil Engineering: Compulsory				
Following Curricula	Civil- and Environmental Engineering: Core Qualific	ation: Compulsory			
Course L0299: Steel Structu	res I				
Тур	Lecture				
Hrs/wk	2				

71	
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	<ul> <li>Introduction to steel constructions</li> <li>Materials</li> <li>Design and security model</li> <li>Tension rods</li> <li>Beams (elsatic and plastic design</li> <li>Column design</li> <li>Bolted connections</li> </ul>
	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	ourse 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
Soil Mechanics (L1493)				Recitation Section (small)	2	2
Module Responsible						
Admission Requirements Recommended Previous						
Kecommended Previous Knowledge	Modules :					
Knowledge	Mechanics I-II					
Educational Objectives	After taking part sur	cossfully students	have reached the follow	ing learning results		
Professional Competence	Arter taking part suc	cessiuily, students				
•	The students know t	bo basics of soil m	ochanics as the structure	e and characteristics of soil, s	trocc distribution	due to weight wa
Knowledge				as failure of the soil due to g		-
Skills				-		
SKIIIS	<i>ills</i> After the successful completion of the module the students should be able to describe the mechanical properties them with the help of geotechnical standard tests. They can calculate stresses and deformation in the soils of					
		-		(settlements) for shallow four		ons que to weight
	initiaence of structur	es. They are are ab	le to prove the usability	(Settlements) for shallow four	luations.	
Personal Competence						
Social Competence						
Autonomy						
Workload in Hours	Independent Study	Time 96, Study Tim	e in Lecture 84			
Credit points	6					
Course achievement		Form	Description			
	No 20 %	Attestation				
Examination	Written exam					
Examination duration and	90 minutes					
scale						
Assignment for the	General Engineering	Science (German	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	ms: Elective Compulsory		
	Technomathematics	: Specialisation III.	Engineering Science: Ele	ctive Compulsory		
	Engineering and Ma	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	2			
CP	2			
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28			
Lecturer	irgen Grabe			
Language	DE			
Cycle	WiSe/SoSe			
Content	<ul> <li>Structure of the soil</li> <li>Ground surveying</li> <li>Compstition and properties of the soil</li> <li>Groundwater</li> <li>One-dimensional compression</li> <li>Spreading of stresses</li> <li>Settlement calculation</li> <li>Consolidation</li> <li>Shear strength</li> <li>Earth pressure</li> <li>Slope failure</li> <li>Ground failure</li> <li>Suspension based earth tenches</li> </ul>			
Literature	<ul> <li>Vorlesungsumdruck, s. ww.tu-harburg.de/gbt</li> <li>Grabe, J. (2004): Bodenmechanik und Grundbau</li> <li>Gudehus, G. (1981): Bodenmechanik</li> <li>Kolymbas, D. (1998): Geotechnik - Bodenmechanik und Grundbau</li> <li>Grundbau-Taschenbuch, Teil 1, aktuelle Auflage</li> </ul>			

Course L0551: Soil Mechanic	S
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	WiSe/SoSe
Content	See interlocking course
Literature	See interlocking course

Course L1493: Soil Mechanic	S
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	WiSe/SoSe
Content	See interlocking course
Literature	See interlocking course

Courses Title							
					Тур	Hrs/wk	СР
Hydrology (L0909)					Lecture	1	1
Hydrology (L0956)					Project-/problem-based Learning	1	2
Hydromechanics (L0615)					Lecture	2	2
Hydromechanics (L0616)					Project-/problem-based Learning	1	1
Module Responsible	Prof. Peter	Fröhle					
Admission Requirements	None						
<b>Recommended Previous</b>	Mathemati	cs I, II and	III				
Knowledge	Mechanics	l und ll					
Educational Objectives	After taking	g part suce	cessfully, students have re	eached the followin	ng learning results		
Professional Competence						-	
Knowledge	They are a and quanti	ble to der fy the rel -off-model	ive the basic formulations evant processes of the I	s of i) hydrostatics, hydrological water	inics, hydrology groundwater hy ii) kinematics of flows and iii) cycle. Besides, the students of models as well as the concept	conservation can describe	laws and to descril the main aspects
Skills	The students are able to apply the fundamental formulations of hydromechanics to basic practical problems. Furthermore, the 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						
	In addition,	the basic		ements of hydrolog	els and a unit-hydrograph to giv gical and hydrodynamic values o ts.		bed and the stude
Personal Competence							
Social Competence		ssions by	use of peer learning appr		structured manner. They can e ore, they are able to prepare an		
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	Independer	nt Study T	ime 110, Study Time in Le	ecture 70			
Credit points							
Course achievement	<b>Compulsory</b> Yes Yes	Bonus None None	Form Subject theoretical practical work Group discussion	Hydromechan Erstellung ei	, Dokumentation und Präs ik oder Hydraulik in Gruppen ne Posters zu einer Themat		
	Yes	None	Excercises		Gruppen und Präsentation ben Hydrologie		
Examination	Written exa				· · · · · · · · · · · · · · · · · · ·		
Examination duration and							
scale	250 minute						
Assignment for the			Science (German progran ntal Engineering: Core Qu		ecialisation Civil Engineering: Co sory	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: <ul> <li>Hydrological cycle</li> <li>Data acquisition in hydrology</li> <li>Data analyses and statistical assessment</li> <li>Statistics of extremes</li> <li>Regionalization methods for hydrological values</li> <li>rainfall-run-off modelling on the basis of a unit hydrograph concept</li> </ul>
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: Hydromechan	ics
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
	Characteristics of fluids
	Hydrostatics
	Kinematics of flows, laminar and turbulent flows
	Conservation laws
	Conservation of mass
	<ul> <li>Conservation of Energy</li> </ul>
	Momentum Equation
	Application of conservation laws to flow conditions
Literature	Skript zur Vorlesung Hydromechanik/Hydraulik, Kapitel 1-2
	E-Learning Werkzeug: Hydromechanik und hydraulik (Link): (http://www.tu-harburg.de/ hydraulik_tool/index.html)
	Truckenbrodt, E.: Lehrbuch der angewandten Fluidmechanik, Springer Verlag, Berlin, 1998.
	Truckenbrodt, E.: Grundlagen und elementare Strömungsvorgänge dichtebeständiger Fluide / Fluidmechanik, Springer Verlag, Berlin, 1996.

Course L0616: Hydromechan	ourse L0616: Hydromechanics		
Тур	Project-/problem-based Learning		
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	See interlocking course		
Literature	See interlocking course		

Courses						
ītle	Тур	)	Hrs/wk	СР		
Basics in Structural Design (L0209)	Proje	ect-/problem-based Learning	2	4		
Basics of Structural Design (L0205)			2	1		
Basics in Structural Design (L0208)		itation Section (large)	1	1		
Module Responsible						
Admission Requirements						
	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						
Knowledge	After attending the "Building Construction" module students are able					
	<ul> <li>to define the basics of building regulations law</li> </ul>					
	<ul> <li>to explain load effects and associated concepts</li> </ul>					
	• to describe overriding conventions of the construction industry	1				
	<ul> <li>to specify typical building components</li> </ul>					
	<ul> <li>to specify typical building components</li> <li>to distinguish between different possibilities of load bearing behaviour and risks due to lack of stability</li> </ul>					
	<ul> <li>to explain the main objective of fire control.</li> </ul>					
Skills	After the successful completion of the "Building Construction" module, students will be able					
	<ul> <li>to apply industry-specific drawing conventions</li> </ul>					
	<ul> <li>carry out preliminary dimensioning of basic building component</li> </ul>	its				
	<ul> <li>develop stability and foundation concepts</li> </ul>					
	use BIM software					
	and to design and construct standard cross-sections due to struct	uctural aspects.				
Demonstration of the second						
Personal Competence	After attending the course students are able					
Social Competence	After attending the course students are able					
	<ul> <li>to work in a team and to persent the results of the team work</li> </ul>					
	<ul> <li>to use the feedback from other students to improve the own re</li> </ul>	sults				
	• to give a feedback to other students in a constructive manner					
Autonomy	After attending the course students are able					
	<ul> <li>to control and improve their knowledge with the help of weeek</li> </ul>	ly presentations (lecture roc	m) and tests			
	<ul> <li>to divide the main task in different parts, to deduce the needed</li> </ul>					
	• to divide the main task in differenc parts, to deduce the needed	a knowledge and to schedule	e the unteren	t work steps		
Workload in Hours	Independent Study Time 110, Study Time in Lecture 70					
Credit points	6					
Course achievement	None					
Examination	Subject theoretical and practical work					
Examination duration and	Desing, Construction and prelimnary design in a written form					
scale						
Assignment for the	General Engineering Science (German program, 7 semester): Speciali	isation Civil Engineering: Cor	mpulsory			
Following Curricula	Civil- and Environmental Engineering: Core Qualification: Compulsory					
	Integrated Building Technology: Core Qualification: Compulsory					

urse 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 building in groups of 4 persons
	<ul> <li>Analysing the informations and the contents of development plans and building regulation laws</li> </ul>
	<ul> <li>Design of building components and approving of the funcionality (sealing, facades, roofs)</li> </ul>
	<ul> <li>Design and approve of the functionality of the component interconnections</li> </ul>
	<ul> <li>Proofing and assessing of moisture behaviour, energy comsumption, acoustic protection and fire control</li> </ul>
	Assessing the building stability
	Basics of building services
	Each week the results of different work steps are presented in oral and written form
Litoratura	Vortragsfolien der Lehrveranstaltung stehen über STUD.IP zum download zur Verfügung
Literature	Torragstonen der Leinveranstatung stehen über Stöblir zum dowinoad zur Verlugdig
	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
	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	
Encluture		
	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	
	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	
	Wendebergt Beinhard (Wetzell O. W., Pourgestoer H.)	
	Wendehorst, Reinhard (Wetzell, O. W.,; Baumgartner, H.,)	
	Wendehorst Bautechnische Zahlentafeln	
	ISBN: 978-3-8351-0055-8 Stuttgart/Berlin: Teubner/Beuth, 2018	

e L0208: Basics in Stru	ctural Design
Typ	Recitation Section (large)
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 funcionality (sealing, facades, roofs)
	Design and approve of the funcionality of the component interconnections
	<ul> <li>Proofing and assessing of moisture behaviour, energy comsumption, acoustic protection and fire control</li> </ul>
	Assessing the building stability
	Basics of building services
	<ul> <li>Each week the results of different work steps are presented in oral and written form</li> </ul>
Literature	Vertragefallen des Lehmenzetelbung stehen über CTUD 10 mm deutsland zur Verfügung
Literature	Vortragsfolien der Lehrveranstaltung stehen über STUD.IP zum download zur Verfügung
	Read to the second se
	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
	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

Module M0631: Reinf	orced Concrete Structures II			
Courses				
Title		Тур	Hrs/wk	СР
Project Concrete Structures II (L089	94)	Project Seminar	1	1
Concrete Structures II (L0348)		Lecture	2	3
Concrete Structures II (L0349)		Recitation Section (large)	2	2
Module Responsible	Prof. Günter Rombach			
Admission Requirements	None			
Recommended Previous	<ul> <li>Knowledge of loads on structures and compared to the structures and struc</li></ul>	mbination of actions		
Knowledge	-			
	<ul> <li>Basics of safety format are required.</li> <li>Knowledge in design of hearns and columniate the same and columniate the same same same same same same same sam</li></ul>	nne for ultimate limit state		
	Knowledge in design of beams and column     Modules, Beinforced, Concrete, Structure			
	Modules: Reinforced Concrete Structure	s I, Structural Analysis I+II, Mechanics I+II		
Educational Objectives	After taking part successfully, students have re	eached the 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			
	-		-	torsion) and in the
	<ul> <li>The students can estimate the member</li> </ul>	ection control) including detailing (anchorage a	nu iinks etc.).	
	<ul> <li>The students know the content and the</li> </ul>			
	The students know the content and the			
Personal Competence				
Social Competence	Cooperation in a project work, where they desi	gn in a team a real concrete building and prese	ent the results at	the end.
Autonomy				
Workload in Hours	Independent Study Time 110, Study Time in Le	ecture 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 Science (German program	n, 7 semester): Specialisation Civil Engineering	Elective Compu	lsory
Following Curricula				
_	Civil- and Environmental Engineering: Specialis		,	
	Civil- and Environmental Engineering: Specialis			
			-	
Course L0894: Project Concr	ete Structures II			

Course L0894: Project Concre	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 Stru	Course L0348: Concrete Structures II		
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	WiSe		
Content	<ul> <li>Design of concrete members for shear, punching and torsion</li> <li>Design for serviceability limit state (durability): crack- and deflection control</li> <li>Detailing</li> <li>Design of discontinuity regions (e.g. corbels, frame corner)</li> <li>design of footings</li> <li>Introduction in the design of slabs</li> <li>Layout and content of a structural design</li> </ul>		
Literature	<ul> <li>Vorlesungsumdrucke zum downloaden im STUDiP</li> <li>Zilch K., Zehetmaier G.: Bemessung im konstruktiven Betonbau. Springer Verlag, 2010</li> <li>König G., Tue N.: Grundlagen des Stahlbetonbaus. Teubner Verlag, Stuttgart 1998</li> <li>Deutscher Beton- und Bautechnikverein E.V.: Beispiele zur Bemessung von Betontragwerken nach Eurocode 2. Band 1: Hochbau, Bauverlag GmbH, Wiesbaden 2011</li> <li>Dahms KH.: Rohbauzeichnungen, Bewehrungszeichnungen. Bauverlag, Wiesbaden 1997</li> <li>Grasser E. ,Thielen G.: Hilfsmittel zur Berechnung der Schnittgrößen und Formänderungen von Stahlbetontragwerken. Deutscher Ausschuss für Stahlbeton, Heft 240, Verlag Ernst &amp; Sohn, Berlin 1978</li> <li>DIN EN 1992-1-1:2011: Bemessung und Konstruktion von Stahlbeton- und Spannbetontragwerken - Teil 1: Allgemeine Bemessungsregeln für den Hochbau.</li> </ul>		

ourse L0349: Concrete Structures II	
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	WiSe
Content	See interlocking course
Literature	See interlocking course

Courses				
Title		Тур	Hrs/wk	СР
Computational Stuctural Mechanics	s (L2475)	Integrated Lecture	2	2
Computational Structural Mechanic	s (Exercise) (L2873)	Recitation Section (small)	1	1
Module Responsible	Prof. Christian Cyron			
Admission Requirements	None			
<b>Recommended Previous</b>	Engineering Mechanics I, Engineering M	Aechanics II, Mathematics I, Mathematics II		
Knowledge				
Educational Objectives	After taking part successfully, students	have reached the following learning results		
<b>Professional Competence</b>				
	importance of computational methods in modern solid mechanics and in particular also the theoretical foundations of the fini element method. Students are able to develop simple computational methods and programs to solve problems in solid mechanics. Moreove student have sufficient basic knowledge about the finite element method to use commercial software in this area for th successful solution of at least simple problems (after a short introduction into the handling of a specific software package)			
Personal Competence				
Social Competence				
Autonomy				
Workload in Hours	Independent Study Time 48, Study Time	e in Lecture 42		
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 Civil Engineerin	ıg: Compulsory	
	Civil- and Environmental Engineering: S			

Course L2475: Computationa	al Stuctural Mechanics
-	Integrated Lecture
Hrs/wk	
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: Computational 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	

Courses				
Title		Тур	Hrs/wk	СР
Introduction to Geoinformation Scie	ence (L2465)	Project-/problem-based Learning	3	3
Module Responsible	Prof. Peter Fröhle			
Admission Requirements	None			
<b>Recommended Previous</b>	Principles of analysis and linear algebra			
Knowledge				
Educational Objectives	After taking part successfully, students have	e reached the following learning results		
Professional Competence				
Knowledge	The students are able to define the tasks a	and terms from the field of application of geo informa	tion systems.	They can report the
	basics, the basic approaches and methods	of geo information systems and are able to transfer th	ese to practio	cal questions.
Skills	rills Students are able to apply the basic methods used in geo-information systems to practical problems. They are able to ap		e able to apply the	
Skiis		mation systems and to transfer them to other problem	-	
	simple GIS project and present their results	5		
Personal Competence				
Social Competence	The students can work together groups coo	peratively and productively.		
Autonomv	Students are able to organize their work	flow to prepare themselves before presentations a	and discussio	n. Thev can acqui
,	appropriate knowledge by making enquiries			5
	Independent Study Time 48, Study Time in	Lecture 42		
Credit points				
Course achievement	None			
Examination	Subject theoretical and practical work			
Examination duration and	Computer aided GIS-Application and writter	n-theoretical part		
scale				
-		ram, 7 semester): Specialisation Civil Engineering: Co	mpulsory	
Following Curricula	Civil- and Environmental Engineering: Speci			
	Civil- and Environmental Engineering: Speci	ialisation 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	<ul> <li>Theoretical basics of Geo-Information-Systems</li> <li>Data models, geographical coordinates, geo-referencing, map-views</li> <li>Data mining and -analyses of geo-data</li> <li>Analysis techniques</li> </ul>
Literature	

Module M0612: Steel	Structures II				
Courses					
Title		Тур	Hrs/wk	СР	
Steel Structures II (L0301)		Lecture	2	3	
Steel Structures II (L0302)	[	Recitation Section (large)	2	3	
Module Responsible	Prof. Marcus Rutner				
Admission Requirements	None				
<b>Recommended Previous</b>	Steel Structures I				
Knowledge					
Educational Objectives	After taking part successfully, students	have reached the following learning results			
Professional Competence					
Knowledge	After successful completition students c	an			
	<ul> <li>describe and explain the helpavie</li> </ul>	ur of bolted and welded connections			
	<ul> <li>design and check simple halls and</li> </ul>				
	- · ·	imple structures (trusses, beams, frames)			
		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 imper	ections, calculate according to 2nd order theory a	nd verify their resul	ts.	
Personal Competence					
Social Competence					
Autonomy					
Workload in Hours	Independent Study Time 124, Study Tim	ne 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 Engineeri	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: S	pecialisation Water and Environment: Elective Com	npulsory		

Course L0301: Steel Structures II			
Тур	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	<ul> <li>Welded connections</li> <li>Simple constructions <ul> <li>Trusses</li> <li>Plate girders</li> <li>Frames</li> <li>Columns</li> </ul> </li> <li>Buildings with several storeys</li> <li>Halls</li> </ul>		
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 Structures 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	

chnics II					
			Тур	Hrs/wk	СР
				-,	2
				2	2
			-	2	2
Prof. Jürgen Grabe					
None					
Modules:					
<ul> <li>Mechanics I-II</li> </ul>					
<ul> <li>Geotechnics I</li> </ul>					
After taking part successfully, students have reached the following learning results					
The students know the basic principles and methods which are required to verificate the stability of geotechnical structures.					
After successful completion of the module the students are able to:					
<ul> <li>verificate the stability and usability of foundations,</li> </ul>					
<ul> <li>know individual methods of ground improvement and apply them in their range of application,</li> </ul>					
design retaining walls.					
Independent Study Time	96. Study Time in L	ecture 84			
	orm	Description			
No 20% At	ttestation				
Written exam					
90 minutes					
General Engineering Scie	ence (German progr	am, 7 semester): Spe	cialisation Civil Engineering	Elective Compu	lsory
				P -	-
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	÷ • ·				
	After taking part success The students know the b After successful completi  verificate the stab know individual m design retaining w Independent Study Time G Compulsory Bonus Fc No 20% Ai Written exam 90 minutes General Engineering Scie Civil- and Environmental Civil- and Environmental Civil- and Environmental	None         Modules:         • Mechanics I-II         • Geotechnics I         After taking part successfully, students have         The students know the basic principles and         After successful completion of the module th         • verificate the stability and usability or         • know individual methods of ground in         • design retaining walls.         Independent Study Time 96, Study Time in I         6         Compulsory Bonus Form         No       20 % Attestation         Written exam         90 minutes         General Engineering Science (German progr         Civil- and Environmental Engineering: Speci         Civil- and Environmental Engineering: Speci         Civil- and Environmental Engineering: Speci	Prof. Jürgen Grabe         None         Modules:         • Mechanics I-II         • Geotechnics I         After taking part successfully, students have reached the followin         The students know the basic principles and methods which are reached the students are able to verificate the stability and usability of foundations,         • know individual methods of ground improvement and apple         • design retaining walls.         Independent Study Time 96, Study Time in Lecture 84         6         Compulsory Bonus       Form         Veritten exam         90 minutes         General Engineering Science (German program, 7 semester): Specialisation Civil Engineering: Specialisation Traffic and M         Civil- and Environmental Engineering: Specialisation Traffic and M         Civil- and Environmental Engineering: Specialisation Water and Engineering: Spe	Lecture Recitation Section (large) Recitation Section (small)         Prof. Jürgen Grabe         None         Modules:         • Mechanics I-II         • Geotechnics I         After taking part successfully, students have reached the following learning results         The students know the basic principles and methods which are required to verificate the stab 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 app         • design retaining walls.         Independent Study Time 96, Study Time in Lecture 84         6         Compulsory Bonus       Form         Description         No       20 %         Attestation         Written exam         90 minutes         General Engineering Science (German program, 7 semester): Specialisation Civil Engineering: Compulsory         Civil- and Environmental Engineering: Specialisation Traffic and Mobility: Elective Compulsory	Lecture       2         Recitation Section (large)       2         Prof. Jürgen Grabe       2         None       4         Modules:       •         •       Mechanics I-II         •       Geotechnics I         After taking part successfully, students have reached the following learning results       -         The students know the basic principles and methods which are required to verificate the stability of geotechni         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.       -         Independent Study Time 96, Study Time in Lecture 84       -         6       -         Compulsory Bonus       Form       Description         No       20 %       Attestation         Written exam       -       -         90 minutes       -       -         General Engineering Science (German program, 7 semester): Specialisation Civil Engineering: Elective Compulsory         Civil- and Environmental Engineering: Specialisation Traffic and Mobility: Elective Compulsory         Civil- and Environmental Engineering: Specialisation Traff

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

Course L0553: Foundation E	ourse L0553: Foundation Engineering		
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/SoSe		
Content	See interlocking course		
Literature	See interlocking course		

Course L1494: Foundation E	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	WiSe/SoSe		
Content	See interlocking course		
Literature	See interlocking course		

## **Specialization Bioprocess Engineering**

Biotechnology provides the basics for sustainable manufacturing of products as food, feed, bioenergy, biopolymers and chemicals and for providing the human being wit medicines and other essential goods. It requires interdisciplinary application of natural (especially biology and chemistry) and engineering sciences. Many everyday products are manufactured by means of biotechnical production processes. Biotechnical material conversion is also used to utilize and minimize byproducts and residues in order to achieve sustainable production. Engineers with biotechnical expertise are needed to meet the growing global demand for the development and operation of biotechnical processes by which to manufacture essential everyday products.

Graduates can explain phenomena that occur in bioprocess engineering and allied disciplines. They can outline the basic bioprocess engineering principles for interpreting, modeling, and simulating biological processes and chemical reactions, energy, material, and momentum transport processes, micro-, meso- and macro-scale separation processes, and for operating the plant required for these processes. They are able to describe the basics of measurement and control technology. They can take into consideration legal aspects that arise in connection with process engineering and production facilities.

Module M0886: Funda	amentals of Process Engineering	g and Material Engineering		
Courses				
Title Introduction into Process Engineeri Fundamentals of material engineer	ng/Bioprocess Engineering (L0829)	<b>Typ</b> Lecture Lecture	Hrs/wk 2 2	<b>CP</b> 1 2
Module Responsible		Locard	La Contra	L
Admission Requirements				
Recommended Previous				
Knowledge				
Educational Objectives	After taking part successfully, students have re	eached the following learning results		
Professional Competence				
Knowledge	After passing this module the students have the	ne ability to:		
	<ul> <li>give an overview of the most important</li> <li>explain some working methods for diffe</li> </ul>		ring,	
Skills	<ul> <li>After passing this module the students should have the ability to:</li> <li>list and outline the most important fields of process engineering,</li> <li>name the most important working approaches or methods of the different fields of process engineering,</li> <li>read and prepare an engineering drawing,</li> <li>explain the most important technologies for wastewater and exhaust air treatment</li> <li>scheme typical chemical and biotechnological processes independently with the aid of pointers.</li> </ul>			
Personal Competence Social Competence	The students are able to <ul> <li>work out results in groups and documer</li> <li>provide appropriate feedback and hand</li> </ul>		nstructively.	
Autonomy Workload in Hours	Engineering and Bioprocess Engineering.		liberate their lack of k	nowledge in Proces:
Credit points				
Course achievement		Description		
	No 5 % Written elaboration			
Examination	Written exam			
Examination duration and	90 min			
scale				
Assignment for the	5 5 7 7 5			
Following Curricula			Engineering: Compulso	ory
	Bioprocess Engineering: Core Qualification: Co Orientation Studies: Core Qualification: Electiv			
	Process Engineering: Core Qualification: Comp			

Course L0829: Introduction into Process Engineering/Bioprocess Engineering		
Тур	Lecture	
Hrs/wk	2	
CP	1	
Workload in Hours	Independent Study Time 2, Study Time in Lecture 28	
Lecturer	Dozenten des SD V	
Language	DE	
Cycle	WiSe	
Content	Introduction into the different research fields of the subject Process Engineering and Bioprocess Engineering.	
Literature	s. StudIP	

Course L0830: Fundamentals	s of material engineering
Тур	Lecture
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Dr. Marko Hoffmann
Language	DE
Cycle	WiSe
Content	<ul> <li>Introduction</li> <li>Atomic structure and bonding</li> <li>Structure of solids</li> <li>Miller indices</li> <li>Imperfections in solids</li> <li>Texture</li> <li>Diffusion</li> <li>Mechanical properties</li> <li>Dislocations and strengthening mechanisms</li> <li>Phase transformations</li> <li>Phase diagrams, iron-carbon phase diagram</li> <li>Metallic materials</li> <li>Corrosion</li> <li>Polymeric materials</li> <li>Ceramic materials</li> </ul>
Literature	<ul> <li>Bargel, HJ.; Schulze, G. (Hrsg.): Werkstoffkunde. Berlin u.a., Springer Vieweg, 2012.</li> <li>Bergmann, W.: Werkstofftechnik 1. München u.a., Hanser, 2009.</li> <li>Bergmann, W.: Werkstofftechnik 2. München u.a., Hanser, 2008.</li> <li>Callister, W. D.; Rethwisch, D. G.: Materialwissenschaften und Werkstofftechnik: eine Einführung, Übersetzungshrsg.: Scheffler, M., 1. Auflage, Weinheim, Wiley-VCH, 2013.</li> <li>Seidel, W. W., Hahn, F.: Werkstofftechnik. München u.a., Hanser, 2012.</li> </ul>

	puter Engineering			
Courses				
Title	Typ Hrs/v	wk	СР	
Computer Engineering (L0321) Computer Engineering (L0324)	Lecture 3 Recitation Section (small) 1		4 2	
Module Responsible			2	
Admission Requirements				
	s Basic knowledge in electrical engineering			
Knowledge				
Educational Objectives	s After taking part successfully, students have reached the following learning results			
Professional Competence	e			
Knowledge	<ul> <li>This module deals with the foundations of the functionality of computing systems. It covers the layer programming down to gates. The module includes the following topics:</li> <li>Introduction</li> </ul>	ers from t	he assembly-le	
	<ul> <li>Combinational logic: Gates, Boolean algebra, Boolean functions, hardware synthesis, combinational networks</li> <li>Sequential logic: Flip-flops, automata, systematic hardware design</li> <li>Technological foundations</li> <li>Computer arithmetic: Integer addition, subtraction, multiplication and division</li> </ul>			
	<ul> <li>Basics of computer architecture: Programming models, MIPS single-cycle architecture, pipelining</li> <li>Memories: Memory hierarchies, SRAM, DRAM, caches</li> <li>Input/output: I/O from the perspective of the CPU, principles of passing data, point-to-point competition</li> </ul>		USSES	
Skills	<ul> <li>Input/output: I/O from the perspective of the CPU, principles of passing data, point-to-point connections, busses</li> <li>The students perceive computer systems from the architect's perspective, i.e., they identify the internal structure and the composition of computer systems. The students can analyze, how highly specific and individual computers can be built l collection of few and simple components. They are able to distinguish between and to explain the different abstraction</li> </ul>			
	today's computing systems - from gates and circuits up to complete processors. After successful completion of the module, the students are able to judge the interdependencies be system and the software executed on it. In particular, they shall understand the consequences that th on the hardware-centric abstraction layers from the assembly language down to gates. This way, they the impact that these low abstraction levels have on an entire system's performance and to propose fea-	e executi will be e	on of software nabled to evalu	
Personal Competence	e			
-	e Students are able to solve similar problems alone or in a group and to present the results accordingly.			
Autonomy	y Students are able to acquire new knowledge from specific literature and to associate this knowledge wi	ith other c	lasses.	
Workload in Hours	s Independent Study Time 124, Study Time in Lecture 56			
Credit points	<b>s</b> 6			
Course achievement				
F	Yes 10 % Excercises			
	n Written exam			
scale	d 90 minutes, contents of course and labs			
	<ul> <li>General Engineering Science (German program, 7 semester): Specialisation Computer Science: Compul</li> </ul>	lsorv		
	<ul> <li>a General Engineering Science (German program, 7 semester): Specialisation Civil Engineering: Compulsi</li> </ul>			
	General Engineering Science (German program, 7 semester): Specialisation Process Engineering: Comp			
	General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineer	ering, Fo	cus Mechatron	
	Compulsory			
	General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineerin	ng, Focus	Aircraft Syste	
	Engineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Fo	ocus Theo	vetical Mechan	
	Engineering: Compulsory	ocus mee		
	General Engineering Science (German program, 7 semester): Specialisation Mechanical Engine	eering, F	ocus Materials	
	Engineering Sciences: Compulsory			
	General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, F	Focus Pro	duct Developm	
	and Production: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineerin	ng, Focus	Energy Syste	
	Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Enginee	ering, Foo	us Biomechan	
	Compulsory General Engineering Science (German program, 7 semester): Specialisation Naval Architecture: Compul	lsory		
	Compulsory	-		
	Compulsory General Engineering Science (German program, 7 semester): Specialisation Naval Architecture: Comput	ompulsory	,	
	Compulsory General Engineering Science (German program, 7 semester): Specialisation Naval Architecture: Compul General Engineering Science (German program, 7 semester): Specialisation Biomedical Engineering: Co General Engineering Science (German program, 7 semester): Specialisation Bioprocess Engineering: Co General Engineering Science (German program, 7 semester): Specialisation Electrical Engineering: Com General Engineering Science (German program, 7 semester): Specialisation Electrical Engineering: Com General Engineering Science (German program, 7 semester): Specialisation Green Technologies, Focus	ompulsory ompulsory opulsory		
	Compulsory General Engineering Science (German program, 7 semester): Specialisation Naval Architecture: Compul General Engineering Science (German program, 7 semester): Specialisation Biomedical Engineering: Co General Engineering Science (German program, 7 semester): Specialisation Bioprocess Engineering: Co General Engineering Science (German program, 7 semester): Specialisation Electrical Engineering: Com General Engineering Science (German program, 7 semester): Specialisation Electrical Engineering: Com General Engineering Science (German program, 7 semester): Specialisation Green Technologies, Focus Compulsory	ompulsory ompulsory opulsory		
	Compulsory General Engineering Science (German program, 7 semester): Specialisation Naval Architecture: Compul General Engineering Science (German program, 7 semester): Specialisation Biomedical Engineering: Co General Engineering Science (German program, 7 semester): Specialisation Bioprocess Engineering: Co General Engineering Science (German program, 7 semester): Specialisation Electrical Engineering: Com General Engineering Science (German program, 7 semester): Specialisation Electrical Engineering: Com General Engineering Science (German program, 7 semester): Specialisation Green Technologies, Focus Compulsory Computer Science: Core Qualification: Compulsory	ompulsory ompulsory opulsory		
	Compulsory General Engineering Science (German program, 7 semester): Specialisation Naval Architecture: Compul General Engineering Science (German program, 7 semester): Specialisation Biomedical Engineering: Co General Engineering Science (German program, 7 semester): Specialisation Bioprocess Engineering: Co General Engineering Science (German program, 7 semester): Specialisation Electrical Engineering: Com General Engineering Science (German program, 7 semester): Specialisation Electrical Engineering: Com General Engineering Science (German program, 7 semester): Specialisation Green Technologies, Focus Compulsory Computer Science: Core Qualification: Compulsory Data Science: Core Qualification: Elective Compulsory	ompulsory ompulsory opulsory		
	Compulsory General Engineering Science (German program, 7 semester): Specialisation Naval Architecture: Compul General Engineering Science (German program, 7 semester): Specialisation Biomedical Engineering: Co General Engineering Science (German program, 7 semester): Specialisation Bioprocess Engineering: Co General Engineering Science (German program, 7 semester): Specialisation Electrical Engineering: Com General Engineering Science (German program, 7 semester): Specialisation Electrical Engineering: Com General Engineering Science (German program, 7 semester): Specialisation Green Technologies, Focus Compulsory Computer Science: Core Qualification: Compulsory	ompulsory ompulsory npulsory Renewab	, ile Energy: Elec	

Engineering: Compulsory
General Engineering Science (English program, 7 semester): Specialisation Mechanical Engineering, Focus Materials in Engineering
Sciences: Compulsory
General Engineering Science (English program, 7 semester): Specialisation Mechanical Engineering, Focus Mechatronics:
Compulsory
General Engineering Science (English program, 7 semester): Specialisation Mechanical Engineering, Focus Product Development
and Production: Compulsory
General Engineering Science (English program, 7 semester): Specialisation Mechanical Engineering, Focus Theoretical Mechanical
Engineering: Compulsory
Computational Science and Engineering: Core Qualification: Compulsory
Mechatronics: Core Qualification: Compulsory
Technomathematics: Specialisation II. Informatics: Elective Compulsory

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

Course L0324: Computer Eng	ourse 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					
<b>Title</b> Fundamentals of Fluid Mechanics ( Fluid Mechanics for Process Engine		<b>Typ</b> Lecture Recitation Section (large)	Hrs/wk 2 2	<b>CP</b> 4 2	
Module Responsible					
Admission Requirements					
Recommended Previous					
Knowledge	Mathematics I+II+III				
	Technical Mechanics I+II     Technical Thermodynamics I+II				
	Technical Thermodynamics I+II     Working with force balances				
	<ul> <li>Simplification and solving of partial differential</li> </ul>	equations			
	Integration				
Educational Objectives	After taking part augeneefully, students have reached	the following learning results			
Professional Competence	After taking part successfully, students have reached	the following learning results			
	Students are able to:				
	explain the difference between different types				
	<ul> <li>give an overview for different applications of th</li> <li>explain simplifications of the Continuity- and N</li> </ul>			ions	
	• explain simplifications of the continuity- and N	avier-stokes-Equation by using physical	boundary condit	10115	
Skills	The students are able to				
	<ul> <li>describe and model incompressible flows math</li> </ul>	ematically			
	reduce the governing equations of fluid mechanics by simplifications to archive quantitative solutions e.g. by integr				
	notice the dependency between theory and technical applications				
	<ul> <li>use the learned basics for fluid dynamical appl</li> </ul>	ications in fields of process engineering			
Personal Competence					
Social Competence	The students				
	- exe conclusion and an information from outling	t velocial professional publications and	valata that inform	untion to the conto	
	<ul> <li>are capable to gather information from subjec of the lecture and</li> </ul>	t related, professional publications and	relate that more	nation to the conte	
	<ul> <li>able to work together on subject related tasks</li> </ul>	in small groups. They are able to pres	ent their results	effectively in Engli	
	(e.g. during small group exercises)	5		, ,	
	• are able to work out solutions for exercises by	themselves, to discuss the solutions ora	lly and to presen	t the results.	
Autonomy	The students are able to				
	<ul> <li>search further literature for each topic and to each topic and topi</li></ul>	expand their knowledge with this literatu	Ire		
	<ul> <li>work on their exercises by their own and to evaluate the second se</li></ul>				
		-			
	Independent Study Time 124, Study Time in Lecture	56			
Credit points		scription			
Course achievement	Yes 5 % Midterm	scription			
Examination	Written exam				
Examination duration and	3 hours				
scale					
Assignment for the	General Engineering Science (German program, 7 ser	nester): Specialisation Process Engineer	ing: Compulsory		
Following Curricula	General Engineering Science (German program, 7 ser			ory	
	General Engineering Science (German program, 7 ser		ies: Compulsory		
	Bioprocess Engineering: Core Qualification: Compulso Energy and Environmental Engineering: Core Qualific				
	Green Technologies: Energy, Water, Climate: Core Qualific				
	Logistics and Mobility: Specialisation Traffic Planning				
	Technomathematics: Specialisation III. Engineering So				
	Process Engineering: Core Qualification: Compulsory				
	Engineering and Management - Major in Logistics and	Mobility: Specialisation Traffic Planning	and Systems: El	ective Compulsory	

Course L0091: Fundamentals	of Fluid Mechanics
Тур	Lecture
Hrs/wk	2
CP	4
Workload in Hours	Independent Study Time 92, Study Time in Lecture 28
Lecturer	Prof. Michael Schlüter
Language	DE
Cycle	SoSe
Content	<ul> <li>fluid properties</li> <li>hydrostatic</li> <li>overall balances - theory of streamline</li> <li>overall balances- conservation equations</li> <li>differential balances - Navier Stokes equations</li> <li>irrotational flows - Potenzialströmungen</li> <li>flow around bodies - theory of physical similarity</li> <li>turbulent flows</li> <li>compressible flows</li> </ul>
Literature	<ol> <li>Crowe, C. T.: Engineering fluid mechanics. Wiley, New York, 2009.</li> <li>Durst, F.: Strömungsmechanik: Einführung in die Theorie der Strömungen von Fluiden. Springer-Verlag, Berlin, Heidelberg, 2006.</li> <li>Fox, R.W.; et al.: Introduction to Fluid Mechanics. J. Wiley &amp; Sons, 1994</li> <li>Herwig, H.: Strömungsmechanik: Eine Einführung in die Physik und die mathematische Modellierung von Strömungen. Springer Verlag, Berlin, Heidelberg, New York, 2006</li> <li>Herwig, H.: Strömungsmechanik: Einführung in die Physik von technischen Strömungen: Vieweg+Teubner Verlag / GWV Fachverlage GmbH, Wiesbaden, 2008</li> <li>Kuhlmann, H.C.: Strömungsmechanik. München, Pearson Studium, 2007</li> <li>Oertl, H.: Strömungsmechanik: Grundlagen, Grundgleichungen, Lösungsmethoden, Softwarebeispiele. Vieweg+ Teubner Verlag / GWV Fachverlage GmbH, Wiesbaden, 2009</li> <li>Schade, H.; Kunz, E.: Strömungslehre. Verlag de Gruyter, Berlin, New York, 2007</li> <li>Truckenbrodt, E.: Fluidmechanik 1: Grundlagen und elementare Strömungsvorgänge dichtebeständiger Fluide. Springer-Verlag, Berlin, Heidelberg, 2008</li> <li>Schlichting, H.: Grenzschicht-Theorie. Springer-Verlag, Berlin, 2006</li> <li>van Dyke, M.: An Album of Fluid Motion. The Parabolic Press, Stanford California, 1882.</li> <li>White, F.: Fluid Mechanics, Mcgraw-Hill, ISBN-10: 0071311211, ISBN-13: 978-0071311212, 2011</li> </ol>

Course L0092: Fluid Mechani	cs for Process Engineering
Тур	Recitation Section (large)
Hrs/wk	2
СР	2
Workload in Hours	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. 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.
	<ol> <li>Crowe, C. T.: Engineering fluid mechanics. Wiley, New York, 2009.</li> <li>Durst, F.: Strömungsmechanik: Einführung in die Theorie der Strömungen von Fluiden. Springer-Verlag, Berlin, Heidelberg, 2006.</li> <li>Fox, R.W.; et al.: Introduction to Fluid Mechanics. J. Wiley &amp; Sons, 1994</li> <li>Herwig, H.: Strömungsmechanik: Eine Einführung in die Physik und die mathematische Modellierung von Strömungen. Springer Verlag, Berlin, Heidelberg, New York, 2006</li> <li>Herwig, H.: Strömungsmechanik: Einführung in die Physik von technischen Strömungen: Vieweg+Teubner Verlag / GWV Fachverlage GmbH, Wiesbaden, 2008</li> <li>Kuhlmann, H.C.: Strömungsmechanik. Grundgleichungen, Lösungsmethoden, Softwarebeispiele. Vieweg+ Teubner Verlag / GWV Fachverlage GmbH, Wiesbaden, 2009</li> <li>Schade, H.; Kunz, E.: Strömungslehre. Verlag de Gruyter, Berlin, New York, 2007</li> <li>Truckenbrodt, E.: Fluidmechanik 1: Grundlagen und elementare Strömungsvorgänge dichtebeständiger Fluide. Springer-Verlag, Berlin, Heidelberg, 2008</li> <li>Schlichting, H.: Grenzschicht-Theorie. Springer-Verlag, Berlin, 2006</li> <li>van Dyke, M.: An Album of Fluid Motion. The Parabolic Press, Stanford California, 1882.</li> <li>White, F.: Fluid Mechanics, Mcgraw-Hill, ISBN-10: 0071311211, ISBN-13: 978-0071311212, 2011</li> </ol>

Courses				
Title	Т	qv	Hrs/wk	СР
Biochemistry (L0351)		ecture	2	2
Biochemistry (L0728)		roject-/problem-based Learning	1	1
Microbiology (L0881)		ecture	2	2
Microbiology (L0888)	Pr	roject-/problem-based Learning	1	1
Module Responsible	Prof. Johannes Gescher			
Admission Requirements	None			
<b>Recommended Previous</b>	none			
Knowledge				
Educational Objectives	After taking part successfully, students have reached the following	learning results		
Professional Competence				
Knowledge	At the end of this module the students can:			
	- explain the methods of biological and biochemical research to determine the properties of biomolecules			
	- name the basic components of a living organism			
	- explain the principles of metabolism			
	- describe the structure of living cells			
	- describe the structure of hving cens			
	-			
Skills				
Personal Competence				
Social Competence	The students are able,			
	- to gather knowledge in groups of about 10 students			
	- to gather knowledge in groups of about 10 students			
	- to introduce their own knowledge and to argue their view in discus	ssions in teams		
	- to divide a complex task into subtasks, solve these and to present	the combined results		
Autonomy	The students are able to present the results of their subtasks in a w	ritten report		
Workload in Hours	Independent Study Time 96, Study Time in Lecture 84			
Credit points	6			
Course achievement	None			
Examination	Written exam			
Examination duration and	90 min			
scale				
Assignment for the	General Engineering Science (German program, 7 semester): Speci	alisation Bioprocess Engineeri	ng: Compulso	ry
-	Bioprocess Engineering: Core Qualification: Compulsory			
<b>J</b>	Green Technologies: Energy, Water, Climate: Specialisation Bioreso	ource Technology: Elective Cor	npulsory	
	Orientation Studies: Core Qualification: Elective Compulsory			
	Technomathematics: Specialisation III. Engineering Science: Electiv	e Compulsory		

Course L0351: Biochemistry			
Тур	Lecture		
Hrs/wk	2		
CP	2		
Workload in Hours	pendent Study Time 32, Study Time in Lecture 28		
Lecturer	aul Bubenheim		
Language	DE		
Cycle	SoSe		
Content	<ol> <li>The molecular logic of Life</li> <li>Biomolecules:         <ol> <li>Amino acids, peptides, proteins</li> <li>Carbohydrates</li> <li>Lipids</li> </ol> </li> <li>Protein functions, Enzymes:         <ol> <li>Michaelis-Menten kinetics</li> <li>Enzyme regulation</li> <li>Enzyme nomenclature</li> </ol> </li> <li>Cofactors and cosubstrates, vitamines</li> <li>Metabolism:         <ol> <li>Basic principles</li> <li>Photosynthesis</li> <li>Glycolysis</li> <li>Citric acid cycle</li> <li>Respiration</li> <li>Anaerobic respirations</li> <li>Fatty acid metabolism</li> <li>Amino acid metabolism</li> </ol> </li> </ol>		
Literature	Biochemie, H. Robert Horton, Laurence A. Moran, K. Gray Scrimeour, Marc D. Perry, J. David Rawn, Pearson Studium, München		
	Prinzipien der Biochemie, A. L. Lehninger, de Gruyter Verlag Berlin		

Course L0728: Biochemistry				
Тур	Project-/problem-based Learning			
Hrs/wk	1			
CP				
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14			
Lecturer	Dr. Paul Bubenheim			
Language	DE			
Cycle	SoSe			
Content				
	1. The molecular logic of Life			
	2. Biomolecules:			
	1. Amino acids, peptides, proteins			
	2. Carbohydrates			
	3. Lipids			
	3. Protein functions, Enzymes:			
	1. Michaelis-Menten kinetics			
	2. Enzyme regulation			
	3. Enzyme nomenclature			
	4. Cofactors and cosubstrates, vitamines			
	5. Metabolism:			
	1. Basic principles			
	2. Photosynthesis			
	3. Glycolysis			
	4. Citric acid cycle			
	5. Respiration			
	6. Anaerobic respirations			
	7. Fatty acid metabolism			
	8. Amino acid metabolism			
Literature	Biochemie, H. Robert Horton, Laurence A. Moran, K. Gray Scrimeour, Marc D. Perry, J. David Rawn, Pearson Studium, München			
	Prinzipien der Biochemie, A. L. Lehninger, de Gruyter Verlag Berlin			

Course L0881: Microbiology	
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	SoSe
Content	<ol> <li>The procaryotic cell         <ul> <li>evolution</li> <li>taxonomy and specific properties of Archaea, Bacteria, and viruses</li> <li>structure and properties of the cell</li> <li>growth</li> </ul> </li> <li>Metabolism         <ul> <li>fermentation and anaerobic respiration</li> <li>methanogenesis and the anaerobic food chain</li> <li>degradation of polymers</li> <li>chemolithotrophy</li> </ul> </li> <li>Microorganisms in relation to the environment         <ul> <li>chemotaxis and motility</li> <li>Elemental cycle of carbon, nitrogen and sulfur</li> <li>biofilms</li> <li>symbiotic relationships</li> </ul> </li> </ol>
Literature	extremophiles     biotechnology
	• Allgemeine Mikrobiologie, 8. Aufl., 2007, Fuchs, G. (Hrsg.), Thieme Verlag (54,95 €)
	• Mikrobiologie, 13 Aufl., 2013, Madigan, M., Martinko, J. M., Stahl, D. A., Clark, D. P. (Hrsg.), ehemals "Brock", Pearson Verlag (89,95 €)
	Taschenlehrbuch Biologie Mikrobiologie, 2008, Munk, K. (Hrsg.), Thieme Verlag
	• Grundlagen der Mikrobiologie, 4. Aufl., 2010, Cypionka, H., Springer Verlag (29,95 €), http://www.grundlagen-der- mikrobiologie.icbm.de/

Course L0888: Microbiology					
Тур	Project-/problem-based Learning				
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				
Content	1. The procaryotic cell				
	evolution				
	<ul> <li>taxonomy and specific properties of Archaea, Bacteria, and viruses</li> </ul>				
	structure and properties of the cell				
	• growth				
	2. Metabolism				
	fermentation and anaerobic respiration				
	<ul> <li>methanogenesis and the anaerobic food chain</li> <li>degradation of polymers</li> </ul>				
	degradation of polymers     chemolithotrophy				
	• chemolichou ophy				
	3. Microorganisms in relation to the environment				
	chemotaxis and motility				
	Elemental cycle of carbon, nitrogen and sulfur				
	• biofilms				
	symbiotic relationships				
	• extremophiles				
	biotechnology				
Literature					
	• Allgemeine Mikrobiologie, 8. Aufl., 2007, Fuchs, G. (Hrsg.), Thieme Verlag (54,95 €)				
	• Mikrobiologie, 13 Aufl., 2013, Madigan, M., Martinko, J. M., Stahl, D. A., Clark, D. P. (Hrsg.), ehemals "Brock", Pearson Verlag (89,95€)				
	Taschenlehrbuch Biologie Mikrobiologie, 2008, Munk, K. (Hrsg.), Thieme Verlag				
	• Grundlagen der Mikrobiologie, 4. Aufl., 2010, Cypionka, H., Springer Verlag (29,95 €), http://www.grundlagen-der- mikrobiologie.icbm.de/				

Courses				
Title		Тур	Hrs/wk	СР
Phase Equilibria Thermodynamics ( Phase Equilibria Thermodynamics (		Lecture Recitation Section (small)	2 1	2 2
Phase Equilibria Thermodynamics ( Phase Equilibria Thermodynamics (		Recitation Section (small)	1	2
Module Responsible		neclation section (https:/	-	-
Admission Requirements				
		hypermice Land II		
Knowledge	Mathematics, Physical Chemistry, Thermoo			
Educational Objectives	After taking part successfully, students have	ve reached the following learning results		
Professional Competence				
	<ul> <li>Starting from the very basics of thermodynamics, the students learn the mathematical tools to describe thermodynam equilibria.</li> <li>They learn how state variables are influenced by the mixing of compounds and learn concepts to quantitatively describ these properties.</li> <li>Moreover, the students learn how phase equilibria can be described mathematically and which phenomena may occur different phases (vapor, liquid, solid) coexist in equilibrium. Furthermore the fundamentals of reaction equilibria are taught</li> <li>For different phase equilibria, several examples relevant for different kinds of processes are shown and the necessar knowledge for plotting and interpreting the equilibria are taught.</li> </ul>			
Skills	<ul> <li>Applying their knowledge, the students are able to identify the correct equation for the determination of the equilibri state and know how to simplify these equations meaningfully.</li> <li>The students know models which can be used to determine the properties of the system in the equilibrium state and t are able to solve the resulting mathematical relations.</li> <li>For specific applications, they are able to self-reliantly find necessary physico-chemical properties of compounds as wel model parameters in literature sources.</li> <li>Beside pure compound properties the students are capable of describing the properties of mixtures.</li> <li>The students know how to visualize phase equilibria graphically and they know how to interpret the occurring phenomena.</li> <li>Based on their knowledge, the students are able to understand fundamental concepts that are the basis for m separation and reaction processes in chemical engineering.</li> </ul>			
Personal Competence				
•	The students are able to work in small gro	oups, to solve the corresponding problems and t	o present them o	raly to the tutors
	other students			
Autonomy	<ul> <li>The students are able to find necessary information self-reliantly in literature sources and to judge their quality.</li> <li>During the semester the students are able to check their learning progress continuously in exercises. Based on knowledge the students can adept their learning process.</li> </ul>			
Workload in Hours	Independent Study Time 124, Study Time i	in Lecture 56		
Credit points	6			
Course achievement	None			
Examination	Written exam			
	120 minutes; theoretical questions and cal	culations		
scale				
-		gram, 7 semester): Specialisation Process Enginee		
Following Curricula		gram, 7 semester): Specialisation Bioprocess Engi		
		gram, 7 semester): Specialisation Green Technolo	gies, Focus Renew	vable Energy: Elec
	Compulsory		elee France P	vehic France - 51
		gram, 7 semester): Specialisation Green Technolo	gies, Focus Renew	vable Energy: Elec
	Compulsory	Compulsory		
	Bioprocess Engineering: Core Qualification:		Compulson	
		te: Specialisation Bioresource Technology: Electiv te: Specialisation Energy Systems: Elective Comp		

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

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	<ol> <li>Introduction: Applications of thermodynamics of mixtures</li> <li>Thermodynamic equations in multi-component systems: Fundamental equations, chemical potential, fugacity</li> <li>Phase equilibria of pure substances: thermodynamic equilibrium, vapor pressure, Gibbs' phase rule</li> <li>Equations of state: virial equations, van-der-Waals equation, generalized equations of state</li> <li>Mixing properties: ideal and real mixtures, excess properties, partial molar properties</li> <li>Vapor-liquid-equilibria: binary systems, azeotropes, equilibrium condition</li> <li>Gas-liquid-equilibria: equilibrium condition, Henry-coefficient</li> <li>G<sup>E</sup>-Models: Hildebrand-model, Flory-Huggins-model, Wilson-model, UNIQUAC, UNIFAC</li> <li>Liquid-liquid-equilibria: equilibrium condition, phase equilibria in binary and ternary systems</li> <li>Solid-liquid-equilibria: reaction coordinate, mass action law, influence of pressure and temperature</li> <li>Osmotic pressure</li> <li>The students work on tasks in small groups and present their results in front of all students.</li> </ol>
Literature	<ul> <li>Jürgen Gmehling, Bärbel Kolbe: Thermodynamik. VCH 1992</li> <li>J.M. Prausnitz, R.N. Lichtenthaler, E.G. de Azevedo: Molecular Thermodynamics of Fluid-Phase Equilibria, 3rd ed. Prentice Hall, 1999.</li> <li>J.W. Tester, M. Modell: Thermodynamics and its Applications. 3<sup>rd</sup> ed. Prentice Hall, 1997.J.P. O'Connell, J.M. Haile: Thermodynamics. Cambridge University Press, 2005.</li> </ul>

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

Courses				
Title		Тур	Hrs/wk	СР
IITIE Bioprocess Engineering - Fundamentals (L0841)		Lecture	2	3
Bioprocess Engineering - Fundamentals (20041) Bioprocess Engineering- Fundamentals (L0842)		Recitation Section (la		1
Bioprocess Engineering - Fundamer	ntal Practical Course (L0843)	Practical Course	2	2
Module Responsible	Prof. Andreas Liese			
Admission Requirements	None			
<b>Recommended Previous</b>	none, module "organic chemistry", module	"fundamentals for process engineering"		
Knowledge				
Educational Objectives	After taking part successfully, students hav	e reached the following learning results		
Professional Competence				
	Students are able to describe the basic con enzymes and microorganisms, as well as rheology can be named and mass transp fundamental bioprocess management, ster	to differentiate different types of inhit ort processes in bioreactors can be exp lization technology and downstream proc	bition. The parameters oblained. The students ar	of stoichiometry a
Skills	After successful completion of this module,	students should be able to		
	<ul> <li>describe different kinetic approaches for growth and substrate-uptake and to calculate the corresponding parameters</li> <li>predict qualitatively the influence of energy generation, regeneration of redox equivalents and growth inhibition or fermentation process</li> <li>analyze bioprocesses on basis of stoichiometry and to set up / solve metabolic flux equations</li> <li>distinguish between scale-up criteria for different bioreactors and bioprocesses (anaerobic, aerobic as well as microaer to compare them as well as to apply them to current biotechnical problem</li> <li>propose solutions to complicated biotechnological problems and to deduce the corresponding models</li> <li>to explore new knowledge resources and to apply the newly gained contents</li> <li>identify scientific problems with concrete industrial use and to formulate solutions.</li> <li>to document and discuss their procedures as well as results in a scientific manner</li> </ul>			wth inhibition on t
	After completion of this module participant take position to their own opinions and incr After completion of this module participant	ease their capacity for teamwork in enginess will be able to solve a technical problem	eering and scientific envi	ironments.
	workflow and to present their results in a p	lenum.		
Workload in Hours	Independent Study Time 96, Study Time in	Lecture 84		
Credit points	6			
Course achievement	Compulsory         Bonus         Form         Description           Yes         5 %         Subject theoretical and practical work         Form			
Examination	Written exam			
Examination duration and scale	90 min			
Assignment for the	General Engineering Science (German prog	ram, 7 semester): Specialisation Process I	Engineering: Compulsory	
Following Curricula	General Engineering Science (German program, 7 semester): Specialisation Bioprocess Engineering: Compulsory			
	Bioprocess Engineering: Core Qualification: Compulsory			
	Green Technologies: Energy, Water, Climate	e: Specialisation Bioresource Technology:	Elective Compulsory	
	Biomedical Engineering: Specialisation Artif	icial Organs and Regenerative Medicine: O	Compulsory	
	Biomedical Engineering: Specialisation Impl	ants and Endoprostheses: Elective Compu	ulsory	
	Biomedical Engineering: Specialisation Med	cal Technology and Control Theory: Elect	ive Compulsory	
	Biomedical Engineering: Specialisation Man	agement and Business Administration: Ele	ective Compulsory	
	Technomathematics: Specialisation III. Engi	neering Science: Elective Compulsory		
	Process Engineering: Core Qualification: Co	npulsory		

Course L0841: Bioprocess En	igineering - Fundamentals
Тур	Lecture
Hrs/wk	2
CP	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Prof. Andreas Liese
Language	DE
Cycle	SoSe
Content	<ul> <li>Introduction: state-of-the-art and development trends in the biotechnology, introduction to the lecture</li> <li>Enzyme kinetics: Michaelis-Menten, differnt types of enzyme inhibition, linearization, conversion, yield, selectivity (Prof. Liese)</li> <li>Stoichiometry: coefficient of respiration, electron balance, degree of reduction, coefficient of yield, theoretical oxygen demand (Prof. Liese)</li> <li>Microbial growth kinetic: batch- and chemostat culture (Prof. Zeng)</li> <li>Kinetic of subtrate consumption and product formation (Prof. Zeng)</li> <li>Rheology: non-newtonian fluids, viscosity, agitators, energy input (Prof. Liese)</li> <li>Transport process in a bioreactor (Prof. Zeng)</li> <li>Fundamentals of bioprocess management: bioreactors and calculation of batch, fed-batch and continuouse bioprocesses (Prof. Zeng/Prof. Liese)</li> <li>Downstream technology in biotechnology: cell breakdown, zentrifugation, filtration, aqueous two phase systems (Prof. Liese)</li> </ul>
Literature	<ul> <li>K. Buchholz, V. Kasche, U. Bornscheuer: Biocatalysts and Enzyme Technology, 2. Aufl. Wiley-VCH, 2012</li> <li>H. Chmiel: Bioproze&amp;technik, Elsevier, 2006</li> <li>R.H. Balz et al.: Manual of Industrial Microbiology and Biotechnology, 3. edition, ASM Press, 2010</li> <li>H.W. Blanch, D. Clark: Biochemical Engineering, Taylor &amp; Francis, 1997</li> <li>P. M. Doran: Bioprocess Engineering Principles, 2. edition, Academic Press, 2013</li> </ul>

Course L0842: Bioprocess Engineering- Fundamentals		
Тур	Recitation Section (large)	
Hrs/wk	2	
CP	1	
Workload in Hours	Independent Study Time 2, Study Time in Lecture 28	
Lecturer	Prof. Andreas Liese	
Language	DE	
Cycle	SoSe	
Content	1. Introduction (Prof. Liese, Prof. Zeng)	
	2. Enzymatic kinetics (Prof. Liese)	
	3. Stoichiometry I + II (Prof. Liese)	
	4. Microbial Kinetics I+II (Prof. Zeng)	
	5. Rheology (Prof. Liese)	
	6. Mass transfer in bioprocess (Prof. Zeng)	
	7. Continuous culture (Chemostat) (Prof. Zeng)	
	8. Sterilisation (Prof. Zeng)	
	9. Downstream processing (Prof. Liese)	
	10. Repetition (Reserve) (Prof. Liese, Prof. Zeng)	
Literature	siehe Vorlesung	

Course L0843: Bioprocess En	ngineering - 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, Prof. An-Ping Zeng
Language	DE
Cycle	SoSe
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

ical Reaction E	ingineering				
		-		Hara facilia	65
damontals) (L0204)		-	-		<b>CP</b> 2
					2
	) (L0221)			2	2
Prof. Raimund Horn					
Contents of the prev	vious modules mathemat	tics I-III, physical chem	istry, technical thermod	ynamics I+II as w	vell as computatio
After taking part suc	cessfully, students have r	reached the following I	earning results		
The students are abl	e to explain basic conce	pts of chemical reaction	on engineering. They are	able to point out	differences betwe
thermodynamical an	d kinetical processes. Th	he students have a st	rong ability to outline pa	arts of isotherma	I and non-isotherr
ideal reactors and to	describe their properties	5.			
After successful com	pletion of the module, stu	udents are able to:			
annly different com	nutational matheda to di	mencien ieethermel en	d non insthemal ideal w	a atawa	
- apply different com	putational methods to di	mension isouriermai ar	a non-isothermai ideal re	actors,	
- determine and compute stable operation points for these reactors ,					
- conduct experiment	ts on a lab-scale phot pla		se according to scientific	guidennes.	
After successful completition of the lab-course the students have a strong ability to organize themselfes in small groups to solv					
issues in chemical reaction engineering. The students can discuss their subject related knowledge among each other and wit					
their teachers.					
The students are a	ble to obtain further i	nformation and asse	ss their relevance auto	nomously. Stude	nts can apply th
knowldege discretely to plan, prepare and conduct experiments.					
Independent Study T	ime 96, Study Time in Le	ecture 84			
		•			
Yes None	-	and			
	practical work				
120 min					
				<b>e</b> .	ory
			-		
			alisation Chemical and Bi	pengineering: Cor	npulsory
	-				
			-	Compulsor	
Green reconologies:	Energy, water, climate:	sheciglization Riolezoi	arce rechnology: Elective	compuisory	
	adamentals) (L0204) adamentals) (L0244) neering (Fundamentals Prof. Raimund Horn None Contents of the prev methods for enginee After taking part succ The students are abl thermodynamical an ideal reactors and to After successful com - apply different com - determine and com - determine and com - conduct experimen After successful com issues in chemical ri- their teachers. The students are a knowldege discretely Independent Study T 6 Compulsory Bonus Yes None Written exam 120 min General Engineering General Engineering Bioprocess Engineeri Chemical and Biopro	Adamentals) (L0204) Adamentals) (L0244) neering (Fundamentals) (L0221) Prof. Raimund Horn None Contents of the previous modules mathematimethods for engineers. After taking part successfully, students have The students are able to explain basic concerthermodynamical and kinetical processes. Tideal reactors and to describe their properties After successful completion of the module, st - apply different computational methods to di - determine and compute stable operation por - conduct experiments on a lab-scale pilot plat After successful completition of the lab-course issues in chemical reaction engineering. The their teachers. The students are able to obtain further in knowldege discretely to plan, prepare and cond Independent Study Time 96, Study Time in Lefe 6 Compulsory Bonus Form Yes None Subject theoretical practical work Written exam 120 min General Engineering Science (German progra General Engineering Science (German progra Bioprocess Engineering: Core Qualification: C Chemical and Bioprocess Engineering: Core Qualification: C Chemical and Bioprocess Engineering: Core Qualification: C	Typ         Indamentals) (L0204)       Lee         Indamentals) (L0244)       Ree         neering (Fundamentals) (L0221)       Prof.         Prof. Raimund Horn       None         Contents of the previous modules mathematics I-III, physical chemmethods for engineers.       After taking part successfully, students have reached the following I         The students are able to explain basic concepts of chemical reaction thermodynamical and kinetical processes. The students have a stideal reactors and to describe their properties.         After successful completion of the module, students are able to:         - apply different computational methods to dimension isothermal and         - determine and compute stable operation points for these reactors         - conduct experiments on a lab-scale pilot plants and document these         After successful completition of the lab-course the students have a stissues in chemical reaction engineering. The students can discuss their teachers.         The students are able to obtain further information and assest knowldege discretely to plan, prepare and conduct experiments.         Independent Study Time 96, Study Time in Lecture 84         6         Compulsory Bonus       Form         Yes       None         Subject theoretical and practical work         Written exam       120 min         General Engineering Science (German program, 7 semester): Specia General Engineering Science (German pr	Indamentals) (L0204)       Lecture         Indamentals) (L024)       Recitation Section (large)         Prof. Raimund Horn       Practical Course         None       Contents of the previous modules mathematics I-III, physical chemistry, technical thermod methods for engineers.         After taking part successfully, students have reached the following learning results       The students are able to explain basic concepts of chemical reaction engineering. They are thermodynamical and kinetical processes. The students have a strong ability to outline prideal reactors and to describe their properties.         After successful completion of the module, students are able to:       -         - apply different computational methods to dimension isothermal and non-isothermal ideal reactors and to describe their properties.         - determine and compute stable operation points for these reactors ,         - conduct experiments on a lab-scale pilot plants and document these according to scientific         After successful completition of the lab-course the students have a strong ability to organiz issues in chemical reaction engineering. The students can discuss their subject related kr their teachers.         The students are able to obtain further information and assess their relevance auto knowledge discretely to plan, prepare and conduct experiments.         Independent Study Time 96, Study Time in Lecture 84       6         Compulsory Bonus Form Description       Pescription         Yet None Subject theoretical and practical work       Mitten exam	Typ         Hrs/wk           idamentals) (L0204)         Lecture         2           neering (Fundamentals) (L0221)         Practical Course         2           Prof. Raimund Horn         None         Contents of the previous modules mathematics I-III, physical chemistry, technical thermodynamics I+II as v           Mone         Contents of the previous modules mathematics I-III, physical chemistry, technical thermodynamics I+II as v           Methods for engineers.         After taking part successfully, students have reached the following learning results           The students are able to explain basic concepts of chemical reaction engineering. They are able to point out thermodynamical and kinetical processes. The students have a strong ability to outline parts of isothermalideal reactors and to describe their properties.           After successful completion of the module, students are able to:         - apply different computational methods to dimension isothermal and non-isothermal ideal reactors,           - determine and compute stable operation points for these reactors ,         - conduct experiments on a lab-scale pilot plants and document these according to scientific guidelines.           After successful completition of the lab-course the students have a strong ability to organize themselfes in s         issues in chemical reaction engineering. The students can discuss their subject related knowledge among their teachers.           The students are able to obtain further information and assess their relevance autonomously. Stude knowledge discretely to plan, prepare and conduct experiments.         Compu

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
	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? 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)

	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 reactor, integration of the batch reactor mole balance for various kinetics, partial fraction decomposition, mole balance of a 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 ex
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

Course L0244: Chemical Read	tion Engineering (Fundamentals)
Тур	Recitation Section (large)
Hrs/wk	2
СР	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 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, adiabatic staged reactors, rotating furnaces, fluidized bed reactor, mole balance of a bach reactor, mole balance of a chemical reactor, 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, nomerical-interative calculation of a cascade of tank reactors, comparison of CSTR and PFR with respect t
	states, ignition-extinction behavior, stability of a CSTR, complex reactions in non-isothermal reactors, optimum temperature profile of a reactor)
Literature	Leaburg apples Deimund Harn
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

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 M1275: Enviro	onmental Techn	ology				
		lology				
Courses						
Title				Тур	Hrs/wk	СР
Practical Exercise Environmental Te	echnology (L1387)			Practical Course	1	1
Environmental Technologie (L0326)				Lecture	2	2
Module Responsible	Prof. Martin Kaltschmi	tt				
Admission Requirements	None					
<b>Recommended Previous</b>	Fundamentals of inorg	janic/organic chemistry a	and biology			
Knowledge						
Educational Objectives	After taking part succe	essfully, students have re	eached the following	ng learning results		
Professional Competence						
Knowledge	the behaviour of chen	f this modul the students nicals in the environmen em to related methods.		-		
Skills	Students are able to propose appropriate management and mitigation measures for environmental problems. They are able to determine geochemical parameters and to assess the potential of pollutants to migrate and transform. The students are able to work out well founded opinions on how Environmental Technology contributes to sustainable development, and they can present and defend these opinons in front of and against the group.					
Personal Competence						
Social Competence		to discuss the various te		-		
	to develop different ap	oproaches to the task as	a group as well as	to discuss their theore	tical or practical impler	nentation.
Autonomy	Students can independ	dently exploit sources ab	oout of the subject,	, acquire the particular	knowledge and tranfer	it to new problems.
Workload in Hours	Independent Study Tir	me 48, Study Time in Leo	cture 42			
Credit points	3					
Course achievement	Compulsory Bonus	Form	Description			
	Yes None	Subject theoretical	and			
		practical work				
Examination	Written exam					
Examination duration and	1 hour					
scale						
Assignment for the	General Engineering S	cience (German progran	n, 7 semester): Spe	ecialisation Bioprocess	Engineering: Elective C	ompulsory
Following Curricula		cience (German progran		ecialisation Process Eng	gineering: Elective Com	pulsory
		g: Core Qualification: Ele				
		ental Engineering: Core C		oulsory		
	Process Engineering: 0	Core Qualification: Electiv	ve Compulsory			

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 L0326: Environmenta	l 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	<ol> <li>Introductory seminar on environmental science:</li> <li>Environmental impact and adverse effects</li> <li>Wastewater technology</li> <li>Air pollution control</li> <li>Noise protection</li> <li>Waste and recycling management</li> <li>Soil and ground water protection</li> <li>Renewable energies</li> <li>Resource conservation and energy efficiency</li> </ol>
Literature	Förster, U.: Umweltschutztechnik; 2012; Springer Berlin (Verlag) 8., Aufl. 2012; 978-3-642-22972-5 (ISBN)

Courses				
litle		Turn	Hrs/wk	СР
Bioprocess Engineering - Advanced	(L1107)	<b>Typ</b> Lecture	2	4
Bioprocess Engineering - Advanced		Recitation Section (small)	2	2
Module Responsible	Prof. Ralf Pörtner			
Admission Requirements	None			
<b>Recommended Previous</b>	Content of module "Biochemisty and Microbiolo	ogy"		
Knowledge	Contant of modulo "Piochomical Engineering !"			
	Content of module "Biochemical Engineering I"			
Educational Objectives	After taking part successfully, students have re	ached the following learning results		
Professional Competence				
Knowledge	After successful completion of this module, stu	dents should be able		
	- explain the microbial, energetic and engineer	ing principles of fermentation process,		
	- explain different kinetic approaches for cel	I growth, substrate uptake and product fo	rmation and app	ly them for proc
	development, - understand and quantify transport phenomen	a in bioreactor and consider them for bioproce	ess scale-up	
	<ul> <li>identify specific scientific problems and soluti</li> </ul>	ons for different types of fermentation process	ses	
Skills	After successful completion of this module, stu	dents should be able to		
	<ul> <li>to identify scientific questions or possible practical problems for concrete industrial applications (eg cultivation of microorganism and animal cells) and to formulate solutions,</li> </ul>			
	<ul> <li>to assess the application of scale-up criteria problems (anaerobic , aerobic or microaerobic</li> </ul>		es and to apply t	hese criteria to giv
	- to formulate questions for the analysis and op	timization of real biotechnological production	processes approp	oriate solutions,
	- to describe the effects of the energy generate behavior of microorganisms and to the total fer		nts , and the gro	wth inhibition of t
	<ul> <li>to establish material balance and fermenta approaches,</li> </ul>	tion equations and solve them to determin	e the kinetic par	rameters of differ
	<ul> <li>to select process control strategies (batch , evaluate them.</li> </ul>	fed-batch ,or continuous culture) appropriat	tely and to calcu	late basic types a
Personal Competence Social Competence	After completion of this module participants sh take position to their own opinions and increas		small teams to e	nhance the ability
Autonomy	After completion of this module participants ar unknown issues and to present these.	e able to acquire new sources of knowledge a	nd apply their kno	wledge to previou
Workload in Hours	Independent Study Time 124, Study Time in Le	cture 56		
Credit points	6			
Course achievement	None			
	Written exam			
Examination				
	90 min			
	90 min			
Examination duration and scale	90 min General Engineering Science (German program	n, 7 semester): Specialisation Bioprocess Engir	eering: Compulso	ory
Examination duration and scale Assignment for the		npulsory		bry

Course L1107: Bioprocess En	gineering - Advanced
Тур	Lecture
Hrs/wk	2
CP	4
Workload in Hours	Independent Study Time 92, Study Time in Lecture 28
Lecturer	Prof. Ralf Pörtner, Prof. Andreas Liese
Language	EN
Cycle	WiSe
Content	• Introduction: state-of-the-art and development trends of microbial and biocatalytic bioprocesses, introduction to the lecture
	Microbial principles of fermentation, Energetic fundamentals of bioreaction
	Medium design and optimization, sterilization
	Kinetics of cell growth
	Kinetics of substrate consumption and product formation
	Material balances and metabolic flux analysis
	<ul> <li>Transport phenomena in bioreactor and bioprocess scale-u</li> </ul>
	Anaerobic fermentation process, integrated downstream processin
	<ul> <li>Microaerobic bioprocess: optimal O2 supply, process control and scale-u</li> </ul>
	Aerobic process and high cell density culture
	Problem-based learning with selected bioprocesses
Literature	P. F. Stanbury, A. Whitaker, S. J. Hall, Principles of Fermentation Technology, 3 <sup>rd</sup> . Edition, Butterworth-Heinemann, 2016.
	H. Chmiel: Bioprozeßtechnik, Elsevier, 2006
	R.H. Balz et al.: Manual of Industrial Microbiology and Biotechnology, 3. edition, ASM Press, 2010
	H.W. Blanch, D. Clark: Biochemical Engineering, Taylor & Francis, 1997
	P. M. Doran: Bioprocess Engineering Principles, 2. edition, Academic Press, 2013
	Skripte für die Vorlesung

Course L1108: Bioprocess En	gineering - Advanced
Тур	Recitation Section (small)
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Prof. Ralf Pörtner, Prof. Andreas Liese
Language	EN
Cycle	WiSe
Content	Introduction: state-of-the-art and development trends of microbial and biocatalytic bioprocesses, introduction to the lecture
	Microbial principles of fermentation, Energetic fundamentals of bioreaction
	Medium design and optimization, sterilization
	Kinetics of cell growth
	Kinetics of substrate consumption and product formation
	Material balances and metabolic flux analysis
	Transport phenomena in bioreactor and bioprocess scale-u
	<ul> <li>Anaerobic fermentation process, integrated downstream processin</li> <li>Microaerobic bioprocess: optimal O2 supply, process control and scale-u</li> </ul>
	Aerobic process and high cell density culture
	Problem-based learning with selected bioprocesses
	The students present exercises and discuss them with their fellow students and faculty statt. In the PBL part of the class the students discuss scientific questions in teams. They acquire knowledge and apply it to unknown questions, present their results and argue their opinions.
Literature	P. F. Stanbury, A. Whitaker, S. J. Hall, Principles of Fermentation Technology, 3 <sup>rd</sup> . Edition, Butterworth-Heinemann, 2016.
	H. Chmiel: Bioprozeßtechnik, Elsevier, 2006
	R.H. Balz et al.: Manual of Industrial Microbiology and Biotechnology, 3. edition, ASM Press, 2010
	P. M. Doran: Bioprocess Engineering Principles, 2. edition, Academic Press, 2013
	Skripte für die Vorlesung

Courses				
Title		Тур	Hrs/wk	СР
Thermal Separation Processes (L01	18)	Lecture	2	2
Thermal Separation Processes (L01	19)	Recitation Section (small)	2	2
Thermal Separation Processes (L01	41)	Recitation Section (large)	1	1
Separation Processes (L1159)		Practical Course	1	1
Module Responsible	Prof. Irina Smirnova			
Admission Requirements	None			
	Recommended requirements: Thermodynamics III			
Knowledge				
Educational Objectives	After taking part successfully, students have reached t	he following learning results		
Professional Competence				
Knowledge	<ul> <li>The students can distinguish and describe different types of separation processes such as distillation, extraction, a adsorption</li> <li>The students develop an understanding for the course of concentration during a separation process, the estimation of energy demand of a process, the possibilities of energy saving, and the selection of separation systems</li> <li>They have good knowledge of designing methods for separation processes and devices</li> </ul>			
Skills	<ul> <li>Using the gained knowledge the students can so close the associated energy and material balance.</li> <li>The students can use different graphical meth theoretical stages required</li> <li>They can select and design a basic type of the disadvantages of the process</li> <li>The students are capable to obtain independen tables)</li> <li>They can calculate continuous and discontinuou</li> <li>The students are able to prove their theoretical colloquium.</li> </ul>	es lods for the designing of a separatio ermal separation process for a given tly the needed material properties fro s processes knowledge in the experimental lab wor background and the content of the ex-	n process and o a case based on m appropriate so rk. xperimental work and use it togeti	lefine the amount the advantages a purces (diagrams a with the teachers
Personal Competence Social Competence	<ul> <li>The students can work technical assignments in</li> <li>The students are able to carry out practical lat</li> </ul>			
Autonomy	<ul> <li>them. They are able to discuss their results and</li> <li>The students are capable to obtain the needed i</li> <li>The students can proof the state of their kno learning process</li> </ul>	nformation from suitable sources by th	emselves and as	
Workload in Hours	Independent Study Time 96, Study Time in Lecture 84			
Credit points				
Course achievement				
Examination				
	120 minutes; theoretical questions and calculations			
scale				
÷	General Engineering Science (German program, 7 sem Compulsory General Engineering Science (German program, 7	-		
	Compulsory General Engineering Science (German program, 7 sem General Engineering Science (German program, 7 sem General Engineering Science (German program, 7 sem Bioprocess Engineering: Core Qualification: Compulsor Chemical and Bioprocess Engineering: Core Qualification Energy and Environmental Engineering: Core Qualification	ester): Specialisation Process Engineer ester): Specialisation Chemical and Bio / m: Compulsory	ing: Compulsory	
	Green Technologies: Energy, Water, Climate: Specialisa Green Technologies: Energy, Water, Climate: Specialisa Process Engineering: Core Qualification: Compulsory	ation Energy Systems: Elective Compu		

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

ourse 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	<ul> <li>Introduction in the thermal process engineering and to the main features of separation processes</li> <li>Simple equilibrium processes, several steps processes</li> <li>Distillation of binary mixtures, enthalpy-concentration diagrams</li> <li>Extractive and azeotrope distillation, water vapor distillation, stepwise distillation</li> <li>Extraction: separation ternary systems, ternary diagram</li> <li>Multiphase separation including complex mixtures</li> <li>Designing of separation devices without discrete stages</li> <li>Drying</li> <li>Chromatographic separation processes</li> <li>Membrane separation</li> <li>Energy demand of separation processes</li> <li>Advance overview of separation processes</li> <li>Selection of separation processes</li> </ul>
Literature	<ul> <li>The students work on tasks in small groups and present their results in front of all students.</li> <li>G. Brunner: Skriptum Thermische Verfahrenstechnik</li> <li>J. King: Separation Processes, McGraw-Hill, 2. Aufl. 1980</li> <li>Sattler: Thermische Trennverfahren, VCH, Weinheim 1995</li> <li>J.D. Seader, E.J. Henley: Separation Process Principles, Wiley, New York, 1998.</li> <li>Mersmann: Thermische Verfahrenstechnik, Springer, 1980</li> <li>Grassmann, Widmer, Sinn: Einführung in die Thermische Verfahrenstechnik, 3. Aufl., Walter de Gruyter, Berlin 1997</li> <li>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.</li> <li>R. Goedecke (Hrsg.): Fluid-Verfahrenstechnik, Wiley-VCH Verlag, Weinheim, 2006.</li> <li>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</li> </ul>

rse L0141: Thermal Sepa	
Тур	Recitation Section (large)
Hrs/wk	
СР	1
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14
Lecturer	Prof. Irina Smirnova
Language	DE
Cycle	WiSe
Content	<ul> <li>Introduction in the thermal process engineering and to the main features of separation processes</li> <li>Simple equilibrium processes, several steps processes</li> <li>Distillation of binary mixtures, enthalpy-concentration diagrams</li> <li>Extractive and azeotrope distillation, water vapor distillation, stepwise distillation</li> <li>Extraction: separation ternary systems, ternary diagram</li> <li>Multiphase separation including complex mixtures</li> <li>Designing of separation devices without discrete stages</li> <li>Drying</li> <li>Chromatographic separation processes</li> <li>Membrane separation</li> <li>Energy demand of separation processes</li> <li>Advance overview of separation processes</li> <li>Selection of separation processes</li> </ul>
Literature	<ul> <li>G. Brunner: Skriptum Thermische Verfahrenstechnik</li> <li>J. King: Separation Processes, McGraw-Hill, 2. Aufl. 1980</li> <li>Sattler: Thermische Trennverfahren, VCH, Weinheim 1995</li> <li>J.D. Seader, E.J. Henley: Separation Process Principles, Wiley, New York, 1998.</li> <li>Mersmann: Thermische Verfahrenstechnik, Springer, 1980</li> <li>Grassmann, Widmer, Sinn: Einführung in die Thermische Verfahrenstechnik, 3. Aufl., Walter de Gruyter, Berlin 1997</li> <li>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.</li> <li>R. Goedecke (Hrsg.): Fluid-Verfahrenstechnik, Wiley-VCH Verlag, Weinheim, 2006.</li> <li>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</li> </ul>

L1159: Separation Pr	Practical Course
Hrs/wk	1
CP	
	Independent Study Time 16, Study Time in Lecture 14
	Prof. Irina Smirnova
Language	
Cycle	
Content	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 can increase their capabilities in this area.
	Topics of the practical course:
	<ul> <li>Introduction in the thermal process engineering and to the main features of separation processes</li> <li>Simple equilibrium processes, several steps processes</li> <li>Distillation of binary mixtures, enthalpy-concentration diagrams</li> <li>Extractive and azeotrope distillation, water vapor distillation, stepwise distillation</li> <li>Extraction: separation ternary systems, ternary diagram</li> <li>Multiphase separation including complex mixtures</li> <li>Designing of separation devices without discrete stages</li> <li>Drying</li> <li>Chromatographic separation processes</li> <li>Membrane separation</li> <li>Energy demand of separation processes</li> <li>Advance overview of separation processes</li> <li>Selection of separation processes</li> </ul>
Literature	<ul> <li>G. Brunner: Skriptum Thermische Verfahrenstechnik</li> <li>J. King: Separation Processes, McGraw-Hill, 2. Aufl. 1980</li> <li>Sattler: Thermische Trennverfahren, VCH, Weinheim 1995</li> <li>J.D. Seader, E.J. Henley: Separation Process Principles, Wiley, New York, 1998.</li> <li>Mersmann: Thermische Verfahrenstechnik, Springer, 1980</li> <li>Grassmann, Widmer, Sinn: Einführung in die Thermische Verfahrenstechnik, 3. Aufl., Walter de Gruyter, Berlin 1997</li> <li>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.</li> <li>R. Goedecke (Hrsg.): Fluid-Verfahrenstechnik, Wiley-VCH Verlag, Weinheim, 2006.</li> <li>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</li> </ul>

Courses				
Title		Тур	Hrs/wk	СР
Case studies project assessment (L		Recitation Section (small) Lecture	1 2	1 2
Environmental Assessment (L0860)		Lecture	Z	Ζ
-	Prof. Martin Kaltschmitt			
Admission Requirements				
	Fundamentals of inorganic/organic chemistry and b	biology		
Knowledge				
Educational Objectives	After taking part successfully, students have reach	ed the following learning results		
Professional Competence				
Knowledge	With the completion of this module the students acquire in-depth knowledge of important cause-effect chains of			
	environmental problems which might occur from p			-
	about the methodological diversity and are compe impacts. Besides the students are able to estimate	-		
	difficulties with their measurement.	e the complexity of these environmental p	rocesses as well	as uncertainties
Skille		for the respective case from the variety of	f according to the	thods Thoroby t
SKIIIS	s The students are able to select a suitable method for the respective case from the variety of assessment methods. Thereby the can develop suitable solutions for managing and mitigating environmental problems in a business context. They are able to car			
	out Life Cycle Impact Assessments independently			-
	After finishing the course the students have th			
	environmental impacts.	te competence to entically judge resear		and publications
Personal Competence				
Social Competence	The students are able to discuss the various techni	cal and scientific tasks, both subject-specif	ic and multidiscip	olinary. They are
	to develop jointly different solutions and to discuss their theoretical or practical implementation. Due to the selected lectu			
	topics, the students receive insights into the multi	-layered issues of the environment protect	ion and the conc	ept of sustainabi
	Their sensitivity and consciousness towards these	e subjects are raised and which helps to	raise their aware	eness of their fu
	social responsibilities in their role as engineers.			
Autonomy	The students learn to research, process and pre-			
	scientific work. They can solve an environmental p	roblem in a business context and are able t	o judge results o	f other publicatio
Workload in Hours	Independent Study Time 48, Study Time in Lecture	42		
Credit points	3			
Course achievement	None			
Examination	Written exam			
Examination duration and	1 hour written exam			
scale				
Assignment for the	General Engineering Science (German program, 7	semester): Specialisation Bioprocess Engine	eering: Elective C	Compulsory
Following Curricula	General Engineering Science (German program, 7	semester): Specialisation Process Engineer	ng: Elective Com	pulsory
	Bioprocess Engineering: Core Qualification: Elective	e Compulsory		
	Energy and Environmental Engineering: Core Quali	fication: Compulsory		

project assessment
Recitation Section (small)
1
1
Independent Study Time 16, Study Time in Lecture 14
Prof. Martin Kaltschmitt, Dozenten des SD V
DE
WiSe
Presentation and application of free software programs in order to understand the concepts of environmental
assessment methods better.
Within the group exercise 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.
Power point Präsentationen

Course L0860: Environmenta	I Assessment
Тур	Lecture
Hrs/wk	2
СР	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Dr. Anne Rödl, Dr. Christoph Hagen Balzer
Language	DE/EN
Cycle	WiSe
Content	Contaminants: Impact- and Risk Assessment
	Environmental damage & precautionary principle: Environmental Risk Assessment (ERA)
	Resource and water consumption: Material flow analysis
	Energy consumption: Cumulated energy demand (CED), cost analysis
	Life cycle concept: Life cycle assessment (LCA)
	Sustainability: Comprehensive product system assessment , SEE-Balance
	Management: Environmental and Sustainability management (EMAS)
	Complex systems: MCDA and scenario method
Literature	Foliensätze der Vorlesung
	Studie: Instrumente zur Nachhaltigkeitsbewertung - Eine Synopse (Forschungszentrum Jülich GmbH)

C				
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)	1	Recitation Section (large)	1	2
Module Responsible	Prof. Irina Smirnova			
Admission Requirements	None			
Recommended Previous Knowledge	5 ,			
Educational Objectives	After taking part successfully, students have r	eached the following learning results		
Professional Competence				
Knowledge	<ul> <li>The students are capable of explaining heat exchanger, chemical reactors).</li> <li>They are capable of distinguish and ch transfer and thermal radiation.</li> <li>The students have the ability to exp qualitative and quantitative by using su</li> <li>They are able to depict the analogy bet</li> </ul>	qualitative and determining quantitative heat aracterize different kinds of heat transfer mech lain the physical basis for mass transfer in uitable mass transfer theories. ween heat- and mass transfer and to describe	aanisms namely h detail and to de	eat conduction, h
Skills	<ul> <li>The students are able to set reasonable system boundaries for a given transport problem by using the gained knowled and to balance the corresponding energy and mass flow, respectively.</li> <li>They are capable to solve specific heat transfer problems (e.g. heated chemical reactors, temperature alteration in flut and to calculate the corresponding heat flows.</li> <li>Using dimensionless quantities, the students can execute scaling up of technical processes or apparatus.</li> <li>They are able to distinguish between diffusion, convective mass transition and mass transfer. They can use this knowled for the description and design of apparatus (e.g. extraction column, rectification column).</li> <li>In this context, the students are capable to choose and design fundamental types of heat and mass exchanger for a spe application considering their advantages and disadvantages, respectively.</li> <li>In addition, they can calculate both, steady-state and non-steady-state processes in procedural apparatus.</li> <li>The students are capable to connect their knowledge obtained in this course with knowledge of other courses particular the courses thermodynamics, fluid mechanics and chemical process engineering) to solve concrete techn problems.</li> </ul>		e alteration in flui s. n use this knowled changer for a spec cus. of other courses	
Personal Competence Social Competence		ubject-specific challenges in teams and to pre	sent the results o	orally in a reasona
Autonomy	<ul><li>The students are able to find and evalu</li><li>They are able to prove their level of</li></ul>	ate necessary information from suitable source knowledge during the course with accompan n this basis they can control their learning proce	ying procedure of	continuously (click
	<u></u>			
Workload in Hours	Independent Study Time 124, Study Time in L	ecture 56		
		ecture 56		
Credit points	6	ecture 56		
Credit points Course achievement	6 None	ecture 56		
Credit points Course achievement Examination	6 None Written exam			
Credit points Course achievement Examination	6 None			
Credit points Course achievement Examination	6 None Written exam 120 minutes; theoretical questions and calcul-			
Credit points Course achievement Examination Examination duration and scale	6 None Written exam 120 minutes; theoretical questions and calcula		ies: Compulsory	
Credit points Course achievement Examination Examination duration and scale	6 None Written exam 120 minutes; theoretical questions and calcul- General Engineering Science (German program	ations		bry
Credit points Course achievement Examination Examination duration and scale Assignment for the	6 None Written exam 120 minutes; theoretical questions and calcul General Engineering Science (German program General Engineering Science (German program	ations m, 7 semester): Specialisation Green Technolog	eering: Compulso	ory
Credit points Course achievement Examination Examination duration and scale Assignment for the	6 None Written exam 120 minutes; theoretical questions and calcul General Engineering Science (German program General Engineering Science (German program General Engineering Science (German program	ations m, 7 semester): Specialisation Green Technolog m, 7 semester): Specialisation Bioprocess Engir	eering: Compulsory	
Credit points Course achievement Examination Examination duration and scale Assignment for the	6 None Written exam 120 minutes; theoretical questions and calcul General Engineering Science (German program General Engineering Science (German program General Engineering Science (German program General Engineering Science (German program	ations m, 7 semester): Specialisation Green Technolog m, 7 semester): Specialisation Bioprocess Engir m, 7 semester): Specialisation Process Engineer m, 7 semester): Specialisation Chemical and Bio	eering: Compulsory	
Credit points Course achievement Examination Examination duration and scale Assignment for the	6 None Written exam 120 minutes; theoretical questions and calcul General Engineering Science (German program General Engineering Science (German program General Engineering Science (German program General Engineering Science (German program Bioprocess Engineering: Core Qualification: Core	ations m, 7 semester): Specialisation Green Technolog m, 7 semester): Specialisation Bioprocess Engir m, 7 semester): Specialisation Process Engineer m, 7 semester): Specialisation Chemical and Bio pmpulsory	eering: Compulsory	
Credit points Course achievement Examination Examination duration and scale Assignment for the	6 None Written exam 120 minutes; theoretical questions and calcul General Engineering Science (German progran General Engineering Science (German progran General Engineering Science (German progran General Engineering Science (German progran Bioprocess Engineering: Core Qualification: Co Chemical and Bioprocess Engineering: Core Q	ations m, 7 semester): Specialisation Green Technolog m, 7 semester): Specialisation Bioprocess Engir m, 7 semester): Specialisation Process Engineer m, 7 semester): Specialisation Chemical and Bio mpulsory ualification: Compulsory	eering: Compulsory	
Credit points Course achievement Examination Examination duration and scale Assignment for the	6 None Written exam 120 minutes; theoretical questions and calcul General Engineering Science (German progran General Engineering Science (German progran General Engineering Science (German progran General Engineering Science (German progran Bioprocess Engineering: Core Qualification: Co Chemical and Bioprocess Engineering: Core Q Energy and Environmental Engineering: Core	ations m, 7 semester): Specialisation Green Technolog m, 7 semester): Specialisation Bioprocess Engir m, 7 semester): Specialisation Process Engineer m, 7 semester): Specialisation Chemical and Bio mpulsory ualification: Compulsory Qualification: Compulsory	eering: Compulsory	
Credit points Course achievement Examination Examination duration and scale Assignment for the	6 None Written exam 120 minutes; theoretical questions and calcul General Engineering Science (German progran General Engineering Science (German progran General Engineering Science (German progran General Engineering Science (German progran Bioprocess Engineering: Core Qualification: Co Chemical and Bioprocess Engineering: Core Q	ations m, 7 semester): Specialisation Green Technolog m, 7 semester): Specialisation Bioprocess Engir m, 7 semester): Specialisation Process Engineer m, 7 semester): Specialisation Chemical and Bio pmpulsory ualification: Compulsory Qualification: Compulsory Core Qualification: Compulsory	eering: Compulsory	

Course L0101: Heat and Mass Transfer						
Тур	ecture					
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	<ol> <li>Heat transfer         <ul> <li>Introduction, one-dimensional heat conduction</li> <li>Convective heat transfer</li> <li>Multidimensional heat conduction</li> <li>Non-steady heat conduction</li> <li>Thermal radiation</li> </ul> </li> <li>Mass transfer         <ul> <li>one-way diffusion, equimolar countercurrent diffusion</li> <li>boundary layer theory, non-steady mass transfer</li> <li>Heat and mass transfer single particle/ fixed bed</li> <li>Mass transfer and chemical reactions</li> </ul> </li> </ol>					
Literature	<ol> <li>H.D. Baehr und K. Stephan: Wärme- und Stoffübertragung, Springer</li> <li>VDI-Wärmeatlas</li> </ol>					

Course L0102: Heat and Mass Transfer					
Тур	ecitation 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 Mass Transfer					
Тур	lecitation 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			
Particle Technology I (L0434)					Lecture	2	3			
Particle Technology I (L0435)					Recitation Section (small) Practical Course	1	1 2			
Particle Technology I (L0440)	Prof. Stefan H	lainviala			Practical Course	Z	Z			
Module Responsible Admission Requirements	None	leinnch								
Recommended Previous	keine									
Knowledge	Kenne									
Educational Objectives										
Professional Competence										
-	After successful completion of the module students are able to									
landineage										
	<ul> <li>name and explain processes and unit-operations of solids process engineering,</li> </ul>									
	<ul> <li>characterize particles, particle distributions and to discuss their bulk properties</li> </ul>									
Skills	Students are a	Students are able to								
	<ul> <li>choose and design apparatuses and processes for solids processing according to the desired solids properties of the produ</li> </ul>									
	<ul> <li>asses solids with respect to their behavior in solids processing steps</li> </ul>									
	document their work scientifically.									
Personal Competence	The standards		he diaman anti-akii ka							
Social Competence	The students are able to discuss scientific topics orally with other students or scientific personal and to develop solutions									
Autonomy	technical-scientific issues in a group. Students are able to analyze and solve questions regarding solid particles independently.									
Autonomy	Students are a		laryze and solve question	is regarding solid p	barticles independently.					
Workload in Hours	Independent S	Study Tim	ne 110, Study Time in Le	cture 70						
Credit points	6									
Course achievement	Compulsory Bo		Form	Description	(mar ) (converse sin Device t) )	5 10 Calibar				
		one	Written elaboration	secns Berichte	(pro Versuch ein Bericht) à	5-10 Seiten				
Examination	Written exam									
Examination duration and scale	90 minutes									
Assignment for the	Conorol Engin	ooring C	cionco (Cormon program	7 comostor), En	ciplication Croon Technolog	aios Focus Mato	r and Environment			
Following Curricula										
Tonowing curricula	Engineering: Elective Compulsory General Engineering Science (German program, 7 semester): Specialisation Bioprocess Engineering: Compulsory									
	General Engineering Science (German program, 7 semester): Specialisation Process Engineering: 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									
	Energy and Environmental Engineering: Core Qualification: Elective Compulsory									
	Green Technologies: Energy, Water, Climate: Specialisation Water: Elective Compulsory									
	I		ore Qualification: Compu							

Course L0434: Particle Techr	nology 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	<ul> <li>Description of particles and particle distributions</li> <li>Description of a separation process</li> <li>Description of a particle mixture</li> <li>Particle size reduction</li> <li>Agglomeration, particle size enlargement</li> <li>Storage and flow of bulk solids</li> <li>Basics of fluid/particle flows</li> <li>classifying processes</li> <li>Separation of particles from fluids</li> <li>Basic fluid mechanics of fluidized beds</li> <li>Pneumatic and hydraulic transport</li> </ul>
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.

Course L0435: Particle Tech	Course L0435: Particle Technology I	
Тур	Recitation Section (small)	
Hrs/wk	1	
CP	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	

Course L0440: Particle Tech	nology I
Тур	Practical Course
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Prof. Stefan Heinrich
Language	DE/EN
Cycle	SoSe
Content	<ul> <li>Sieving</li> <li>Bulk properties</li> <li>Size reduction</li> <li>Mixing</li> <li>Gas cyclone</li> <li>Blaine-test, filtration</li> <li>Sedimentation</li> </ul>
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.

Courses						
Title				Тур	Hrs/wk	СР
Process and Plant Engineering I (L0095)			Lecture	2	4	
Process and Plant Engineering I (L0096)		I	Recitation Section (large)	1	1	
Process and Plant Engineering I (L1	214)			Recitation Section (small)	1	1
Module Responsible	Prof. Mirko Skiborows	Prof. Mirko Skiborowski				
Admission Requirements	None					
Recommended Previous	unit operation of ther	mal an dmechanical sep	aration processes			
Knowledge	chemical reactor eing	ineering				
Educational Objectives	After taking part succ	essfully, students have r	eached the following	g learning results		
Professional Competence						
Knowledge	students can:					
	classify and formulate	e blobal balance equation	ns of chemical proce	esses		
	specify linear compor	ent equations of comple	ex chemical processe	25		
	explain linear regression and data reconcilliation problems					
	explain pfd-diagrams					
Skills	students are capable of					
	- formulation of mass and energy balance equations and estimation of product streams					
	- estimation of compo	onent streams of chemica	al plants using linear	component balance model	S	
	- solution of data reco	oncilliation tasks				
	- conduction of process synthesis					
	- economic evaluatior	n of processes and the es	stimation of producti	ion costs		
Personal Competence						
Social Competence						
Autonomy						
Workload in Hours	Independent Study Ti	me 124, Study Time in L	ecture 56			
Credit points	6					
Course achievement	Compulsory Bonus Yes 10 %	Form Subject theoretical	Description			
	Yes 10 %	practical work	and			
Examination	Written exam	practical work				
Examination duration and		as and books				
scale	120 Mill. lectures not					
	General Engineering	Science (German program	m, 7 semester): Spe	cialisation Bioprocess Engin	eering: Compulso	ory
				cialisation Process Engineer		,
-				cialisation Chemical and Bio	• • •	npulsory
		ng: Core Qualification: Co				-
	Chemical and Bioproc	ess Engineering: Core Q	ualification: Compul	sory		
	Green Technologies: I	Energy, Water, Climate:	Specialisation Biores	ource Technology: Elective	Compulsory	
	Process Engineering:	Core Qualification: Comp	oulsory			

Course L0095: Process and P	lant Engineering I
Тур	Lecture
Hrs/wk	2
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
	I

	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)
	4. Process safety 5. Cost estimation of production plants
	Production costs, capital costs, economic evaluation
Literature	S.D. Barnicki, J.R. Fair, Ind. End. Chem., 29(1990), S. 421, Ind. End. Chem., 31(1992), S. 1679
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	D. Hairston, Chemical Engineering, October 2001, S. 31-37
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	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 F	ourse L1214: Process and Plant Engineering I		
Тур	Recitation Section (small)		
Hrs/wk	1		
СР	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

Тур	Hrs/wk	СР	
Lecture	3	4	
Recitation Section (small)	2	2	
he following learning results			
Students are able to explain the basic methods for calculating electrical circuits. They know the Fourier series analysis of line			
•			
haviour and the synthesis of passive tw	o-terminal-circui	ts.	
in line		- les cols en alchara les	
		-	
	5		
and to synthesize the nequency	, benaviour of p		
oups. They are encouraged to present	and discuss the	eir results within the	
s for solving the given practice probler	ns. Possibilities a	re given to test thei	
vledge to other courses like Electrical E	ingineering I and	Mathematics I.	
0			
-			
semester): Specialisation Mechanica	al Engineering,	Focus Mechatronics	
ester): Specialisation Electrical Enginee	ering: Compulsor	ý	
	- Engineering	Focus Mochatronia	
semester): Specialisation Mechanica	in Engineering,	rocus mechatronics	
II Mathematics & Engineering Science	e Elective Comp	Ilsory	
Engineering Science	. Licenve compt		
ener, Elective Compulsory			
	Lecture Recitation Section (small) the following learning results alculating electrical circuits. They know methods for transient analysis of lineat haviour and the synthesis of passive tw ages in linear networks by means of n electrical circuits in time and frequent alyse and to synthesize the frequency bups. They are encouraged to present s for solving the given practice probler ans of short-time tests. This allows in wedge to other courses like Electrical E 0 0 semester): Specialisation Mechanica nester): Specialisation Electrical Engineet ing: Compulsory semester): Specialisation Mechanica in II. Mathematics & Engineering Science	Lecture       3         Recitation Section (small)       2         the following learning results         alculating electrical circuits. They know the Fourier sermethods for transient analysis of linear networks in the haviour and the synthesis of passive two-terminal-circuit         ages in linear networks by means of basic methods, n electrical circuits in time and frequency domain and a alyse and to synthesize the frequency behaviour of p         bups. They are encouraged to present and discuss the analysis of short-time tests. This allows them to control wledge to other courses like Electrical Engineering I and         0         semester): Specialisation Mechanical Engineering, integer ing: Specialisation Electrical Engineering: Compulsor	

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	/
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
	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			
<b>Recommended Previous</b>	Basic knowledge in electrical engineering			
Knowledge				
Educational Objectives	After taking part successfully, students have reached th	e 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 following topics:   Introduction  Complete the production  Complete the pr			
	<ul> <li>Combinational logic: Gates, Boolean algebra, Boolean functions, hardware synthesis, combinational networks</li> <li>Sequential logic: Flip-flops, automata, systematic hardware design</li> <li>Technological foundations</li> <li>Computer arithmetic: Integer addition, subtraction, multiplication and division</li> <li>Basics of computer architecture: Programming models, MIPS single-cycle architecture, pipelining</li> <li>Memories: Memory hierarchies, SRAM, DRAM, caches</li> <li>Input/output: I/O from the perspective of the CPU, principles of passing data, point-to-point connections, busses</li> </ul>			
Skills	The students perceive computer systems from the archi composition of computer systems. The students can and collection of few and simple components. They are abl today's computing systems - from gates and circuits up After successful completion of the module, the studen system and the software executed on it. In particular, t on the hardware-centric abstraction layers from the ass the impact that these low abstraction levels have on an	alyze, how highly specific and individu e to distinguish between and to expl to complete processors. ts are able to judge the interdepend hey shall understand the consequence embly language down to gates. This	al computers car ain the different a encies between a es that the execu way, they will be	h be built based of abstraction layers a physical compu- tion of software h enabled to evalua
Personal Competence				
	Students are able to solve similar problems alone or in a	aroup and to present the results acc	ordinaly	
Social Competence	Students are able to solve similar problems alone of in a	I group and to present the results acc	bruingry.	
Autonomy	Students are able to acquire new knowledge from specif	ic literature and to associate this kno	wledge with othe	classes.
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56			
Credit points				
Course achievement		iption		
	Yes 10 % Excercises			
Examination	Written exam			
Examination duration and	90 minutes, contents of course and labs			
scale				
Assignment for the		ster): Specialisation Computer Science	e: Compulsory	
Following Curricula				
	General Engineering Science (German program, 7 seme			
	General Engineering Science (German program, 7	semester): Specialisation Mechanica	l Engineering, F	ocus Mechatroni
	Compulsory	weater) Constitution Machanical		Alizza fit. Country
	General Engineering Science (German program, 7 se	mester): Specialisation Mechanical	Engineering, Foc	us Aircraft Syste
	Engineering: Compulsory General Engineering Science (German program, 7 seme	stor): Specialisation Mechanical Engli	ooring Focus Th	oorotical Mochani
	Engineering: Compulsory	ster). Specialisation Meenamear Engi	leening, rocus m	
	General Engineering Science (German program, 7	semester): Specialisation Mechanic	al Engineering,	Focus Materials
	Engineering Sciences: Compulsory			
	Engineering Sciences: Compulsory General Engineering Science (German program, 7 semi	ester): Specialisation Mechanical Eng	ineering, Focus P	
		ester): Specialisation Mechanical Eng	ineering, Focus P	
	General Engineering Science (German program, 7 sem and Production: Compulsory General Engineering Science (German program, 7 se			roduct Developme
	General Engineering Science (German program, 7 sem and Production: Compulsory General Engineering Science (German program, 7 se Compulsory	mester): Specialisation Mechanical I	Engineering, Foc	roduct Developme us Energy System
	General Engineering Science (German program, 7 sem and Production: Compulsory General Engineering Science (German program, 7 se Compulsory General Engineering Science (German program, 7 se	mester): Specialisation Mechanical I	Engineering, Foc	roduct Developm us Energy Syster
	General Engineering Science (German program, 7 sem and Production: Compulsory General Engineering Science (German program, 7 se Compulsory	mester): Specialisation Mechanical I semester): Specialisation Mechanica ster): Specialisation Naval Architectur ster): Specialisation Biomedical Engin ster): Specialisation Bioprocess Engine ster): Specialisation Electrical Engine	Engineering, Focu I Engineering, F e: Compulsory eering: Compulso ering: Compulsory	roduct Developm us Energy Syster ocus Biomechani ry ry
	General Engineering Science (German program, 7 sem and Production: Compulsory General Engineering Science (German program, 7 se Compulsory General Engineering Science (German program, 7 se Compulsory General Engineering Science (German program, 7 seme General Engineering Science (German program, 7 seme	mester): Specialisation Mechanical I semester): Specialisation Mechanica ster): Specialisation Naval Architectur ster): Specialisation Biomedical Engin ster): Specialisation Bioprocess Engine ster): Specialisation Electrical Engine	Engineering, Focu I Engineering, F e: Compulsory eering: Compulso ering: Compulsory	roduct Developm us Energy Syster ocus Biomechani ry ry
	General Engineering Science (German program, 7 sem and Production: Compulsory General Engineering Science (German program, 7 se Compulsory General Engineering Science (German program, 7 se Compulsory General Engineering Science (German program, 7 seme General Engineering Science (German program, 7 seme	mester): Specialisation Mechanical I semester): Specialisation Mechanica ster): Specialisation Naval Architectur ster): Specialisation Biomedical Engin ster): Specialisation Bioprocess Engine ster): Specialisation Electrical Engine	Engineering, Focu I Engineering, F e: Compulsory eering: Compulso ering: Compulsory	roduct Developm us Energy Syster ocus Biomechani ry ry
	General Engineering Science (German program, 7 sem and Production: Compulsory General Engineering Science (German program, 7 se Compulsory General Engineering Science (German program, 7 se Compulsory General Engineering Science (German program, 7 seme General Engineering Science (German program, 7 seme Compulsory	mester): Specialisation Mechanical I semester): Specialisation Mechanica ster): Specialisation Naval Architectur ster): Specialisation Biomedical Engin ster): Specialisation Bioprocess Engine ster): Specialisation Electrical Engine	Engineering, Focu I Engineering, F e: Compulsory eering: Compulso ering: Compulsory	roduct Developm us Energy Syster ocus Biomechani ry ry
	General Engineering Science (German program, 7 sem- and Production: Compulsory General Engineering Science (German program, 7 se Compulsory General Engineering Science (German program, 7 se Compulsory General Engineering Science (German program, 7 seme General Engineering Science (German program, 7 seme Compulsory Computer Science: Core Qualification: Compulsory Data Science: Core Qualification: Elective Compulsory Electrical Engineering: Core Qualification: Compulsory General Engineering Science (English program, 7 semes	mester): Specialisation Mechanical I semester): Specialisation Mechanica ster): Specialisation Naval Architectur ster): Specialisation Bioprocess Engin ster): Specialisation Bioprocess Engin ster): Specialisation Green Technologi ster): Specialisation Green Technologi	Engineering, Focu I Engineering, F e: Compulsory eering: Compulso ering: Compulsory es, Focus Renewa Compulsory	roduct Developm us Energy Syster ocus Biomechani ry ry able Energy: Elect
	General Engineering Science (German program, 7 sem and Production: Compulsory General Engineering Science (German program, 7 se Compulsory General Engineering Science (German program, 7 se Compulsory General Engineering Science (German program, 7 seme General Engineering Science (German program, 7 seme Compulsory Computer Science: Core Qualification: Compulsory Electrical Engineering: Core Qualification: Compulsory	mester): Specialisation Mechanical I semester): Specialisation Mechanica ster): Specialisation Naval Architectur ster): Specialisation Bioprocess Engin ster): Specialisation Bioprocess Engin ster): Specialisation Green Technologi ster): Specialisation Green Technologi	Engineering, Focu I Engineering, F e: Compulsory eering: Compulso ering: Compulsory es, Focus Renewa Compulsory	roduct Developm us Energy Syster ocus Biomechani ry ry able Energy: Elect

Engineering: Compulsory
General Engineering Science (English program, 7 semester): Specialisation Mechanical Engineering, Focus Materials in Engineering
Sciences: Compulsory
General Engineering Science (English program, 7 semester): Specialisation Mechanical Engineering, Focus Mechatronics:
Compulsory
General Engineering Science (English program, 7 semester): Specialisation Mechanical Engineering, Focus Product Development
and Production: Compulsory
General Engineering Science (English program, 7 semester): Specialisation Mechanical Engineering, Focus Theoretical Mechanical
Engineering: Compulsory
Computational Science and Engineering: Core Qualification: Compulsory
Mechatronics: Core Qualification: Compulsory
Technomathematics: Specialisation II. Informatics: Elective Compulsory

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

Course L0324: Computer Eng	ourse 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	: Time-Independent Fields (L0180)	Lecture	3	5
Theoretical Electrical Engineering I	: Time-Independent Fields (L0181)	Recitation Section (small)	2	1
Module Responsible	Prof. Christian Schuster			
Admission Requirements	None			
<b>Recommended Previous</b>	Basic principles of electrical engineering and ad	vanced mathematics		
Knowledge				
Educational Objectives	After taking part successfully, students have rea	ached the following learning results		
Professional Competence				
Knowledge	Students can explain the fundamental formulas They can explicate the principal behavior of a sources. They can describe the properties of a fields. The students are aware of applications for these.	electrostatic, magnetostatic, and current de complex electromagnetic fields by means o	ensity fields with f superposition of	regard to respecti f solutions for simp
Skills	Students can apply Maxwell's Equations in electromagnetic field problems. Furthermore, 1 Equations for more general problems. The stude analyze these quantitatively. They can deduce electrical flow fields (capacitances, inductances	they are capable of applying a variety of ments can assess the principal effects of given meaningful quantities for the characterization	nethods that requ time-independent on of electrostatic	ire solving Maxwel t sources of fields a , magnetostatic, ar
Personal Competence Social Competence	Students are able to work together on subject r during exercise sessions).	elated tasks in small groups. They are able t	to present their re	esults effectively (e
Autonomy	Students are capable to gather necessary inform able to continually reflect their knowledge by m lectures and exercises that are related to the ex- learning process. They are able to draw conne- lectures (e.g. Electrical Engineering I, Linear Alg	eans of activities that accompany the lecture kam. Based on respective feedback, students actions between their knowledge obtained in	e, such as short of are expected to a	ral quizzes during t adjust their individu
Workload in Hours	Independent Study Time 110, Study Time in Lee	cture 70		
Credit points	6			
Course achievement	None			
Examination	Written exam			
Examination duration and scale	90-150 minutes			
Assignment for the	General Engineering Science (German program	, 7 semester): Specialisation Electrical Engine	eering: Compulsor	У
Following Curricula	Electrical Engineering: Core Qualification: Comp		•	
	Computational Science and Engineering: Specia	lisation II. Mathematics & Engineering Science	e: Elective Comp	ulsory
	Technomathematics: Specialisation III. Engineer	ring Science: Elective Compulsory		

Typ	Lecture
Hrs/wk	
СР	
Workload in Hours	Independent Study Time 108, Study Time in Lecture 42
Lecturer	Prof. Christian Schuster
Language	DE
Cycle	
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 usi 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	rse 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 Materials in Electrical Engineering (		Lecture Lecture	2	1 3
Materials in Electrical Engineering (		Recitation Section (small)	2	2
Module Responsible	Prof. Manfred Eich			
Admission Requirements	None			
<b>Recommended Previous</b>	Highschool level physics and mathematics			
Knowledge				
Educational Objectives	After taking part successfully, students hav	ve reached the following learning results		
Professional Competence				
-	Students can explain the composition and the structural properties of materials used in electrical engineering. Students of explicate the relevance of mechanical, electrical, thermal, dielectric, magnetic and chemical properties of materials in view of the applications in electrical engineering.			
SkillS		tive models and apply them mathematically. Th nance of materials in electrical engineering applic		roximative solutio
Personal Competence				
Social Competence	Students can jointly solve subject related p problem solving course.	roblems in groups. They can present their results	; 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 in	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		

Course L0714: Electrotechnic	cal Experiments
Тур	Lecture
Hrs/wk	1
CP	1
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14
Lecturer	Dr. Wieland Hingst
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
	1

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	ilectrical 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	<ul> <li>Atom structure and periodic system</li> <li>Atom binding and crystal structure</li> <li>Structure and properties of alloys: diffusion, phase diagrams, phase separation and grain boundaries</li> <li>Material properties: Mechanical, thermal, electrical, dielectric properties</li> <li>Metals</li> <li>Semiconductors</li> <li>Ceramics and glasses</li> <li>Polymers</li> <li>Magnetic materials</li> <li>Electrochemistry Oxidation numbers, electrolysis, batteries, fuel cells</li> </ul>
Literature	H. Schaumburg: Einführung in die Werkstoffe der Elektrotechnik, Teubner (1993)

Module M0854: Math	ematics IV			
Courses				
Title		Тур	Hrs/wk	СР
Differential Equations 2 (Partial Dif	erential Equations) (11043)	Lecture	2	1
Differential Equations 2 (Partial Dif		Recitation Section (small)	1	1
Differential Equations 2 (Partial Dif	-	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
	Drof Anucch Toroz			
Module Responsible				
Admission Requirements	None			
<b>Recommended Previous</b>	Mathematics 1 - III			
Knowledge				
Educational Objectives	After taking part successfully, students have reached the f	ollowing learning results		
Professional Competence		5 5		
-				
Knowledge	<ul> <li>Students can name the basic concepts in Mathemat</li> </ul>	ics IV. They are able to explain the	m using appropri	ate examples.
	<ul> <li>Students can discuss logical connections between t</li> </ul>			
	the help of examples.			
	<ul> <li>They know proof strategies and can reproduce them</li> </ul>			
Skills				
	<ul> <li>Students can model problems in Mathematics IV w</li> </ul>		ed in this course	. Moreover, they a
	capable of solving them by applying established me	thods.		
	<ul> <li>Students are able to discover and verify further logical</li> </ul>	cal connections between the conce	pts studied in the	e course.
	<ul> <li>For a given problem, the students can develop ar</li> </ul>	nd execute a suitable approach, a	nd are able to c	ritically evaluate t
	results.			
Personal Competence				
Social Competence				
	<ul> <li>Students are able to work together in teams. They a</li> </ul>			
	<ul> <li>In doing so, they can communicate new concepts a</li> </ul>	ccording to the needs of their coop	perating partners	. Moreover, they c
	design examples to check and deepen the understa	nding of their peers.		
Autonomv				
Autonomy	<ul> <li>Students are capable of checking their understandi</li> </ul>	ng of complex concepts on their o	wn. They can sp	ecify open questic
	precisely and know where to get help in solving the	m.		
	• Students have developed sufficient persistence to	be able to work for longer period	s in a goal-orien	ted manner on ha
	problems.	5	<u>.</u>	
	problems.			
Workload in Hours Credit points	Independent Study Time 68, Study Time in Lecture 112			
Course achievement				
	Written exam			
	60 min (Complex Functions) + 60 min (Differential Equatio	ns 2)		
scale		- 1		
Assignment for the	General Engineering Science (German program, 7 semeste	er): Specialisation Electrical Enginee	ering: Compulson	V
-	General Engineering Science (German program, 7 seriesce			-
. Snowing curricula			Engineering, I	. Jeas meenau Ull
	Compulsory			
	General Engineering Science (German program, 7 semeste		1	
	General Engineering Science (German program, 7 semeste	er): Specialisation Mechanical Engir	neering, Focus Th	neoretical Mechani
	Engineering: Elective Compulsory			
	Computer Science: Specialisation Computational Mathema	tics: Elective Compulsory		
	Electrical Engineering: Core Qualification: Compulsory			
	General Engineering Science (English program, 7 semester	r): Specialisation Electrical Engineer	rina: Compulsory	
	General Engineering Science (English program, 7 seriester			
	General Engineering Science (English program, 7 sen	nester). Specialisation Mechanica	in Engineering, I	ocus Mecharioni
	Compulsory			a sucht and the state of
	Compulsory General Engineering Science (English program, 7 semeste	er): Specialisation Mechanical Engir	neering, Focus Th	leoretical Mechan
		er): Specialisation Mechanical Engir	ieering, Focus Th	ieoretical Mechan
	General Engineering Science (English program, 7 semeste		-	
	General Engineering Science (English program, 7 semeste Engineering: Compulsory Computational Science and Engineering: Specialisation II. I	Mathematics & Engineering Science	-	
	General Engineering Science (English program, 7 semeste Engineering: Compulsory Computational Science and Engineering: Specialisation II. I Mechanical Engineering: Specialisation Mechatronics: Com	Mathematics & Engineering Science	e: Elective Compu	
	General Engineering Science (English program, 7 semeste Engineering: Compulsory Computational Science and Engineering: Specialisation II. I Mechanical Engineering: Specialisation Mechatronics: Com Mechanical Engineering: Specialisation Theoretical Mechar	Mathematics & Engineering Science	e: Elective Compu	
	General Engineering Science (English program, 7 semeste Engineering: Compulsory Computational Science and Engineering: Specialisation II. I Mechanical Engineering: Specialisation Mechatronics: Com Mechanical Engineering: Specialisation Theoretical Mechar Mechatronics: Core Qualification: Compulsory	Mathematics & Engineering Science	e: Elective Compu	
	General Engineering Science (English program, 7 semeste Engineering: Compulsory Computational Science and Engineering: Specialisation II. I Mechanical Engineering: Specialisation Mechatronics: Com Mechanical Engineering: Specialisation Theoretical Mechar	Mathematics & Engineering Science	e: Elective Compu	

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	<ul> <li>Examples of partial differential equations</li> <li>First order quasilinear differential equations</li> <li>Normal forms of second order differential equations</li> <li>Harmonic functions and maximum principle</li> <li>Maximum principle for the heat equation</li> <li>Wave equation</li> <li>Liouville's formula</li> <li>Special functions</li> <li>Difference methods</li> <li>Finite elements</li> <li>http://www.math.uni-hamburg.de/teaching/export/tuhh/index.html</li> </ul>

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	
	<ul> <li>Functions of one complex variable</li> <li>Complex differentiation</li> <li>Conformal mappings</li> <li>Complex integration</li> <li>Cauchy's integral theorem</li> <li>Cauchy's integral formula</li> <li>Taylor and Laurent series expansion</li> <li>Singularities and residuals</li> <li>Integral transformations: Fourier and Laplace transformation</li> </ul>	
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		Torre	Line (suit	СР
Electrical Machines and Actuators	(1.0293)	<b>Typ</b> Lecture	Hrs/wk 3	4
Electrical Machines and Actuators		Recitation Section (large)	2	2
Module Responsible	Prof. Thorsten Kern			
Admission Requirements	None			
<b>Recommended Previous</b>	Basics of mathematics, in particular complex	ke numbers, integrals, differentials		
Knowledge				
	Basics of electrical engineering and mechan	ical engineering		
Educational Objectives	After taking part successfully, students have	reached the following learning results		
Professional Competence				
Knowledge	Students can to draw and explain the basic	principles of electric and magnetic fields.		
	They can describe the function of the st	andard types of electric machines and pres	ent the correspon	ding equations a
	characteristic curves. For typically used driv	es they can explain the major parameters of the	e energy efficiency	of the whole syste
	from the power grid to the driven engine.			
Skills	Students are able to calculate two dimension	anal electric and magnetic fields in particular f	orromognotic circu	uite with air gap
SKIIIS	this they apply the usual methods of the des	onal electric and magnetic fields in particular f sign auf electric machines	erromagnetic circt	uits with all gap. r
		nce of electric machines from their given char	acteristic data and	d selected quantit
	and characteristic curves. They apply the us	ual equivalent circuits and graphical methods.		
Personal Competence				
Social Competence			- -	
Autonomy	Students are able independently to calculate electric and magnatic fields for applications. They are able to analyse independently			
	the operational performance of electric machines from the charactersitic data and theycan calculate thereof selected quantities and characteristic curves.			
	and characteristic curves.			
Workload in Hours	Independent Study Time 110, Study Time in	Lecture 70		
Credit points	6			
Course achievement	None			
Examination	Subject theoretical and practical work			
Examination duration and	Design of four machines and actuators, review	ew of design files		
scale				
		am, 7 semester): Specialisation Electrical Engine		
Following Curricula		gram, 7 semester): Specialisation Mechanical	Engineering, Foc	us Energy System
	Compulsory	ogram 7 comostor). Enocialization Machani	al Engineering	Focus Machatrania
	Compulsory	ogram, 7 semester): Specialisation Mechanic	ai Engineering, i	Focus Mechacionic
		am, 7 semester): Specialisation Mechanical Eng	ineering. Focus Th	eoretical Mechanic
	Engineering: Elective Compulsory		5,	
	Digital Mechanical Engineering: Core Qualifi	cation: Compulsory		
	Electrical Engineering: Core Qualification: Electrical	ective Compulsory		
	Energy and Environmental Engineering: Core	e Qualification: Compulsory		
	General Engineering Science (English progra	am, 7 semester): Specialisation Mechanical Engi	neering: Elective C	ompulsory
		: Specialisation Energy Technology: Elective Cor	mpulsory	
	Logistics and Mobility: Specialisation Engine			
	Logistics and Mobility: Specialisation Traffic		ulcon	
		tion Management and Processes: Elective Comp	шьогу	
	Mechanical Engineering: Core Qualification: Mechatronics: Core Qualification: Compulsor			
	Technomathematics: Specialisation III. Engin	•		
		istics and Mobility: Specialisation Traffic Plannin	g and Systems: Fle	ective Compulsory
	Engineering and Management - Major in Lu			
		byistics and mobility. Specialisation Froduction	management and	TIOCESSES. LICCU

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		Тур	Hrs/wk	CP	
	nas, and Electromagnetic Compatibility (L1669) nas, and Electromagnetic Compatibility (L1877)	Lecture Recitation Section (small)	3 2	4 2	
	Prof. Christian Schuster	Recitation Section (smail)	2	2	
Admission Requirements	None				
Recommended Previous	Basic principles of physics and electrical engineering				
Knowledge	basic principles of physics and electrical engineering				
Educational Objectives	After taking part successfully, students have reached th	e following learning results			
Professional Competence	Arter taking part successiony, students have reached th	e following learning results			
Knowledge	Students can explain the basic principles, relationship Electromagnetic Compatibility. Specific topics are: - Fundamental properties and phenomena of electrical of - Steady-state sinusoidal analysis of electrical circuits - Fundamental properties and phenomena of electroma	ircuits	veguides and an	tennas as well as	
	<ul> <li>Steady-state sinusoidal description of electromagnetic fields and waves</li> <li>Useful microwave network parameters</li> </ul>				
	<ul> <li>Transmission lines and basic results from transmissior</li> <li>Plane wave propagation, superposition, reflection and</li> <li>General theory of waveguides</li> <li>Most important types of waveguides and their propert</li> <li>Radiation and basic antenna parameters</li> </ul>	refraction			
	<ul> <li>Most important types of antenna parameters</li> <li>Numerical techniques and CAD tools for waveguide an</li> <li>Fundamentals of Electromagnetic Compatibility</li> <li>Coupling mechanisms and countermeasures</li> <li>Shielding, grounding, filtering</li> </ul>	d antenna design			
	- Standards and regulations - EMC measurement techniques				
Skills	Students know how to apply various methods and more able to assess and qualify their basic electromagne Electromagnetic Compatibility to the development of electromagnetic for the development of electromagnetic fo	tic properties. They can apply resu			
Personal Competence					
Social Competence	Students are able to work together on subject related English (e.g. during small group exercises).	tasks in small groups. They are able	to present their	results effectively	
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 content other lectures (e.g. theory of electromagnetic fields, fundamentals of electrical engineering / physics). They can discuss techning problems and physical effects in English.				
Workload in Hours	Independent Study Time 110, Study Time in Lecture 70				
Credit points	6				
Course achievement	None				
Examination	Oral exam				
Examination duration and	45 min				
scale					
Assignment for the Following Curricula	Electrical Engineering: Core Qualification: Elective Com	pulsory	ering: Elective Co	mpulsory	
	Aircraft Systems Engineering: Core Qualification: Electiv Mechatronics: Specialisation System Design: Elective Co				

Тур	Lecture			
Hrs/wk	3			
CP	4			
Workload in Hours	Independent Study Time 78, Study Time in Lecture 42			
Lecturer	Prof. Christian Schuster			
Language				
Cycle	SoSe			
-	<ul> <li>This course is intended as an introduction to the topics of wave propagation, guiding, sending, and receiving as well</li> <li>Electromagnetic Compatibility (EMC). It will be useful for engineers that face the technical challenge of transmitting high frequen</li> <li>/ 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.</li> <li>Topics: <ul> <li>Fundamental properties and phenomena of electrical circuits</li> <li>Steady-state sinusoidal analysis of electrical circuits</li> <li>Fundamental properties and phenomena of electromagnetic fields and waves</li> <li>Steady-state sinusoidal description of electromagnetic fields and waves</li> <li>Useful microwave network parameters</li> <li>Transmission lines and basic results from transmission line theory</li> <li>Plane wave propagation, superposition, reflection and refraction</li> <li>General theory of waveguides</li> <li>Most important types of waveguides and their properties</li> <li>Radiation and basic antenna parameters</li> <li>Stundental techniques and CAD tools for waveguide and antenna design</li> <li>Fundamentals of Electromagnetic Compatibility</li> <li>Coupling mechanisms and countermeasures</li> <li>Shielding, grounding, filtering</li> <li>Standards and regulations</li> <li>EMC measurement techniques</li> </ul> </li> </ul>			
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 to Waveguides, Antennas, and Electromagnetic Compatibility		
Тур	Recitation Section (small)	
Hrs/wk	2	
СР	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	

Module M1235: Electr	ical Power Systems I: Introduction	to Electrical Power Systems	5		
Courses					
Title		Тур	Hrs/wk	СР	
-	Electrical Power Systems I: Introduction to Electrical Power Systems (L1670)		3	4	
Electrical Power Systems I: Introduc	tion to Electrical Power Systems (L1671)	Recitation Section (small)	2	2	
Module Responsible	Prof. Christian Becker				
Admission Requirements	None				
<b>Recommended Previous</b>	Fundamentals of Electrical Engineering				
Knowledge					
Educational Objectives	After taking part successfully, students have reache	ed the following learning results			
Professional Competence					
Knowledge	Students are able to give an overview of convention	nal and modern electric power systems.	They can explain i	n detail and critically	
	evaluate technologies of electric power generation,	transmission, storage, and distribution a	s well as integrati	on of equipment into	
	electric power systems.				
Skille	With completion of this module the students are	able to apply the acquired skills in ar	polications of the	docian integration	
Skiiis	With completion of this module the students are able to apply the acquired skills in applications of the design, integration development of electric power systems and to assess the results.				
	development of electric power systems and to assess the results.				
Personal Competence					
Social Competence	The students can participate in specialized and inte	rdisciplinary discussions, advance ideas a	and represent thei	r own work results in	
	front of others.				
Autonomy	Students can independently tap knowledge of the e	mphasis of the lectures.			
Workload in Hours	Independent Study Time 110, Study Time in Lectur	e 70			
Credit points	6				
Course achievement					
Examination					
Examination duration and					
scale					
Assignment for the	General Engineering Science (German program, 7 s	emester): Specialisation Electrical Engine	erina: Elective Co	mpulsory	
Following Curricula					
	Compulsory			- 5,	
	Data Science: Core Qualification: Elective Compulso	pry			
	Electrical Engineering: Core Qualification: Elective (	Compulsory			
	Energy Systems: Specialisation Energy Systems: El	ective Compulsory			
	Engineering Science: Specialisation Electrical Engin	eering: Elective Compulsory			
	Green Technologies: Energy, Water, Climate: Speci	alisation Energy Systems: Elective Compu	lsory		
	Computer Science in Engineering: Specialisation II.	Mathematics & Engineering Science: Elec	tive Compulsory		
	Integrated Building Technology: Core Qualification:	Compulsory			
	Renewable Energies: Core Qualification: Compulsor	У			
	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	<ul> <li>fundamentals and current development trends in electric power engineering</li> </ul>
	tasks and history of electric power systems
	symmetric three-phase systems
	fundamentals and modelling of eletric power systems
	◦ lines
	• transformers
	<ul> <li>synchronous machines</li> </ul>
	<ul> <li>induction machines</li> </ul>
	<ul> <li>loads and compensation</li> </ul>
	<ul> <li>grid structures and substations</li> </ul>
	fundamentals of energy conversion
	<ul> <li>electro-mechanical energy conversion</li> </ul>
	<ul> <li>thermodynamics</li> </ul>
	<ul> <li>power station technology</li> </ul>
	<ul> <li>renewable energy conversion systems</li> </ul>
	<ul> <li>steady-state network calculation</li> </ul>
	<ul> <li>network modelling</li> </ul>
	<ul> <li>load flow calculation</li> </ul>
	• (n-1)-criterion
	<ul> <li>symmetric failure calculations, short-circuit power</li> </ul>
	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
	<ul> <li>fundamentals and modelling of eletric power systems</li> </ul>
	◦ lines
	• transformers
	<ul> <li>synchronous machines</li> </ul>
	<ul> <li>induction machines</li> </ul>
	<ul> <li>loads and compensation</li> </ul>
	<ul> <li>grid structures and substations</li> </ul>
	fundamentals of energy conversion
	<ul> <li>electro-mechanical energy conversion</li> </ul>
	• thermodynamics
	<ul> <li>power station technology</li> </ul>
	<ul> <li>renewable energy conversion systems</li> </ul>
	steady-state network calculation
	network modelling
	<ul> <li>load flow calculation</li> </ul>
	• (n-1)-criterion
	symmetric failure calculations, short-circuit power
	<ul> <li>control in networks and power stations</li> </ul>
	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

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 Schl	aefer				
Admission Requirements	None					
<b>Recommended Previous</b>	principles of mathem	natics				
Knowledge	principles of electrica	al engineering				
Educational Objectives	After taking part suc	cessfully, student	s have reached the follow	ving learning results		
Professional Competence						
	aspects of probabilit describe measured s		rs, and explain the proce	ssing of stochastic signals.	Students know meth	nods to digitalize an
Skills	The students are abl	le to evaluate prol	blems of metrology and to	o apply methods for describ	ing and processing	of measurements.
Personal Competence						
Social Competence	The students solve p	problems in small	groups.			
Autonomy	The students can ref	flect their knowled	dge and discuss and evalu	uate their results.		
Workload in Hours	Indonondont Study T	Time 110 Study T	imo in Locturo 70			
		Time 110, Study I	Inte in Lecture 70			
Credit points Course achievement	o Compulsory Bonus	Form	Description			
course achievement	Yes 10 %	Excercises	Description			
Examination						
Examination duration and	90 min					
scale	50 1111					
	General Engineering	Science (German	nrogram 7 semester). S	pecialisation Electrical Engi	neering: Elective Co	mpulsory
Following Curricula				pectation Electrical Engl	Licente Co	
ronowing carricula	-	-	ectrical Engineering: Elec	tive Compulsory		
			Qualification: Elective Co			
	megratea banding i					

Course L0781: EE Experimen	tal Lab
Тур	Practical Course
Hrs/wk	2
СР	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	Course 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				
Title		Tun	Hac fords	СР
Theoretical Electrical Engineering I	I. Time-Dependent Fields (I 0182)	<b>Typ</b> Lecture	Hrs/wk 3	5
Theoretical Electrical Engineering I	-	Recitation Section (small)	2	1
	Prof. Christian Schuster			
Admission Requirements				
Recommended Previous	Electrical Engineering I, Electrical Engineering	II, Theoretical Electrical Engineering I		
Knowledge	Mathematics I, Mathematics II, Mathematics III,	Mathematics IV		
Educational Objectives	After taking part successfully, students have re	eached the following learning results		
Professional Competence		5 5		
Knowledge	Students are able to explain fundamental	formulas, relations, and methods related	to the theory	of time-depende
	electromagnetic fields. They can assess the pr regard to respective sources. They can descr solutions for simple fields. The students are av able to explicate these.	ibe the properties of complex electromagneti	ic fields by mean	s of superposition
Skills	s Students are able to apply a variety of procedures in order to solve the diffusion and the wave equation for general time-dependent field problems. They can assess the principal effects of given time-dependent sources of fields and analyze these quantitative They can deduce meaningful quantities for the characterization of fully dynamic fields (wave impedance, skin depth, Poyntin vector, radiation resistance, etc.) from given fields and interpret them with regard to practical applications.			
Personal Competence Social Competence	Students are able to work together on subject	related tasks in small groups. They are able t	o present their re	sults effectively (e
	during exercise sessions).			
Autonomy	Students are capable to gather necessary information from provided references and relate this information to the lecture. The able to continually reflect their knowledge by means of activities that accompany the lecture, such as short oral quizzes durin lectures and exercises that are related to the exam. Based on respective feedback, students are expected to adjust their individering process. They are able to draw connections between acquired knowledge and ongoing research at the Han University of Technology (TUHH), e.g. in the area of high frequency engineering and optics.		ral quizzes during th adjust their individu	
Weddeed to Decor	Indexeduct Charles Time 110, Charles Time in La	-t <b>7</b> 0		
	Independent Study Time 110, Study Time in Le	clure /0		
Credit points				
Course achievement				
Examination				
Examination duration and scale	90-150 minutes			
Assignment for the	General Engineering Science (German program	7 semester): Specialisation Electrical Engine	ering: Compulsor	M.
Following Curricula			ening. compuisor	у
ronowing curricula	5 5 .			
	Engineering Science: Specialisation Electrical E			
	Engineering Science: Specialisation Mechatron			
	Engineering Science: Specialisation Mechatron	1 5		
	Technomathematics: Specialisation III. Enginee	ring Science: 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 El	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		

Module M0675: Introd	luction to Communications a	nd Random Processes		
Courses				
Title		Тур	Hrs/wk	СР
Introduction to Communications an	d Random Processes (L0442)	Lecture	3	4
Introduction to Communications an	d Random Processes (L0443)	Recitation Section (large)	1	1
Introduction to Communications an	d Random Processes (L2354)	Recitation Section (small)	1	1
Module Responsible	Prof. Gerhard Bauch			
Admission Requirements	None			
<b>Recommended Previous</b>	Mathematics 1.2			
Knowledge	Mathematics 1-3			
	<ul> <li>Signals and Systems</li> </ul>			
Educational Objectives	After taking part successfully, students have	ve reached the following learning results		
Professional Competence				
Knowledge	The students know and understand the fu	ndamental building blocks of a communications sy	stem. They can d	describe and analy
	the individual building blocks using knowle	edge of signal and system theory as well as the th	eory of stochasti	c processes. The a
	aware of the essential resources and eval	luation criteria of information transmission and are	able to design a	and evaluate a bas
	communications system.			
	The students are familiar with the contents of lecture and tutorials. They can explain and apply them to new problems.			
Skille				
SKIIIS	The students are able to design and evaluate a basic communications system. In particular, they can estimate the requ resources in terms of bandwidth and power. They are able to assess essential evaluation parameters of a basic communicati			
		error rate and to decide for a suitable transmission		
Devenuel Commetence	system such as bandwidth eniciency of bit	error rate and to decide for a suitable transmission	i metnoa.	
Personal Competence	The students can isintly salve energies are	blong		
Social Competence	The students can jointly solve specific pro	blems.		
Autonomy	The students are able to acquire releva	ant information from appropriate literature source	ces. They can c	ontrol their level
	knowledge during the lecture period by sol	lving tutorial problems, software tools, clicker syste	m.	
Workload in Hours	Independent Study Time 110, Study Time i	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 pro	gram, 7 semester): Specialisation Electrical Enginee	ering: Compulsor	/
-	Data Science: Core Qualification: Elective O			
5	Data Science: Specialisation I. Mathematic			
	Electrical Engineering: Core Qualification: 0			
	Computer Science in Engineering: Core Qu			
	, <u></u> ,			

	o Communications and Random Processes			
	Lecture			
Hrs/wk	3			
CP	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			
	<ul> <li>Analog and digital signals</li> <li>Description of Analog to digital (A/D) conversion</li> </ul>			
	<ul> <li>Principles of Analog-to-digital (A/D) conversion</li> <li>Deterministic and random signals</li> </ul>			
	Power and energy of signals			
	Linear time-invariant (LTI) systems     Our distance simplified can distribute (CANN)			
	Quadrature amplitude modulation (QAM)			
	Introduction to stochastics			
	Probability theory			
	Random experiments			
	Probability model, probability space, sample space     Definitions of each shifting			
	Definitions of probability			
	Probability according to Bernoulli/Laplace			
	<ul> <li>Probability according to van Mises, relative frequency</li> </ul>			
	<ul> <li>Bertrand's paradox</li> </ul>			
	Axiomatic definition of probability according to Kolmogorov			
	<ul> <li>Probability of disjoint and non-disjoint events</li> </ul>			
	Venn diagrams			
	<ul> <li>Continuous and discrete random variables</li> </ul>			

- 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
  - Discrete memoryless channels (DMC)
- Analog-to-digital conversion
  - Sampling
    - Sampling theorem
  - Pulse modulation
    - Pulse-amplitude modulation (PAM)
    - Pulse-duration modulation (PDM), pulse-width modulation (PWM)
    - Pulse-position modulation (PPM)
    - Pulse-code modulation (PCM)
  - Quantization
    - Linear quantizaton, midtread and midrise characteristic
    - Quantization error, quantization 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
    - SNR gain of DPCM over PCM

	<ul> <li>Delta modulation</li> <li>Europerately of information theory and coding</li> </ul>
	<ul> <li>Fundamentals of information theory and coding</li> <li>Definitions of information: Self-information, entropy</li> </ul>
	<ul> <li>Binary entropy function</li> </ul>
	Source coding theorem
	Source coding: Huffman code
	Mutual information and channel capacity
	<ul> <li>Channel capacity of the AWGN channel and the binary input AWGN channel</li> </ul>
	Channel coding theorem
	<ul> <li>Principles of channel coding: Code rate and data rate, Hamming distance, minimum Hamming distance, error</li> </ul>
	detection and error correction
	<ul> <li>Examples for channel codes: Block codes and convolutional codes, repetition code, single parity check code,</li> </ul>
	Hamming code, Turbo codes
	Combinatorics
	Variation with and without repetition
	<ul> <li>Combination with and without repetition</li> </ul>
	<ul> <li>Permutation, Permutation of multisets</li> </ul>
	Word error probabilities of linear block codes
	Baseband transmission
	<ul> <li>Pulse shaping: Non-return to zero (NRZ) rectangular pulses, Manchester pulses, raised-cosine pulses, square-root</li> </ul>
	raised-cosine pulses, Gaussian pulses
	<ul> <li>Transmit signal energy, average energy per symbol</li> </ul>
	<ul> <li>Power spectral density (psd) of baseband signals</li> </ul>
	<ul> <li>Definitions of signal bandwidth</li> </ul>
	Bandwidth efficiency
	<ul> <li>Intersymbol interference (ISI)</li> </ul>
	<ul> <li>First and second Nyquist criterion</li> </ul>
	Eye patterns
	Receive filter design: Matched filter
	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
	<ul> <li>Linear digital modulation methods: On-off keying (OOK), phase-shift keying (PSK), amplitude shift keying (ASK),</li> </ul>
	quadrature amplitude shift keying (QAM)
	•
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.
	J. S. Froukis, M. Saleni, G. Buden, Contemporary Communication Systems. Cenyage Learning.
	1

ourse L0443: Introduction to Communications and Random Processes		
Тур	Recitation Section (large)	
Hrs/wk	1	
CP	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	
Language	DE/EN	
Cycle	WiSe	
Content	See interlocking course	
Literature	See interlocking course	

Courses						
Title			Тур		Hrs/wk	СР
Electronic Devices (L0720) Electronic Devices (L0721)			Lectu		3 2	4 2
	Prof. Hoc Khiem Trieu		Projec	ct-/problem-based Learning	Z	Z
Module Responsible Admission Requirements	None					
Recommended Previous						
Knowledge						
	Successful participation of Physics for Engineers and Materials in Electrical Engineering or courses with equivalent contents				ent contents	
Educational Objectives	After taking part successful	ly, students have re	eached the following lea	rning results		
Professional Competence						
Knowledge						
	Students are able					
	<ul> <li>to represent the basis</li> </ul>	ics of semiconducto	r physics,			
	<ul> <li>to explain the operation</li> </ul>	ing principle of imp	ortant semiconductor d	evices,		
	<ul> <li>to outline device cha</li> </ul>	racteristics and equ	uivalent circuits as well a	as to explain their derivation	on and	
	<ul> <li>to discuss the limitat</li> </ul>	ion of device mode	IS.			
Skills						
	Students are capable					
	<ul> <li>to apply devices in b</li> </ul>	asic circuits,				
	<ul> <li>to realize the physical</li> </ul>	al context and to so	lve complex problems b	v oneself		
				,		
Personal Competence						
Social Competence	Students are able to prepare and perform their lab experiments in team work as well as to present and discuss the results in from					
	of audience.					
Autonomy	Students are capable to acquire knowledge based on literature in order to prepare their experiments.					
Workload in Hours	Independent Study Time 110, Study Time in Lecture 70					
Credit points						
Course achievement	Compulsory Bonus Form Yes 10 % Sub		Description	oiton in Kloingruppon Wig	on zu einem	bostimmton Thom
		ject theoretical		eiten in Kleingruppen Wis eses in Form eines Ve		
	P. 23			er hinaus betreut jede G		
			inhaltlich zu dem je	weiligen Versuch gehört.		
Examination	Written exam					
Examination duration and	120 min					
scale						
	General Engineering Science			ation Electrical Engineering	g: Compulsory	1
Following Curricula	Electrical Engineering: Core Engineering Science: Speci			,		
	General Engineering Science. Speci-				: Compulsory	
	Computer Science in Engine			5 5	1 3	

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	<ul> <li>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)</li> <li>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)</li> <li>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)</li> <li>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; MESFET: 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)</li> </ul>
Literature	<ul> <li>S.M. Sze: Semiconductor devices, Physics and Technology, John Wiley &amp; Sons (1985)F. Thuselt: Physik der Halbleiterbauelemente, Springer (2011)</li> <li>T. Thille, D. Schmitt-Landsiedel: Mikroelektronik, Halbleiterbauelemente und deren Anwendung in elektronischen Schaltungen, Springer (2004)</li> <li>B.L. Anderson, R.L. Anderson: Fundamentals of Semiconductor Devices, McGraw-Hill (2005)</li> <li>D.A. Neamen: Semiconductor Physics and Devices, McGraw-Hill (2011)</li> <li>M. Shur: Introduction to Electronic Devices, John Wiley &amp; Sons (1996)</li> <li>S.M. Sze: Physics of semiconductor devices, John Wiley &amp; Sons (2007)</li> <li>H. Schaumburg: Halbleiter, B.G. Teubner (1991)</li> <li>A. Möschwitzer: Grundlagen der Halbleiter-&amp;Mikroelektronik, Bd1 Elektronische Halbleiterbauelemente, Carl Hanser (1992)</li> <li>HG. Unger, W. Schultz, G. Weinhausen: Elektronische Bauelemente und Netzwerke I, Physikalische Grundlagen der Halbleiterbauelemente, Vieweg (1985)</li> </ul>

Course L0721: Electronic Devices		
Тур	Project-/problem-based Learning	
Hrs/wk		
CP	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		Тур	Hrs/wk	СР
Semiconductor Circuit Design (L07)	53)	Lecture	3	4
Semiconductor Circuit Design (L08	54)	Recitation Section (small)	1	2
Module Responsible	Prof. Matthias Kuhl			
Admission Requirements	None			
<b>Recommended Previous</b>	Fundamentals of electrical engineering			
Knowledge				
	Basics of physics, especially semiconductor p	hysics		
Educational Objectives	After taking part successfully, students have	reached the following learning results		
Professional Competence				
Knowledge				
		onality of different MOS devices in electronic circ		
		og circuits functions and where they are applied.		225
		onality of fundamental operational amplifiers an I logic circuits and can discuss their advantages		
	-	bry circuits and can explain their functionality an	-	5.
	<ul> <li>Students have knowledge about mental</li> <li>Students know the appropriate fields f</li> </ul>		a specifications.	
Skills				
D.M.D	<ul> <li>Students can calculate the specification</li> </ul>	ns of different MOS devices and can define the p	parameters of elec	tronic circuits.
		logic circuits and can design different types of lo		
	<ul> <li>Students can use MOS devices, operat</li> </ul>	ional amplifiers and bipolar transistors for specif	ic applications.	
Personal Competence				
Social Competence	<ul> <li>Students are able work efficiently in here</li> </ul>	eterogeneous teams.		
		bups can solve problems and answer professiona	l questions.	
Autonomy				
	<ul> <li>Students are able to assess their level</li> </ul>	of knowledge.		
	Independent Study Time 124, Study Time in	Lecture 56		
Credit points				
Course achievement				
Examination				
Examination duration and scale	120 Min			
	Constal Engineering Science (Corman progra	m 7 competer): Specialization Electrical Engine	oring, Compulson	
-		Im, 7 semester): Specialisation Electrical Engine Ogram, 7 semester): Specialisation Mechanica		
ronowing curricula	Compulsory	grunn, 7 semester). Specialisation mechanica	in Engineering, i	ocus mechanor
	Data Science: Core Qualification: Elective Col	npulsory		
	Electrical Engineering: Core Qualification: Co			
	Engineering Science: Specialisation Electrical			
	Engineering Science: Specialisation Mechatro			
		n, 7 semester): Specialisation Electrical Enginee	ring: Compulsory	
		n, 7 semester): Specialisation Mechatronics: Cor		
	Computer Science in Engineering: Specialisat	ion II. Mathematics & Engineering Science: Elect	tive Compulsory	
	Mechanical Engineering: Specialisation Mech	atronics: Compulsory		
	Mechatronics: Core Qualification: Compulsory	/		
	Technomathematics: Specialisation III. Engine	eering Science: Elective Compulsory		

Course L0763: Semiconducto	or 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	<ul> <li>Repetition Semiconductorphysics and Diodes</li> <li>Functionality and characteristic curve of bipolar transistors</li> <li>Basic circuits with bipolar transistors</li> <li>Functionality and characteristic curve of MOS transistors</li> <li>Basic circuits with MOS transistors for amplifiers</li> <li>Operational amplifiers and their applications</li> <li>Typical applications for analog and digital circuits</li> <li>Realization of logical functions</li> <li>Basic circuits with MOS transistors for combinational logic</li> <li>Memory circuits</li> <li>Basic circuits with MOS transistors for sequential logic</li> <li>Basic concepts of analog-to-digital and digital-to-analog-converters</li> </ul>
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: 047170055S 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	<ul> <li>Basic circuits and characteristic curves of bipolar transistors</li> <li>Basic circuits and characteristic curves of MOS transistors for amplifiers</li> <li>Realization and dimensioning of operational amplifiers</li> <li>Realization of logic functions</li> <li>Basic circuits with MOS transistors for combinational and sequential logic</li> <li>Memory circuits</li> <li>Circuits for analog-to-digital and digital-to-analog converters</li> <li>Design of exemplary circuits</li> </ul>
Literature	<ul> <li>U. Tietze und Ch. Schenk, E. Gamm, Halbleiterschaltungstechnik, Springer Verlag, 14. Auflage, 2012, ISBN 3540428496</li> <li>R. J. Baker, CMOS - Circuit Design, Layout and Simulation, J. Wiley &amp; Sons Inc., 3. Auflage, 2011, ISBN: 0471700555</li> <li>H. Göbel, Einführung in die Halbleiter-Schaltungstechnik, Berlin, Heidelberg Springer-Verlag Berlin Heidelberg, 2011, ISBN: 9783642208874 ISBN: 9783642208874</li> <li>URL: http://site.ebrary.com/lib/alltitles/docDetail.action?docID=10499499</li> <li>URL: http://ebooks.ciando.com/book/index.cfm/bok_id/319955</li> <li>URL: http://www.ciando.com/img/bo</li> </ul>

Module M0734: Electr	ical Engineering Project Labor	atory			
Courses					
Title Electrical Engineering Project Labor	ratory (L0640)	<b>Typ</b> Projec	t-/problem-based Learning	Hrs/wk	<b>СР</b> 6
Module Responsible	Prof. Christian Becker				
Admission Requirements	None				
Recommended Previous	Electrical Engineering I, Electrical Engineerin	ig II			
Knowledge					
Educational Objectives	After taking part successfully, students have	reached the following lear	rning results		
Professional Competence					
Knowledge	Students are able to give a summary of				
	respective relationships. They are capable				
	technical language. They can explain the typ	pical process of solving pra	ctical problems and prese	nt related resul	ts.
Chille	The students can brancfer their fundament	al knowladza an alastrias	I anaineering to the succ	ee of column	avertical problems
SKIIIS	The students can transfer their fundament They identify and overcome typical problem				
	able to develop, compare, and choose conce		-	icectrical engine	sening. Statents are
Personal Competence					
Social Competence	Students are able to cooperate in small, mix	ked-subject groups in orde	r to independently derive	solutions to giv	en problems in the
	context of electrical engineering. They are	able to effectively presen	t and explain their result	s alone or in g	roups in front of a
	qualified audience. Students have the a			electrical en	gineering problem
	independently or in groups and discuss adva	intages as well as drawbac	ks.		
Autonomy	Students are capable of independently solvi	na electrical engineering r	problems using provided li	torature They	are able to fill gans
Autonomy	in as well as extent their knowledge using				
	meaningfully extend given problems and pra				
Workload in Hours	Independent Study Time 68, Study Time in L	ecture 112			
Credit points	6				
Course achievement	None				
	Subject theoretical and practical work				
Examination duration and	based on task + presentation				
scale					
Assignment for the	General Engineering Science (German progr		ation Electrical Engineerin	g: Compulsory	
Following Curricula					
	Engineering Science: Specialisation Electrica				
	Engineering Science: Specialisation Electrica Technomathematics: Specialisation III. Engir	5 5			
L	recimonationation and specialisation III. Engli	leening Science, Elective C			

Course L0640: Electrical Eng	ineering Project Laboratory
Тур	Project-/problem-based Learning
Hrs/wk	8
CP	6
Workload in Hours	Independent Study Time 68, Study Time in Lecture 112
Lecturer	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	n Technologies I			
Courses				
Title		Тур	Hrs/wk	СР
Introduction to Green Technologies	; (L2727)	Seminar	2	2
Meteorology and Climate Systems	- Introduction (L2726)	Lecture	2	2
Meteorology and Climate Systems	- Introduction (L2829)	Recitation Section (	small) 2	2
Module Responsible	Prof. Martin Kaltschmitt			
Admission Requirements	None			
<b>Recommended Previous</b>	none			
Knowledge				
Educational Objectives	After taking part successfully, students have re	eached the following learning results		
Professional Competence				
Knowledge	Upon completion of this module, students w	ill be able to describe and critically	v evaluate current enviro	nmental and climate
	problems, especially in Hamburg. Furthermore	e, they are able to find and process s	uitable approaches to sol	utions. The students
	can compare learned technologies in the field and defend it in discussions.	d of climate and environmental prote	ection, develop and take a	a standpoint on then
	In addition, students can give an overview of t	he basics of meterology and climate.		
Skills	The students are able to apply the knowledge and climate-friendly water, energy and climate		-	-
	Furthermore, the students are able to explain to renewable energy projects in the context of		bics of climate and metero	logy and apply them
Personal Competence				
Social Competence	Students can			
	<ul> <li>work together in a team of about 3-5 per</li> </ul>	anla		
	<ul> <li>discuss tasks on the topics of environm solutions,</li> <li>present their own work results to fellow</li> <li>assess the performance of fellow stude performance.</li> </ul>	ental, resource and climate protection students and		
Autonomy	The students are able to independently acc respective learning status in consultation v necessary to solve them.			
Workload in Hours	Independent Study Time 96, Study Time in Leo	cture 84		
Credit points	6			
	Computerny Bonus Form	Description		
Course achievement	CompulsoryBonusFormYes20 %Presentation	Description		
Framination	Written exam			
Examination duration and				
Examination duration and scale				
	Conoral Engineering Science (Cormon arcora	7 competer): Specialization Cross	Tochnologios: Compulsary	
Assignment for the	General Engineering Science (German program Green Technologies: Energy, Water, Climate: (		echnologies. Compuisory	
Following Curricula	Green reciniologies. Energy, water, climate: C			
Course L2727: Introduction t	o Green Technologies			
	-			
Тур	Seminar			
Hrs/wk	2			
СР	2			
Workload in Hours		cture 28		
Lecturer				
Language				
Cycle	WiSe			
Content	Preliminary discussion of the seminar			

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.

Тур	and Climate Systems - Introduction
Hrs/wk	
CP	
	Independent Study Time 32, Study Time in Lecture 28
	Prof. Martin Kaltschmitt, Prof. Dr. Felix Ament, Prof. Dr. Stefan Bühler
Language	
Cycle	
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
	Water vapour, temperature gradient, ice albedo, cioluos 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	

Course L2829: Meteorology a	Ind 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. Martin Kaltschmitt, Prof. Dr. Felix Ament, Prof. Dr. Stefan Bühler
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, paralle
	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	

Courses					
Title			Тур	Hrs/wk	СР
Practical Course Measurement Technology (L2270)		Practical Course	2	2	
Measurement Technology (L2268)		Lecture	2	2	
Physical Fundamentals of Measurement Technology (L2269)			Lecture	2	2
Module Responsible	Prof. Alexander Penn				
Admission Requirements	None				
Recommended Previous Knowledge					
Educational Objectives	After taking part su	uccessfully, students ha	ve reached the following learning results		
Professional Competence	1				
Knowledge	-		ics (theory of motion), rotation of rigid boo operature and heat, ideal gas.	lies, energy and mo	omentum, electrici
			easurement uncertainty, basics of sensor tec vel measurement, flow measurement. Usage of		nciples, temperatu
			calorimetry, image data acquisition, flow meas of solid concentrations, spectroscopy, error calo		
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	tical training and learning groups, assessmer tion with persons responsible for teaching,		-
Autonomy	Time management of the workload, independent development of the thematic basics, personal responsibility 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	Independent Study	/ Time 96, Study Time ir	n Lecture 84		
	6				
Credit points					
Credit points Course achievement		Form	Description Popup Quizzos währen der Verlegung		
Course achievement	No 20 %	Form Excercises	Description Popup-Quizzes währen der Vorlesung		
Course achievement Examination	No 20 % Written exam				
Course achievement Examination Examination duration and	No20 %Written exam120 min				
Course achievement Examination Examination duration and scale	No 20 % Written exam 120 min	Excercises	Popup-Quizzes währen der Vorlesung		
Course achievement Examination Examination duration and scale Assignment for the	No     20 %       Written exam       120 min       General Engineerin	Excercises	Popup-Quizzes währen der Vorlesung gram, 7 semester): Specialisation Process Engi	neering: Compulsory	
Course achievement Examination Examination duration and scale	No     20 %       Written exam       120 min       General Engineerin       General Engineerin	Excercises ng Science (German pro ng Science (German pro	Popup-Quizzes währen der Vorlesung gram, 7 semester): Specialisation Process Engi gram, 7 semester): Specialisation Process Engi	neering: Compulsory neering: Compulsory	
Course achievement Examination Examination duration and scale Assignment for the	No     20 %       Written exam       120 min       General Engineerin       General Engineerin       General Engineerin	Excercises ng Science (German pro ng Science (German pro ng Science (German pro	Popup-Quizzes währen der Vorlesung gram, 7 semester): Specialisation Process Engi gram, 7 semester): Specialisation Process Engi gram, 7 semester): Specialisation Bioprocess E	ineering: Compulsory ineering: Compulsory ingineering: Compulso	
Course achievement Examination Examination duration and scale Assignment for the	No     20 %       Written exam       120 min       General Engineerin       General Engineerin       General Engineerin       General Engineerin       General Engineerin	Excercises ng Science (German pro ng Science (German pro ng Science (German pro ng Science (German pro ng Science (German pro	Popup-Quizzes währen der Vorlesung gram, 7 semester): Specialisation Process Engi gram, 7 semester): Specialisation Process Engi gram, 7 semester): Specialisation Bioprocess E gram, 7 semester): Specialisation Green Techr	ineering: Compulsory ineering: Compulsory ingineering: Compulso	
Course achievement Examination Examination duration and scale Assignment for the	No     20 %       Written exam       120 min       General Engineerin       General Engineerin       General Engineerin       General Engineerin       General Engineerin       Bioprocess Engineerin	Excercises ng Science (German pro ng Science (German pro ng Science (German pro ng Science (German pro ering: Core Qualification	Popup-Quizzes währen der Vorlesung gram, 7 semester): Specialisation Process Engi gram, 7 semester): Specialisation Process Engi gram, 7 semester): Specialisation Bioprocess E gram, 7 semester): Specialisation Green Techr h: Compulsory	ineering: Compulsory ineering: Compulsory ingineering: Compulso iologies: Compulsory	
Course achievement Examination Examination duration and scale Assignment for the	No     20 %       Written exam     120 min       General Engineerin	Excercises ng Science (German pro ng Science (German pro ng Science (German pro ng Science (German pro ering: Core Qualification ng Science (English prog	Popup-Quizzes währen der Vorlesung gram, 7 semester): Specialisation Process Engi gram, 7 semester): Specialisation Process Engi gram, 7 semester): Specialisation Bioprocess E gram, 7 semester): Specialisation Green Techr 1: Compulsory gram, 7 semester): Specialisation Process Engir	ineering: Compulsory ineering: Compulsory ingineering: Compulso iologies: Compulsory	
Course achievement Examination Examination duration and scale Assignment for the	No         20 %           Written exam         120 min           General Engineerin         General Engineerin           General Engineerin         General Engineerin	Excercises ng Science (German pro ng Science (German pro ng Science (German pro ng Science (German pro ering: Core Qualification ng Science (English prog	Popup-Quizzes währen der Vorlesung gram, 7 semester): Specialisation Process Engi gram, 7 semester): Specialisation Process Engi gram, 7 semester): Specialisation Bioprocess E gram, 7 semester): Specialisation Green Techr 1: Compulsory gram, 7 semester): Specialisation Process Engir te: Core Qualification: Compulsory	ineering: Compulsory ineering: Compulsory ingineering: Compulso iologies: 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
Content	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
	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.
	<ul> <li>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&amp;scope=site&amp;db=nlebk&amp;AN=1081958.</li> <li>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.</li> <li>Strohrmann, Günther (2004): Messtechnik im Chemiebetrieb. Einführung in das Messen verfahrenstechnischer Größen. 10., durchges. Aufl. München: Oldenbourg.</li> <li>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.</li> <li>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.</li> </ul>

Course L2269: Physical Fund	ourse 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		
Literature		

Courses				
Title		Тур	Hrs/wk	СР
Fundamentals of Fluid Mechanics (L0091)		Lecture	2	4
Fluid Mechanics for Process Engine		Recitation Section (large)	2	2
Module Responsible				
Admission Requirements	None			
Recommended Previous	Mathematics I+II+III			
Knowledge	Technical Mechanics I+II			
	<ul> <li>Technical Thermodynamics I+II</li> </ul>			
	<ul> <li>Working with force balances</li> </ul>			
	<ul> <li>Simplification and solving of partial differential</li> </ul>	equations		
	Integration			
Educational Objectives	After taking part successfully, students have reached	the following learning results		
Professional Competence				
Knowledge	Students are able to:			
		- 6 6		
	<ul> <li>explain the difference between different types</li> <li>give an overview for different applications of the second secon</li></ul>		ss opginooring	
	<ul> <li>explain simplifications of the Continuity- and N</li> </ul>			ions
			Soundary contain	
Skills	The students are able to			
	<ul> <li>describe and model incompressible flows math</li> </ul>	ematically		
	<ul> <li>reduce the governing equations of fluid mecha</li> </ul>	nics by simplifications to archive quantit	tative solutions e	.g. by integration
	<ul> <li>notice the dependency between theory and ter</li> </ul>	chnical applications		
	<ul> <li>use the learned basics for fluid dynamical appl</li> </ul>	ications in fields of process engineering		
Personal Competence				
Social Competence	The students			
	<ul> <li>are capable to gather information from subject</li> </ul>	t related, professional publications and	relate that inforr	nation to the conte
	of the lecture and • able to work together on subject related tasks	in small groups. They are able to pres	ent their results	effectively in Engli
	(e.g. during small group exercises)	in small groups. They are able to pres	ent then results	enectively in Engli
	<ul> <li>are able to work out solutions for exercises by</li> </ul>	themselves, to discuss the solutions ora	lly and to presen	t the results.
Autonomy	The students are able to			
	<ul> <li>search further literature for each topic and to e</li> </ul>	expand their knowledge with this literatu	ire,	
	<ul> <li>work on their exercises by their own and to evaluate the evaluation of the evaluation of</li></ul>	aluate their actual knowledge with the fe	eedback.	
Workload in Hours	Independent Study Time 124, Study Time in Lecture !	56		
Credit points				
Course achievement		scription		
	Yes 5 % Midterm			
Examination	Written exam			
Examination duration and	3 hours			
scale				
÷	General Engineering Science (German program, 7 ser			
Following Curricula	General Engineering Science (German program, 7 ser General Engineering Science (German program, 7 ser			y ic
	Bioprocess Engineering: Core Qualification: Compulso		ies. compuisory	
	Energy and Environmental Engineering: Core Qualific			
	Green Technologies: Energy, Water, Climate: Core Quante			
	Logistics and Mobility: Specialisation Traffic Planning			
	Technomathematics: Specialisation III. Engineering So			
	Process Engineering: Core Qualification: Compulsory			
	Engineering and Management - Major in Logistics and	Mobility: Specialisation Traffic Planning	and Systems: El	ective Compulsory

urse L0091: Fundamentals	s of Fluid Mechanics
Тур	Lecture
Hrs/wk	2
CP	4
Workload in Hours	Independent Study Time 92, Study Time in Lecture 28
Lecturer	Prof. Michael Schlüter
Language	DE
Cycle	SoSe
Content	<ul> <li>fluid properties</li> <li>hydrostatic</li> <li>overall balances - theory of streamline</li> <li>overall balances- conservation equations</li> <li>differential balances - Navier Stokes equations</li> <li>irrotational flows - Potenzialströmungen</li> <li>flow around bodies - theory of physical similarity</li> <li>turbulent flows</li> <li>compressible flows</li> </ul>
Literature	<ol> <li>Crowe, C. T.: Engineering fluid mechanics. Wiley, New York, 2009.</li> <li>Durst, F.: Strömungsmechanik: Einführung in die Theorie der Strömungen von Fluiden. Springer-Verlag, Berlin, Heidelberg, 2006.</li> <li>Fox, R.W.; et al.: Introduction to Fluid Mechanics. J. Wiley &amp; Sons, 1994</li> <li>Herwig, H.: Strömungsmechanik: Eine Einführung in die Physik und die mathematische Modellierung von Strömungen. Springer Verlag, Berlin, Heidelberg, New York, 2006</li> <li>Herwig, H.: Strömungsmechanik: Einführung in die Physik von technischen Strömungen: Vieweg+Teubner Verlag / GWV Fachverlage GmbH, Wiesbaden, 2008</li> <li>Kuhlmann, H.C.: Strömungsmechanik. München, Pearson Studium, 2007</li> <li>Oertl, H.: Strömungsmechanik: Grundlagen, Grundgleichungen, Lösungsmethoden, Softwarebeispiele. Vieweg+ Teubner Verlag / GWV Fachverlage GmbH, Wiesbaden, 2009</li> <li>Schade, H.; Kunz, E.: Strömungslehre. Verlag de Gruyter, Berlin, New York, 2007</li> <li>Truckenbrodt, E.: Fluidmechanik 1: Grundlagen und elementare Strömungsvorgänge dichtebeständiger Fluide. Springer-Verlag, Berlin, Heidelberg, 2008</li> <li>Schlichting, H.: Grenzschicht-Theorie. Springer-Verlag, Berlin, 2006</li> <li>van Dyke, M.: An Album of Fluid Motion. The Parabolic Press, Stanford California, 1882.</li> <li>White, F.: Fluid Mechanics, Mcgraw-Hill, ISBN-10: 0071311211, ISBN-13: 978-0071311212, 2011</li> </ol>

Course L0092: Fluid Mechani	ics for Process Engineering
Тур	Recitation Section (large)
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 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	<ol> <li>Crowe, C. T.: Engineering fluid mechanics. Wiley, New York, 2009.</li> <li>Durst, F.: Strömungsmechanik: Einführung in die Theorie der Strömungen von Fluiden. Springer-Verlag, Berlin, Heidelberg, 2006.</li> <li>Fox, R.W.; et al.: Introduction to Fluid Mechanics. J. Wiley &amp; Sons, 1994</li> <li>Herwig, H.: Strömungsmechanik: Eine Einführung in die Physik und die mathematische Modellierung von Strömungen. Springer Verlag, Berlin, Heidelberg, New York, 2006</li> <li>Herwig, H.: Strömungsmechanik: Einführung in die Physik von technischen Strömungen: Vieweg+Teubner Verlag / GWV Fachverlage GmbH, Wiesbaden, 2008</li> <li>Kuhlmann, H.C.: Strömungsmechanik. Grundgleichungen, Lösungsmethoden, Softwarebeispiele. Vieweg+ Teubner Verlag / GWV Fachverlage GmbH, Wiesbaden, 2009</li> <li>Schade, H.; Kunz, E.: Strömungslehre. Verlag de Gruyter, Berlin, New York, 2007</li> <li>Truckenbrodt, E.: Fluidmechanik 1: Grundlagen und elementare Strömungsvorgänge dichtebeständiger Fluide. Springer-Verlag, Berlin, Heidelberg, 2008</li> <li>Schlichting, H.: Grenzschicht-Theorie. Springer-Verlag, Berlin, 2006</li> <li>van Dyke, M.: An Album of Fluid Motion. The Parabolic Press, Stanford California, 1882.</li> <li>White, F.: Fluid Mechanics, Mcgraw-Hill, ISBN-10: 0071311211, ISBN-13: 978-0071311212, 2011</li> </ol>

	ary Engineering I			
Courses				
Title		Тур	Hrs/wk	СР
Wastewater Disposal (L0276)		Lecture	2	2
Wastewater 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				
Admission Requirements	None			
<b>Recommended Previous</b>	<ul> <li>Basic knowledge on Chemistry and Biolog</li> </ul>			
Knowledge	<ul> <li>Hydraulics of pipe systems and open char</li> </ul>			
	<ul> <li>Basic knowledge on water management:</li> </ul>			
	<ul> <li>Basic knowledge on Environmental Legisl</li> </ul>	ation. Federal Water Act		
Educational Objectives	After taking part successfully, students have rea	ached the following learning results		
<b>Professional Competence</b>				
Knowledge	The students can examplify their expert knowle	edge on urban water infrastructures. They o	an present the de	erivation and detail
	explanation of important standards for the desig	gn of drinking water supply and wastewater	disposal systems	in Germany and th
	are capable of reproducing the relevant empiric	als assumptions and scientific simplifcation	s. The students ar	e able to present a
	discuss sanitary engineering processes and the	e technologies used for drinking and waste	water treatment.	They can also asse
	existing problems in the field of sanitary engine	ering by considering legal, risk and saftey a	spects. Furthermo	re, they know how
	draft the features and effectiveness of importa	nt technologies of the future such as high	- and low-pressure	e membrane filtrati
	systems and techniques for the removal of trace	e pollutants.		
Skills	The students are able to apply the relevant sta	indards and guidelines for the design and g	peration of urban	water infrastructur
2 miles	independently. Their expertise comprises expert			
	associated treatment facilities. Besides the acqu			
	problems in the filed of drinking water and wa			
	improve the existing water related infrastructure		uble to develop	lacas of their own
	improve the existing water related initiastrated	es, systems and concepts.		
Personal Competence				
-	Social skills are not targeted in this module.			
Autonomy	Students are able to form concepts on their or	wn to optimize urban water infrastructure	processes. Theref	ore they can acqu
	appropriate knowledge when being given some	e clues or information with regard to the a	pproach to proble	ems (preparation a
	follow-up of the exercises).			
Workload in Hours	Independent Study Time 96, Study Time in Lect	ure 84		
Credit points				
Course achievement				
Examination	Written exam			
Examination duration and				
scale	Conoral Engineering Science (Corman program	7 semester): Specialisation Civil Engineerin	a: Elective Compu	lsorv
		, semester, specialisation civil Engliteerin	g. License compu	
Assignment for the		7 semester): Specialisation Green Technolo	aies: Compulsory	
Assignment for the	General Engineering Science (German program,		gies: Compulsory	
Assignment for the	General Engineering Science (German program, Civil- and Environmental Engineering: Core Qual	lification: Compulsory	gies: Compulsory	
Assignment for the	General Engineering Science (German program,	lification: Compulsory lification: Compulsory	5 1 5	sorv

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
	<ul> <li>Mechanical treatment (Screens, Grit chamber, Preliminary Sedimentation, Secondary Settlement Tanks, Membra Filtration)</li> </ul>
	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.
	<ul> <li>Taschenbuch der Stadtentwässerung : mit 10 Tafeln und 67 Tabellen, Imhoff, K., &amp; . (2009). (31., verbesserte Aufl München: Oldenbourg Industrieverl.</li> </ul>
	<ul> <li>Abwasser : Technik und Kontrolle. Neitzel, Volkmar, and Weinheim [u.a.]: Wiley-VCH, 1998.</li> </ul>
	<ul> <li>Kommunale Kläranlagen : Bemessung, Erweiterung, Optimierung, Betrieb und Kosten, (2009). Günthert, F. Wolfgang: völlig neu bearb. Aufl.). Renningen: expert-Verl.</li> </ul>
	<ul> <li>Water and wastewater technology Hammer, M. J. 1., &amp; . (2012). (7. ed., internat. ed.). Boston [u.a.]: Pearson Educat International.</li> </ul>
	<ul> <li>Water and wastewater engineering : design principles and practice: Davis, M. L. 1. (2011) New York, NY: McGraw-Hill.</li> <li>Biological wastewater treatment: (2011). C. P. Leslie Grady, Jr. (3. ed.). London, Boca Raton, Fla. [u.a.]: IWA Publ.</li> </ul>

Course L0278: Wastewater D	Course L0278: Wastewater Disposal	
Тур	Recitation Section (large)	
Hrs/wk	1	
СР	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	

Course L0306: Drinking Wate	er Supply
Тур	Lecture
Hrs/wk	2
CP	1
Workload in Hours	Independent Study Time 2, Study Time in Lecture 28
Lecturer	Dr. Klaus Johannsen, Prof. Mathias Ernst
Language	DE
Cycle	SoSe
Content	The lecture on drinking water supply provides students with a basic understanding of the entire water supply system, encompassing water catchment, water treatment including pump systems, water storage, and the distribution system that carries water to the consumer.
	Initially, basics in hydraulics and pump systems are presented (system curve and pump curve). Students learn how the duty point of the pump is determined. Students learn about different water resources and will be able to design groundwater wells. Students learn how to determine water demand and derive planning values for designing the different elements of a water supply system (e.g. firefighting requirements). The functions of reservoirs, their design and arrangement in the water supply system are explained. Students will be able to design simple water distribution systems.
	A further part of the lecture deals with the processes involved in drinking water supply. This includes a presentation of the essential mechanisms and layout parameters for sedimentation, filtration, coagulation, membrane treatment, adsorption, water softening, gas exchange, ion exchange and disinfection. The basics of process treatment technology will be built on with parallel analysis of the impacts on chemical and physical water quality parameters.
Literature	Gujer, Willi (2007): Siedlungswasserwirtschaft. 3., bearb. Aufl., Springer-Verlag. Karger, R., Cord-Landwehr, K., Hoffmann, F. (2005): Wasserversorgung. 12., vollst. überarb. Aufl., Teubner Verlag
	Rautenberg, J. et al. (2014): Mutschmann/Stimmelmayr Taschenbuch der Wasserversorgung. 16. Aufl., Springer-Vieweg Verlag. DVGW Lehr- und Handbuch Wasserversorgung: Wasseraufbereitung - Grundlagen und Verfahren, m. CD-ROM: Band 6 (2003).

ourse L0308: Drinking Water 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

determine geochemical parameters and to assess the potential of pollu work out well founded opinions on how Environmental Technology contr and defend these opinons in front of and against the group. The students are able to select a suitable method for the respective cas can develop suitable solutions for managing and mitigating environment out Life Cycle Impact Assessments independently and can apply the so			
Practical Exercise Environmental Technology (L1387)         Practical Exercise Environmental Technology (L1387)         Practical Exercise Environmental Technology (L1387)         Lecture           Pollutari analysis (L2996)         Lecture         Lecture           Environmental Technologie (L0326)         Lecture           Module Responsible         Dr. Marvin Scherzinger         Admission Requirements         None           Recommended Previous         Fundamentals of inorganic/organic chemistry and biology.         Knowledge           Educational Objectives         After taking part successfully, students have reached the following learni           Professional Competence         Knowledge         With the completion of this modul the students obtain profound knowledg the behaviour of chemicals in the environment. Students aca give an ov terms and allocate them to related methods.           Additional students acquire in-depth knowledge of important cause-effect occur from production processes, projects or construction measures. The are complexity of these environmental processes as well as used to estimate the complexity of these environmental rechnology contr and defermine geochemical parameters and to assess the potential of pollu work out well founded opinions on how Environmental Technology contr and defend these opinons in front of and against the group.           The students are able to select a suitable method for the respective cas can develop suitable solutions for managing and mitigating environment out Life Cycle Impact Assessments independently and can apply the so the future social responsolbilites in their role as engineers.			
Pollutant analysis (L2996)         Lecture           Module Responsible         Dr. Marvin Scherzinger         Lecture           Admission Requirements         None         Recommended Previous         Fundamentals of inorganic/organic chemistry and biology.           Knowledge         Educational Objectives         After taking part successfully, students have reached the following learni           Professional Competence         With the completion of this modul the students obtain profound knowledge the behaviour of chemicals in the environment. Students can give an ox terms and allocate them to related methods.           Additional students acquire in-depth knowledge of important cause-effec occur from production processes, projects or construction measures. The are competent in dealing with different methods and instruments to assis to estimate the complexity of these environmental processes as well as to estimate the complexity of these environmental rechnology contr and defend these opinons in front of and against the group.           The students are able to below so how Environmental Technology contr and defend these opinons in front of and against the group.           The students are able to discuss the various technical and scientific tasks to develop suitable solutions for managing and mitigating environmental out Life Cycle Impact Assessments independently and can apply the si a wareness of their future social responsibilities in their role as engineers.           Personal Competence         The students are able to discuss the various technical and scientific tasks to develop different approaches to the task as a group as well as to discus to develop different approaches to the tas		Hrs/wk	СР
Environmental Technologie (L0326)         Lecture           Module Responsible         Dr. Marvin Scherzinger           Admission Requirements         None           Recommended Previous         Fundamentals of inorganic/organic chemistry and biology. Knowledge           Educational Objectives         After taking part successfully, students have reached the following learni           Professional Competence         Knowledge           Knowledge         With the completion of this modul the students obtain profound knowledge the behaviour of chemicals in the environment. Students can give an ov terms and allocate them to related methods.           Additional students acquire in-depth knowledge of important cause-effect occur from production processes, projects or construction measures. The are competent in dealing with different methods and instruments to asset to estimate the complexity of these environmental processes as well as to skills           Skills         Students are able to propose appropriate management and mitigation determine geochemical parameters and to assess the potential of pollu work out well founded opinions on how Environmental Technology contr and defend these opinons in front of and against the group.           The students are able to select a suitable method for the respective cass can develop suitable solutions for managing and mitigating environment out Life Cycle Impact Assessments independently and can apply the sc After finishing the course the students have the competence to cri environmental impacts.           Personal Competence         The students are able to discuss the various technical and scientific tasks to devel	Course	1 2	1 3
Admission Requirements         None           Recommended Previous Knowledge         Fundamentals of inorganic/organic chemistry and biology.           Educational Objectives         After taking part successfully, students have reached the following learni           Professional Competence         With the completion of this modul the students obtain profound knowledge the behaviour of chemicals in the environment. Students can give an ow terms and allocate them to related methods.           Additional students acquire in-depth knowledge of important cause-effec occur from production processes, projects or construction measures. The are competent in dealing with different methods and instruments to assis to estimate the complexity of these environmental processes as well as to skills           Students are able to propose appropriate management and mitigation determine geochemical parameters and to assess the potential of pollu work out well founded opinions on how Environmental Technology contr and defend these opinons in front of and against the group.           The students are able to select a suitable method for the respective cas can develop suitable solutions for managing and mitigating environment out Life Cycle Impact Assessments independently and can apply the sis After finishing the course the students have the competence to cri environmental impacts.           Personal Competence         The students are able to discuss the various technical and scientific tasks to develop different approaches to the task as a group as well as to discus Due to the selected lecture topics, the students receive insights into the iconcept of sustainability. Their sensitivity and consciousness towards to awareness of their future social responsibilities in their role as eng		2	2
Recommended Previous Knowledge         Fundamentals of inorganic/organic chemistry and biology.           Educational Objectives         After taking part successfully, students have reached the following learni           Professional Competence         Knowledge           With the completion of this modul the students obtain profound knowledg the behaviour of chemicals in the environment. Students can give an ov terms and allocate them to related methods.           Additional students acquire in-depth knowledge of important cause-effec occur from production processes, projects or construction measures. The are competent in dealing with different methods and instruments to asses to estimate the complexity of these environmental processes as well as to skills           Students are able to propose appropriate management and mitigation determine geochemical parameters and to assess the potential of pollu work out well founded opinions on how Environmental Technology contr and defend these opinons in front of and against the group.           The students are able to select a suitable method for the respective cas can develop suitable solutions for managing and mitigating environment out Life Cycle Impact Assessments independently and can apply the st After finishing the course the students have the competence to cri environmental impacts.           Personal Competence         The students are able to discuss the various technical and scientific tasks to develop different approaches to the task as a group as well as to discus unverness of their future social responsibilities in their role as engineers.           Autonomy         The students learn to research, process and present a scientific topic scientific work. They can solve an environment			
Knowledge           Educational Objectives         After taking part successfully, students have reached the following learni           Professional Competence         Knowledge           Knowledge         With the completion of this modul the students obtain profound knowledg the behaviour of chemicals in the environment. Students can give an ox terms and allocate them to related methods.           Additional students acquire in-depth knowledge of important cause-effect occur from production processes, projects or construction measures. The are complexity of these environmental processes as well as to estimate the complexity of these environmental processes as well as to estimate the complexity of these environmental Technology contr and defend these opinons in front of and against the group.           The students are able to select a suitable method for the respective cas can develop suitable solutions for managing and mitigating environment out Life Cycle Impact Assessments independently and can apply the so After finishing the course the students have the competence to crienvironmental impacts.           Personal Competence         The students are able to discuss the various technical and scientific tasks to develop different approaches to the task as a group as well as to discus           Autonomy         The students learn to research, process and present a scientific topic scientific towrk. They can solve an environmental problem in a business or scientific work. They can solve an environmental problem in a business or scientific work. They can solve an environmental problem in a business or scientific work. They can solve an environmental problem in a business or scientific work. They can solve an environmental problem in a business or scientific work. The			
Educational Objective         After taking part successfully, students have reached the following learni           Professional Competence         Knowledge           With the completion of this modul the students obtain profound knowledge the behaviour of chemicals in the environment. Students can give an ow terms and allocate them to related methods.           Additional students acquire in-depth knowledge of important cause-effect occur from production processes, projects or construction measures. The are competent in dealing with different methods and instruments to assis to estimate the complexity of these environmental processes as well as to students are able to propose appropriate management and mitigation determine geochemical parameters and to assess the potential of pollu work out well founded opinions on how Environmental Technology contr and defend these opinons in front of and against the group.           The students are able to select a suitable method for the respective cas can develop suitable solutions for managing and mitigating environment out Life Cycle Impact Assessments independently and can apply the so After finishing the course the students have the competence to cri environmental impacts.           Personal Competence         The students are able to discuss the various technical and scientific tasks to develop different approaches to the task as a group as well as to discus           Autonomy         The students learn to research, process and present a scientific topic scientific work. They can solve an environmental problem in a business concept of sustainability. Their sensitivity and consciousness towards t awareness of their future social responsibilities in their role as engineers.           Workload in Hours         Independent St			
Professional Competence Knowledge         With the completion of this modul the students obtain profound knowledge the behaviour of chemicals in the environment. Students can give an ow terms and allocate them to related methods.           Additional students acquire in-depth knowledge of important cause-effec occur from production processes, projects or construction measures. The are competent in dealing with different methods and instruments to assis to estimate the complexity of these environmental processes as well as to skills           Stills         Students are able to propose appropriate management and mitigation determine geochemical parameters and to assess the potential of pollu work out well founded opinions on how Environmental Technology contr and defend these opinons in front of and against the group.           The students are able to select a suitable method for the respective cas can develop suitable solutions for managing and mitigating environment out Life Cycle Impact Assessments independently and can apply the so After finishing the course the students have the competence to cri environmental impacts.           Personal Competence Social Competence         The students are able to discuss the various technical and scientific tasks to develop different approaches to the task as a group as well as to discus Due to the selected lecture topics, the students receive insights into the i concept of sustainability. Their sensitivity and consciousness towards t awareness of their future social responsibilities in their role as engineers.           Autonomy         The students learn to research, process and present a scientific topic scientific work. They can solve an environmental problem in a business c           Workload in Hours         Independent Study Time 110, Study Tim			
Knowledge       With the completion of this modul the students obtain profound knowledge the behaviour of chemicals in the environment. Students can give an outerms and allocate them to related methods.         Additional students acquire in-depth knowledge of important cause-effect occur from production processes, projects or construction measures. The are competent in dealing with different methods and instruments to assist to estimate the complexity of these environmental processes as well as to estimate the complexity of these environmental processes as well as to estimate the complexity of these environmental rechnology contrand determine geochemical parameters and to assess the potential of polluwork out well founded opinions on how Environmental Technology contrand defend these opinons in front of and against the group.         The students are able to select a suitable method for the respective cas can develop suitable solutions for managing and mitigating environment out Life Cycle Impact Assessments independently and can apply the set of the finishing the course the students have the competence to crienvironmental impacts.         Personal Competence       The students are able to discuss the various technical and scientific tasks to develop different approaches to the task as a group as well as to discus.         Autonomy       The students learn to research, process and present a scientific topic scientific	ng results		
the behaviour of chemicals in the environment. Students can give an orterms and allocate them to related methods.         Additional students acquire in-depth knowledge of important cause-effectoccur from production processes, projects or construction measures. The are competent in dealing with different methods and instruments to assist to estimate the complexity of these environmental processes as well as to estimate the complexity of these environmental processes as well as to estimate the complexity of these environmental Technology contrand determine geochemical parameters and to assess the potential of pollu work out well founded opinions on how Environmental Technology contrand defend these opinons in front of and against the group.         The students are able to select a suitable method for the respective cas can develop suitable solutions for managing and mitigating environment out Life Cycle Impact Assessments independently and can apply the second the function of the subject as a subject of the select to criterion environmental impacts.         Personal Competence       The students are able to discuss the various technical and scientific tasks to develop different approaches to the task as a group as well as to discus.         Social Competence       The students learn to research, process and present a scientific topic scientific			
occur from production processes, projects or construction measures. The are competent in dealing with different methods and instruments to assis to estimate the complexity of these environmental processes as well as u         Skills       Students are able to propose appropriate management and mitigation determine geochemical parameters and to assess the potential of pollu work out well founded opinions on how Environmental Technology contr and defend these opinons in front of and against the group.         The students are able to select a suitable method for the respective cas can develop suitable solutions for managing and mitigating environment out Life Cycle Impact Assessments independently and can apply the so After finishing the course the students have the competence to critenvironmental impacts.         Personal Competence       The students are able to discuss the various technical and scientific tasks to develop different approaches to the task as a group as well as to discus         Due to the selected lecture topics, the students receive insights into the reconcept of sustainability. Their sensitivity and consciousness towards to awareness of their future social responsibilities in their role as engineers.         Autonomy       The students learn to research, process and present a scientific topic scientific work. They can solve an environmental problem in a business concept for points 6         Course achievement       None	-		
determine geochemical parameters and to assess the potential of pollu         work out well founded opinions on how Environmental Technology contrand defend these opinons in front of and against the group.         The students are able to select a suitable method for the respective case can develop suitable solutions for managing and mitigating environment out Life Cycle Impact Assessments independently and can apply the set After finishing the course the students have the competence to critenvironmental impacts.         Personal Competence       The students are able to discuss the various technical and scientific tasks to develop different approaches to the task as a group as well as to discus but on the selected lecture topics, the students receive insights into the recorcept of sustainability. Their sensitivity and consciousness towards to awareness of their future social responsibilities in their role as engineers.         Autonomy       The students learn to research, process and present a scientific topic scientific work. They can solve an environmental problem in a business or scientific work. They can solve an environmental problem in a business or scientific topicts and the selected tecture topics.         Workload in Hours       Independent Study Time 110, Study Time in Lecture 70         Credit points       6         Course achievement       None	y have knowled ess environmen	ge about the method tal impacts. Besides t	ological diversity a he students are al
can develop suitable solutions for managing and mitigating environment out Life Cycle Impact Assessments independently and can apply the sa After finishing the course the students have the competence to cri- environmental impacts.Personal Competence Social CompetenceThe students are able to discuss the various technical and scientific tasks to develop different approaches to the task as a group as well as to discu Due to the selected lecture topics, the students receive insights into the in- concept of sustainability. Their sensitivity and consciousness towards the awareness of their future social responsibilities in their role as engineers.AutonomyIndependent Study Time 110, Study Time in Lecture 70Credit points6Course achievementNone	Skills Students are able to propose appropriate management and mitigation measures for environmental problems. They a determine geochemical parameters and to assess the potential of pollutants to migrate and transform. The students work out well founded opinions on how Environmental Technology contributes to sustainable development, and they c and defend these opinons in front of and against the group.		students are able
Social Competence       The students are able to discuss the various technical and scientific tasks to develop different approaches to the task as a group as well as to discus         Due to the selected lecture topics, the students receive insights into the inconcept of sustainability. Their sensitivity and consciousness towards to awareness of their future social responsibilities in their role as engineers.         Autonomy       The students learn to research, process and present a scientific topic scientific work. They can solve an environmental problem in a business of the study Time 110, Study Time in Lecture 70         Credit points       6         Course achievement       None	The students are able to select a suitable method for the respective case from the variety of assessment methods. Thereby the can develop suitable solutions for managing and mitigating environmental problems in a business context. They are able to car out Life Cycle Impact Assessments independently and can apply the software programs OpenLCA and the database Econver After finishing the course the students have the competence to critically judge research results or other publications environmental impacts.		
to develop different approaches to the task as a group as well as to discu         Due to the selected lecture topics, the students receive insights into the reconcept of sustainability. Their sensitivity and consciousness towards to awareness of their future social responsibilities in their role as engineers.         Autonomy       The students learn to research, process and present a scientific topic scientific work. They can solve an environmental problem in a business or their future social responsibilities in their role as engineers.         Workload in Hours       Independent Study Time 110, Study Time in Lecture 70         Credit points       6         Course achievement       None			
Autonomy       concept of sustainability. Their sensitivity and consciousness towards to awareness of their future social responsibilities in their role as engineers.         Autonomy       The students learn to research, process and present a scientific topic scientific work. They can solve an environmental problem in a business concept of subtract the study Time 110, Study Time in Lecture 70         Credit points       6         Course achievement       None			
scientific work. They can solve an environmental problem in a business of         Workload in Hours       Independent Study Time 110, Study Time in Lecture 70         Credit points       6         Course achievement       None	hese subjects a		
Credit points 6 Course achievement None			
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): Specialisati	on Green Techn	ologies: Compulsory	

Course L1387: Practical Exer	cise Environmental Technology
Тур	Practical Course
Hrs/wk	1
СР	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
СР	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	I 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	<ol> <li>Introductory seminar on environmental science:</li> <li>Environmental impact and adverse effects</li> <li>Wastewater technology</li> <li>Air pollution control</li> <li>Noise protection</li> <li>Waste and recycling management</li> <li>Soil and ground water protection</li> <li>Renewable energies</li> <li>Resource conservation and energy efficiency</li> </ol>
Literature	Förster, U.: Umweltschutztechnik; 2012; Springer Berlin (Verlag) 8., Aufl. 2012; 978-3-642-22972-5 (ISBN)

Courses				
Title		Turn	I las (add	CD.
Heat and Mass Transfer (L0101)		<b>Typ</b> Lecture	Hrs/wk 2	<b>CP</b> 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				
	Basic knowledge: Technical Thermodynamic			
Knowledge	basic knowledge. Fechnical merniodynamic	3		
Educational Objectives	After taking part successfully, students have	e reached the following learning results		
Professional Competence				
Knowledge	<ul><li>heat exchanger, chemical reactors).</li><li>They are capable of distinguish and c transfer and thermal radiation.</li><li>The students have the ability to ex qualitative and quantitative by using</li></ul>	ng qualitative and determining quantitative heat characterize different kinds of heat transfer mec explain the physical basis for mass transfer in suitable mass transfer theories. etween heat- and mass transfer and to describe	hanisms namely h detail and to de	neat conduction, h
Skills	<ul> <li>and to balance the corresponding ene</li> <li>They are capable to solve specific he and to calculate the corresponding he</li> <li>Using dimensionless quantities, the sl</li> <li>They are able to distinguish between for the description and design of appa</li> <li>In this context, the students are capa application considering their advantae</li> <li>In addition, they can calculate both, s</li> <li>The students are capable to conn</li> </ul>	eat transfer problems (e.g. heated chemical rea eat flows. tudents can execute scaling up of technical proc diffusion, convective mass transition and mass aratus (e.g. extraction column, rectification colur ble to choose and design fundamental types of	ctors, temperatur esses or apparatu transfer. They car nn). neat and mass exu rocedural apparat with knowlegde	re alteration in flui is. n use this knowled changer for a spec tus. of other courses
<b>Personal Competence</b> Social Competence	<ul> <li>The students are capable to work on manner to tutors and other students.</li> </ul>	subject-specific challenges in teams and to pre	esent the results o	orally in a reasona
Autonomy	• They are able to prove their level of	luate necessary information from suitable sourc of knowledge during the course with accompa on this basis they can control their learning proc	nying procedure	continuously (click
Workload in Hours	Independent Study Time 124, Study Time in	Lecture 56		
Credit points	6			
Course achievement				
Examination				
	120 minutes; theoretical questions and calco	ulations		
scale	220 minutes, metretical questions and talt	6.62.01.0		
	Conoral Engineering Science (Correct and	am 7 competer), Specialization Cross Tachard	nioci Compulsor	
Assignment for the		ram, 7 semester): Specialisation Green Technolo ram, 7 semester): Specialisation Bioprocess Engi		orv
Following Curricula		am, 7 semester): Specialisation Bioprocess Engl am, 7 semester): Specialisation Process Enginee		-
Following Curricula				
Following Curricula	General Engineering Science (German progr	am, 7 semester): Specialisation Chemical and B	oengineering: Cor	npulsory
Following Curricula	Discourse Facely 1 Contraction 1			
Following Curricula	Bioprocess Engineering: Core Qualification:			
Following Curricula	Chemical and Bioprocess Engineering: Core	Qualification: Compulsory		
Following Curricula	Chemical and Bioprocess Engineering: Core Energy and Environmental Engineering: Core	Qualification: Compulsory e Qualification: Compulsory		
Following Curricula	Chemical and Bioprocess Engineering: Core	Qualification: Compulsory e Qualification: Compulsory		
Following Curricula	Chemical and Bioprocess Engineering: Core Energy and Environmental Engineering: Core	Qualification: Compulsory e Qualification: Compulsory :: Core Qualification: 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	<ol> <li>Heat transfer         <ul> <li>Introduction, one-dimensional heat conduction</li> <li>Convective heat transfer</li> <li>Multidimensional heat conduction</li> <li>Non-steady heat conduction</li> <li>Thermal radiation</li> </ul> </li> <li>Mass transfer         <ul> <li>one-way diffusion, equimolar countercurrent diffusion</li> <li>boundary layer theory, non-steady mass transfer</li> <li>Heat and mass transfer single particle/ fixed bed</li> <li>Mass transfer and chemical reactions</li> </ul> </li> </ol>
Literature	<ol> <li>H.D. Baehr und K. Stephan: Wärme- und Stoffübertragung, Springer</li> <li>VDI-Wärmeatlas</li> </ol>

Course 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
Power Industry (L0316)		Lecture	1	1
Energy markets and energy trading	1 (L2744)	Lecture	2	2
Fossil Energy Systems (L2745)		Lecture	2	2
ossil Energy Systems (L2746)		Recitation Section (	large) 1	1
	Prof. Martin Kaltschmitt			
Admission Requirements	None			
Recommended Previous	none			
Knowledge				
Educational Objectives Professional Competence	After taking part successfully, students	have reached the following learning results		
Skills	Upon completion of this module, students will be able to provide an overview of characteristics of energy systems. They ca explain the issues that arise. Furthermore, they are able to explain knowledge of energy production, energy distribution an energy trade in this context, taking into account contexts bordering on other disciplines. The students can explain this knowledge which is applicable to almost all energy systems, in particular detail for conventional energy systems and take a critical stance o them. Furthermore, they can explain the environmental impact of using conventional energy systems. They also have an overview of reserves and resources as well as global and national market volumes. This also includes the legal framework, which shoul 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 alse able to design them under certain given conditions. They are able to select the regulations necessary for this in a subject-specifi 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 th respective context.			
Personal Competence				
	criteria under sustainability aspects.	able technical alternatives and to assess th burces , acquire the particular knowledge a		-
Workload in Hours	Independent Study Time 96, Study Tim	e 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	Technologies: Compulsorv	
Assignment for the Following Curricula		program, 7 semester): Specialisation Green <sup>-</sup> program, 7 semester): Specialisation Green <sup>-</sup>		

Course L0316: Power Industr	у
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	<ul> <li>Electrical energy in the energy system</li> <li>Demand and use of electrical energy (households, industry, "new" buyers (including e-mobility))</li> <li>Electricity generation <ul> <li>electricity generation technologies using fossil fuels and their characteristics</li> <li>combined heat and power technologies and their production characteristics</li> <li>electricity generation from renewable energy technologies and their characteristics</li> </ul> </li> <li>Power distribution <ul> <li>"classic" distribution of electrical energy</li> <li>challenges of fluctuating electricity generation by distributed systems (electricity market, electricity stock exchange, emissions trading)</li> </ul> </li> <li>District heating industry</li> <li>Legal and administrative aspects <ul> <li>Energy Act</li> <li>support instruments for renewable energy</li> <li>CHP Act</li> </ul> </li> <li>Cost and efficiency calculation</li> </ul>
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
CP	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
5	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 addition, the respective reserve and resource availability is illuminated.
Literature	Unterlagen des Übung

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			
<b>Recommended Previous</b>	none			
Knowledge				
Educational Objectives	After taking part successfully, students	have reached the following learning results		
<b>Professional Competence</b>				
	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 Energies 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
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
	<ul> <li>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</li> <li>(a) heat generation from biogenic solid fuels in small and large-scale plants</li> <li>(b) power generation from solid biomass via combustion</li> <li>(c) a biogas production from residues, by-products and waste,</li> <li>(d) alcohol production from sugar and starch</li> <li>(e) biodiesel production from vegetable oils.</li> </ul> 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

## Focus Renewable Energy

Module M1693: Comp	uter Science for	r Engineers - Prog	gramming	Concepts, Data Hand	dling & Com	munication
Courses						
ſitle				Тур	Hrs/wk	СР
Computer Science for Engineers - P	rogramming Concepts, D	ata Handling & Communicat	ion (L2689)	Lecture	3	3
Computer Science for Engineers - P	rogramming Concepts, D	ata Handling & Communicat	ion (L2690)	Recitation Section (small)	2	3
Module Responsible	Prof. Sibylle Fröschle					
Admission Requirements	None					
<b>Recommended Previous</b>						
Knowledge						
Educational Objectives	After taking part succe	essfully, students have rea	ched the follow	ing learning results		
Professional Competence						
Knowledge						
Skills						
Personal Competence						
Social Competence						
Autonomy						
	Independent Study Tin	ne 110, Study Time in Lec	ture 70			
	6	, ,				
Course achievement	Compulsory Bonus	Form	Description			
	No 10 %	Attestation	Testate find	en semesterbegleitend statt.		
Examination	Written exam					
Examination duration and	120 min					
scale						
Assignment for the	General Engineering	Science (German progra	am, 7 semeste	er): Specialisation Mechanica	l Engineering, F	ocus Biomechanio
Following Curricula	Compulsory					
	General Engineering S	cience (German program,	7 semester): Sp	pecialisation Process Engineer	ing: Compulsory	
	General Engineering S	cience (German program,	7 semester): Sp	pecialisation Biomedical Engin	eering: Compulso	ory
	General Engineering S	cience (German program,	7 semester): Sp	pecialisation Green Technolog	ies, Focus Renew	able Energy: Electi
	Compulsory					
	General Engineering	Science (German program	m, 7 semester)	: Specialisation Mechanical	Engineering, Foc	us Energy System
	Compulsory					
			m, 7 semester	): Specialisation Mechanical	Engineering, Foc	us Aircraft Syster
	Engineering: Compulso	-				
			am, 7 semest	er): Specialisation Mechanic	al Engineering,	Focus Materials
	Engineering Sciences:		m 7 comocto	r), Enocialization Machanics		Focus Mochatropic
	Compulsory	Science (German progra	ann, 7 senneste	er): Specialisation Mechanica	ii Eligineering, i	Focus Mechadionic
		cience (German program	7 semester): S	pecialisation Mechanical Engir	peering Focus Th	eoretical Mechanic
	Engineering: Compulso		, semester, s	pecialisation reciliancai Engli	leening, rocus in	
			, 7 semester): S	Specialisation Mechanical Eng	ineering, Focus P	Product Developme
	and Production: Electiv				5.	
			7 semester): Sp	pecialisation Electrical Enginee	ering: Elective Co	mpulsory
	General Engineering S	cience (German program,	7 semester): Sp	pecialisation Green Technolog	ies, Focus Renew	able Energy: Electi
	Compulsory					
	Bioprocess Engineering	g: Core Qualification: Com	pulsory			
	Electrical Engineering:	Core Qualification: Comp	ulsory			
		ntal Engineering: Core Qu				
				ecialisation Process Engineeri		
		Science (English prograr	n, 7 semester	): Specialisation Energy and	Enviromental E	ngineering: Electi
	Compulsory					
				rgy Systems: Elective Compul	sory	
		Core Qualification: Compu	-	amaulaan.		
		Specialisation Information	i iechnology: C	ompulsory		
		alification: Compulsory	con/			
		Core Qualification: Compul	-	Enocialization Information To-	haology, Comercia	
	Engineering and Maha	yement - Major in Logistic	s and Mobility:	Specialisation Information Tec	mology: Comput	sury

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
Phase Equilibria Thermodynamics (		Lecture	2	2
Phase Equilibria Thermodynamics ( Phase Equilibria Thermodynamics (		Recitation Section (small) Recitation Section (large)	1	2
		Recitation Section (large)	1	2
Module Responsible				
	None	U		
Recommended Previous Knowledge	Mathematics, Physical Chemistry, Thermodynamics I	and II		
Educational Objectives	After taking part successfully, students have reached	the following learning results		
Professional Competence	······			
Knowledge Skills	<ul> <li>Starting from the very basics of thermodynar equilibria.</li> <li>They learn how state variables are influenced these properties.</li> <li>Moreover, the students learn how phase equidifferent phases (vapor, liquid, solid) coexist in</li> <li>For different phase equilibria, several examp knowledge for plotting and interpreting the equidinary state and know how to simplify these equation.</li> <li>The students know models which can be used are able to solve the resulting mathematical results and the students how apply a plot to self.</li> </ul>	by the mixing of compounds and learn libria can be described mathematically equilibrium. Furthermore the fundamen les relevant for different kinds of proc uilibria are taught.	n concepts to qu and which pher tals of reaction e esses are shown the determination em in the equili	antitatively descr nomena may occu equilibria are taugh n and the necess on of the equilibri orium state and th
<ul> <li>For specific applications, they are able to self-reliantly find necessary physico-chemical properties of comodel parameters in literature sources.</li> <li>Beside pure compound properties the students are capable of describing the properties of mixtures.</li> <li>The students know how to visualize phase equilibria graphically and they know how to interpret the occu.</li> <li>Based on their knowledge, the students are able to understand fundamental concepts that are the separation and reaction processes in chemical engineering.</li> </ul>			urring phenomena	
	The students are able to work in small groups, to so	lve the corresponding problems and to	present them or	aly to the tutors a
Autonomy	<ul> <li>other students</li> <li>The students are able to find necessary inform.</li> <li>During the semester the students are able knowledge the students can adept their learning</li> </ul>	to check their learning progress conti		
Workload in Hours	Independent Study Time 124, Study Time in Lecture 5	56		
Credit points				
Course achievement				
Examination				
	120 minutes; theoretical questions and calculations			
scale	220 minutes, measured questions and calculations			
	General Engineering Science (German program, 7 ser	nester): Specialisation Process Engineer	na: Compulsory	
-	General Engineering Science (German program, 7 ser			orv
. showing curricula	General Engineering Science (German program, 7 ser			-
	Compulsory		, i scus nenew	Lote Lifergy. Life
	General Engineering Science (German program, 7 ser	nester): Specialisation Green Technologi	es, Focus Renew	able Energy: Elec
	Compulsory			
	Bioprocess Engineering: Core Qualification: Compulso	ry		
	Green Technologies: Energy, Water, Climate: Speciali		Compulsory	
	Green Technologies: Energy, Water, Climate: Speciali	•••		
	Process Engineering: Core Qualification: Compulsory			

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

Hall, 1999. • J.W. Tester, M. Modell: Thermodynamics and its Applications. 3 <sup>rd</sup> ed. Prentice Hall, 1997, J.P. O'Connell, J.M. H	Course L0140: Phase Equilib	ria Thermodynamics
CP 2         Workload in Hours         Independent Study Time 46, Study Time in Lecture 14         Lecturer         Prof. Irina Smirnova         Language DE         Cycle SoSe         Content         1.       Introduction: Applications of thermodynamics of mixtures         2.       Thermodynamic equations in multi-component systems: Fundamental equations, chemical potential, fugacity         3.       Phase equilibria of pure substances: thermodynamic equilibrium, vapor pressure, Gibbs' phase rule         4.       Equations of state: virial equations, van-der-Waals equation, generalized equations of state         5.       Mixing properties: ideal and real mixtures, excess properties, partial molar properties         6.       Vapor-liquid-equilibria: binary systems, azeotropes, equilibrium condition         7.       Gas-liquid-equilibria: equilibrium condition, Henry-coefficient         8.       G <sup>E</sup> -Models: Hildebrand-model, Flory-Huggins-model, WilSon-model, UNIQUAC, UNIFAC         9.       Liquid-liquid-equilibria: equilibrium condition, phase equilibria in binary and ternary systems         10.       Solid-liquid-equilibria: equilibrium condition, binary systems         11.       Chemical reactions: reaction coordinate, mass action law, influence of pressure and temperature         12.       Os	Тур	Recitation Section (small)
Workload in Hours         Independent Study Time 46, Study Time in Lecture 14           Lecturer         Prof. Irina Smirnova           Language         DE           Cycle         SoSe           Content         1.           Introduction: Applications of thermodynamics of mixtures         2.           Phase equilibria of pure substances: thermodynamic equilibrium, vapor pressure, Gibbs' phase rule           4.         Equations of state: virial equations, van-der-Waals equation, generalized equations of state           5.         Mixing properties: ideal and real mixtures, excess properties, partial molar properties           6.         Vapor-liquid-equilibria: equilibrium condition, Henry-coefficient           8.         G <sup>E</sup> -Models: Hildebrand-model, Flory-Huggins-model, Wilson-model, UNIQUAC, UNIFAC           9.         Liquid-liquid-equilibria: equilibrium condition, binary systems           10.         Solid-liquid-equilibria: equilibrium condition, binary systems           11.         Chemical reactions: reaction coordinate, mass action law, influence of pressure and temperature           12.         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, 3r	Hrs/wk	1
Lecturer         Prof. Irina Smirnova           Language         DE           Cycle         SoSe           Content         1. Introduction: Applications of thermodynamics of mixtures           2. Thermodynamic equations in multi-component systems: Fundamental equations, chemical potential, fugacity           3. Phase equilibria of pure substances: thermodynamic equilibrium, vapor pressure, Gibbs' phase rule           4. Equations of state: virial equations, van-der-Waals equation, generalized equations of state           5. Mixing properties: ideal and real mixtures, excess properties, partial molar properties           6. Vapor-liquid-equilibria: binary systems, azeotropes, equilibrium condition           7. Gas-liquid-equilibria: equilibrium condition, Henry-coefficient           8. G <sup>E</sup> -Models: Hildebrand-model, Flory-Huggins-model, Wilson-model, UNIQUAC, UNIFAC           9. Liquid-liquid-equilibria: equilibrium condition, phase equilibria in binary and ternary systems           10. Solid-liquid-equilibria: equilibrium condition, phase equilibria in binary and ternary systems           11. Chemical reactions: reaction coordinate, mass action law, influence of pressure and temperature           12. 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	CP	2
Language         DE           Cycle         SoSe           Content         1. Introduction: Applications of thermodynamics of mixtures           2. Thermodynamic equilibria of pure substances: thermodynamic equilibrium, vapor pressure, Gibbs' phase rule           4. Equations of state: virial equations, van-der-Waals equation, generalized equations of state           5. Mixing properties: ideal and real mixtures, excess properties, partial molar properties           6. Vapor-liquid-equilibria: binary systems, azeotropes, equilibrium condition           7. Gas-liquid-equilibria: equilibrium condition, Henry-coefficient           8. G <sup>E</sup> -Models: Hildebrand-model, Flory-Huggins-model, Wilson-model, UNIQUAC, UNIFAC           9. Liquid-liquid-equilibria: equilibrium condition, binary systems           10. Solid-liquid-equilibria: equilibrium condition, binary systems           11. Chemical reactions: reaction coordinate, mass action law, influence of pressure and temperature           12. 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. Prer Hall, 1999.           • J.W. Tester, M. Modell: Thermodynamics and its Applications. 3 <sup>rd</sup> ed. Prentice Hall, 1997, J.P. O'Connell, J.M. H	Workload in Hours	Independent Study Time 46, Study Time in Lecture 14
Cycle         SoSe           Content         1. Introduction: Applications of thermodynamics of mixtures           2. Thermodynamic equations in multi-component systems: Fundamental equations, chemical potential, fugacity           3. Phase equilibria of pure substances: thermodynamic equilibrium, vapor pressure, Gibbs' phase rule           4. Equations of state: virial equations, van-der-Waals equation, generalized equations of state           5. Mixing properties: ideal and real mixtures, excess properties, partial molar properties           6. Vapor-liquid-equilibria: binary systems, azeotropes, equilibrium condition           7. Gas-liquid-equilibria: equilibrium condition, Henry-coefficient           8. GE-Models: Hildebrand-model, Flory-Huggins-model, Wilson-model, UNIQUAC, UNIFAC           9. Liquid-liquid-equilibria: equilibrium condition, phase equilibriary and ternary systems           10. Solid-liquid-equilibria: equilibrium condition, binary systems           11. Chemical reactions: reaction coordinate, mass action law, influence of pressure and temperature           12. Osmotic pressure           The students work on tasks in small groups and present their results in front of all students.           Literature           IJürgen Gmehling, Bärbel Kolbe: Thermodynamik. VCH 1992           I.M. Prausnitz, R.N. Lichtenthaler, E.G. de Azevedo: Molecular Thermodynamics of Fluid-Phase Equilibria, 3rd ed. Preri-Hall, 1999.           J.W. Tester, M. Modell: Thermodynamics and its Applications. 3 <sup>rd</sup> ed. Prentice Hall, 1997, J.P. O'Conn	Lecturer	Prof. Irina Smirnova
Content       1. Introduction: Applications of thermodynamics of mixtures         2. Thermodynamic equations in multi-component systems: Fundamental equations, chemical potential, fugacity         3. Phase equilibria of pure substances: thermodynamic equilibrium, vapor pressure, Gibbs' phase rule         4. Equations of state: virial equations, van-der-Waals equation, generalized equations of state         5. Mixing properties: ideal and real mixtures, excess properties, partial molar properties         6. Vapor-liquid-equilibria: binary systems, azeotropes, equilibrium condition         7. Gas-liquid-equilibria: equilibrium condition, Henry-coefficient         8. G <sup>E</sup> -Models: Hildebrand-model, Flory-Huggins-model, Wilson-model, UNIQUAC, UNIFAC         9. Liquid-liquid-equilibria: equilibrium condition, phase equilibria in binary and ternary systems         10. Solid-liquid-equilibria: equilibrium condition, binary systems         11. Chemical reactions: reaction coordinate, mass action law, influence of pressure and temperature         12. Osmotic pressure         The students work on tasks in small groups and present their results in front of all students.         Literature <ul> <li>Jürgen Gmehling, Bärbel Kolbe: Thermodynamik. VCH 1992</li> <li>J.M. Prausnitz, R.N. Lichtenthaler, E.G. de Azevedo: Molecular Thermodynamics of Fluid-Phase Equilibria, 3rd ed. Preri Hail, 1999.</li> <li>J.W. Tester, M. Modell: Thermodynamics and its Applications. 3<sup>rd</sup> ed. Prentice Hall, 1997.J.P. O'Connell, J.M. H</li> </ul>	Language	DE
1.       Introduction: Applications of thermodynamics of mixtures         2.       Thermodynamic equations in multi-component systems: Fundamental equations, chemical potential, fugacity         3.       Phase equilibria of pure substances: thermodynamic equilibrium, vapor pressure, Gibbs' phase rule         4.       Equations of state: virial equations, van-der-Waals equation, generalized equations of state         5.       Mixing properties: ideal and real mixtures, excess properties, partial molar properties         6.       Vapor-liquid-equilibria: binary systems, azeotropes, equilibrium condition         7.       Gas-liquid-equilibria: equilibrium condition, Henry-coefficient         8.       G <sup>E</sup> -Models: Hildebrand-model, Flory-Huggins-model, Wilson-model, UNIQUAC, UNIFAC         9.       Liquid-liquid-equilibria: equilibrium condition, phase equilibria in binary and ternary systems         10.       Solid-liquid-equilibria: equilibrium condition, phase action law, influence of pressure and temperature         12.       Osmotic pressure         The students work on tasks in small groups and present their results in front of all students.         Literature         9.       Jürgen Gmehling, Bärbel Kolbe: Thermodynamik. VCH 1992         9.       J.M. Prausnitz, R.N. Lichtenthaler, E.G. de Azevedo: Molecular Thermodynamics of Fluid-Phase Equilibria, 3rd ed. Preri Hall, 1999.         9.       J.W. Tester, M. Modell: Thermodynamics and its Applications. 3 <sup>rd</sup> ed	Cycle	SoSe
		<ol> <li>Thermodynamic equations in multi-component systems: Fundamental equations, chemical potential, fugacity</li> <li>Phase equilibria of pure substances: thermodynamic equilibrium, vapor pressure, Gibbs' phase rule</li> <li>Equations of state: virial equations, van-der-Waals equation, generalized equations of state</li> <li>Mixing properties: ideal and real mixtures, excess properties, partial molar properties</li> <li>Vapor-liquid-equilibria: binary systems, azeotropes, equilibrium condition</li> <li>Gas-liquid-equilibria: equilibrium condition, Henry-coefficient</li> <li>G<sup>E</sup>-Models: Hildebrand-model, Flory-Huggins-model, Wilson-model, UNIQUAC, UNIFAC</li> <li>Liquid-liquid-equilibria: equilibrium condition, phase equilibria in binary and ternary systems</li> <li>Solid-liquid-equilibria: equilibrium condition, binary systems</li> <li>Chemical reactions: reaction coordinate, mass action law, influence of pressure and temperature</li> <li>Osmotic pressure</li> <li>The students work on tasks in small groups and present their results in front of all students.</li> <li>Jürgen Gmehling, Bärbel Kolbe: Thermodynamik. VCH 1992</li> <li>J.M. Prausnitz, R.N. Lichtenthaler, E.G. de Azevedo: Molecular Thermodynamics of Fluid-Phase Equilibria, 3rd ed. Prentice</li> </ol>

Course L0142: Phase Equilibri	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	<ol> <li>Introduction: Applications of thermodynamics of mixtures</li> <li>Thermodynamic equations in multi-component systems: Fundamental equations, chemical potential, fugacity</li> <li>Phase equilibria of pure substances: thermodynamic equilibrium, vapor pressure, Gibbs' phase rule</li> <li>Equations of state: virial equations, van-der-Waals equation, generalized equations of state</li> <li>Mixing properties: ideal and real mixtures, excess properties, partial molar properties</li> <li>Vapor-liquid-equilibria: binary systems, azeotropes, equilibrium condition</li> <li>Gas-liquid-equilibria: equilibrium condition, Henry-coefficient</li> <li>G<sup>E</sup>-Models: Hildebrand-model, Flory-Huggins-model, Wilson-model, UNIQUAC, UNIFAC</li> <li>Liquid-liquid-equilibria: equilibrium condition, phase equilibria in binary and ternary systems</li> <li>Solid-liquid-equilibria: eaction coordinate, mass action law, influence of pressure and temperature</li> <li>Osmotic pressure</li> </ol>
Literature	<ul> <li>Jürgen Gmehling, Bärbel Kolbe: Thermodynamik. VCH 1992</li> <li>J.M. Prausnitz, R.N. Lichtenthaler, E.G. de Azevedo: Molecular Thermodynamics of Fluid-Phase Equilibria, 3rd ed. Prentice Hall, 1999.</li> <li>J.W. Tester, M. Modell: Thermodynamics and its Applications. 3<sup>rd</sup> ed. Prentice Hall, 1997.J.P. O'Connell, J.M. Haile: Thermodynamics. Cambridge University Press, 2005.</li> </ul>

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	.41)	Recitation Section (large)	1	1	
Separation Processes (L1159)		Practical Course	1	1	
Module Responsible	Prof. Irina Smirnova				
Admission Requirements	None				
	Recommended requirements: Thermodynamics III				
Knowledge					
Educational Objectives	After taking part successfully, students have reached	d the following learning results			
Professional Competence					
Knowledge	• The students can distinguish and describe	different types of separation processes	such as distillat	tion. extraction. a	
	adsorption				
	<ul> <li>The students develop an understanding for the students develop and understanding for the students of the students</li></ul>	he course of concentration during a sep	aration process, f	the estimation of	
	energy demand of a process, the possibilities	of energy saving, and the selection of se	paration systems		
	<ul> <li>They have good knowledge of designing meth</li> </ul>	ods for separation processes and device	S		
Skills					
SKIIIS	<ul> <li>Using the gained knowledge the students can</li> </ul>	select a reasonable system boundary for	or a given separa	tion process and o	
	close the associated energy and material bala	inces			
	<ul> <li>The students can use different graphical me</li> </ul>	ethods for the designing of a separatio	n process and d	efine the amount	
	theoretical stages required				
	<ul> <li>They can select and design a basic type of</li> </ul>	thermal separation process for a giver	case based on	the advantages a	
	disadvantages of the process				
	• The students are capable to obtain independently the needed material properties from appropriate sources (diagrams an				
	tables)				
	<ul> <li>They can calculate continuous and discontinuous</li> </ul>				
	The students are able to prove their theoretics				
	The students are able to discuss the theoretic	cal background and the content of the e	kperimental work	with the teachers	
	colloquium.				
	The students are capable of linking their gained know	wledge with the content of other lectures	and use it togeth	ner for the solutior	
	technical problems. Other lectures such as thermody	namics, fluid mechanics and chemical e	ngineering.		
<b>.</b>					
Personal Competence					
Social Competence	• The students can work technical assignments	in small groups and present the combine	ed results in the t	utorial	
	• The students are able to carry out practical	lab work in small groups and organize a	a functional division	ion of labor betwe	
	them. They are able to discuss their results an	nd to document them scientifically in a re	port.		
Autonomy	• The students are capable to obtain the neede	the needed information from suitable sources by thomselves and assess t			
	<ul> <li>The students are capable to obtain the needed information from suitable sources by themselves and as</li> <li>The students can proof the state of their knowledge with exam resembling assignments and in the students can proof the state of their knowledge with exam resembling assignments and in the students are capable to obtain the state of their knowledge with exam resembling assignments and in the students are capable to obtain the state of their knowledge with exam resembling assignments and in the students are capable to obtain the state of the s</li></ul>				
learning process				2	
	Independent Study Time 96, Study Time in Lecture 8	34			
Credit points					
Course achievement					
E	written exam				
Examination	120 minutes: theoretical questions and calculations				
	120 minutes; theoretical questions and calculations				
Examination duration and scale	120 minutes; theoretical questions and calculations General Engineering Science (German program, 7 se	mester): Specialisation Green Technolog	ies, Focus Renew	able Energy: Elect	
Examination duration and scale		mester): Specialisation Green Technolog	ies, Focus Renew	able Energy: Elect	
Examination duration and scale Assignment for the	General Engineering Science (German program, 7 se				
Examination duration and scale Assignment for the	General Engineering Science (German program, 7 se Compulsory				
Examination duration and scale Assignment for the	General Engineering Science (German program, 7 se Compulsory General Engineering Science (German program,	7 semester): Specialisation Green Tech	nnologies, Focus	Renewable Energ	
Examination duration and scale Assignment for the	General Engineering Science (German program, 7 se Compulsory General Engineering Science (German program, Compulsory	7 semester): Specialisation Green Tech emester): Specialisation Bioprocess Engin	nnologies, Focus eering: Compulso	Renewable Energ	
Examination duration and scale Assignment for the	General Engineering Science (German program, 7 se Compulsory General Engineering Science (German program, Compulsory General Engineering Science (German program, 7 se	7 semester): Specialisation Green Tech emester): Specialisation Bioprocess Engin emester): Specialisation Process Engineer	nologies, Focus eering: Compulso ing: Compulsory	Renewable Energ	
Examination duration and scale Assignment for the	General Engineering Science (German program, 7 se Compulsory General Engineering Science (German program, Compulsory General Engineering Science (German program, 7 se General Engineering Science (German program, 7 se	7 semester): Specialisation Green Tech emester): Specialisation Bioprocess Engine emester): Specialisation Process Engineer emester): Specialisation Chemical and Bio	nologies, Focus eering: Compulso ing: Compulsory	Renewable Ener	
Examination duration and scale Assignment for the	General Engineering Science (German program, 7 se Compulsory General Engineering Science (German program, Compulsory General Engineering Science (German program, 7 se General Engineering Science (German program, 7 se General Engineering Science (German program, 7 se	7 semester): Specialisation Green Tech emester): Specialisation Bioprocess Engine emester): Specialisation Process Engineer emester): Specialisation Chemical and Bio ory	nologies, Focus eering: Compulso ing: Compulsory	Renewable Ener	
Examination duration and scale Assignment for the	General Engineering Science (German program, 7 se Compulsory General Engineering Science (German program, Compulsory General Engineering Science (German program, 7 se General Engineering Science (German program, 7 se General Engineering Science (German program, 7 se Bioprocess Engineering: Core Qualification: Compuls Chemical and Bioprocess Engineering: Core Qualifica Energy and Environmental Engineering: Core Qualifica	7 semester): Specialisation Green Tech emester): Specialisation Bioprocess Engine emester): Specialisation Process Engineer emester): Specialisation Chemical and Bio ory ation: Compulsory cation: Elective Compulsory	nnologies, Focus eering: Compulso ing: Compulsory pengineering: Cor	Renewable Ener	
Examination duration and scale Assignment for the	General Engineering Science (German program, 7 se Compulsory General Engineering Science (German program, Compulsory General Engineering Science (German program, 7 se General Engineering Science (German program, 7 se General Engineering Science (German program, 7 se Bioprocess Engineering: Core Qualification: Compuls Chemical and Bioprocess Engineering: Core Qualificat	7 semester): Specialisation Green Tech emester): Specialisation Bioprocess Engine emester): Specialisation Process Engineer emester): Specialisation Chemical and Bio ory ation: Compulsory cation: Elective Compulsory lisation Energy Systems: Elective Compu	nnologies, Focus eering: Compulso ing: Compulsory bengineering: Cor	Renewable Ener	

avT	Lecture				
Hrs/wk					
CP					
-	Independent Study Time 32, Study Time in Lecture 28				
	Prof. Irina Smirnova				
Language					
Cycle					
Content					
Literature	<ul> <li>G. Brunner: Skriptum Thermische Verfahrenstechnik</li> <li>J. King: Separation Processes, McGraw-Hill, 2. Aufl. 1980</li> <li>Sattler: Thermische Trennverfahren, VCH, Weinheim 1995</li> <li>J.D. Seader, E.J. Henley: Separation Process Principles, Wiley, New York, 1998.</li> <li>Mersmann: Thermische Verfahrenstechnik, Springer, 1980</li> <li>Grassmann, Widmer, Sinn: Einführung in die Thermische Verfahrenstechnik, 3. Aufl., Walter de Gruyter, Berlin 1997</li> <li>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 .</li> <li>R. Goedecke (Hrsg.): Fluid-Verfahrenstechnik, Wiley-VCH Verlag, Weinheim, 2006.</li> <li>Perry"s Chemical Engineers" Handbook, R.H. Perry, D.W. Green, J.O. Maloney (Hrsg.), 6th ed., McGraw-Hill, New Yor</li> </ul>				

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	<ul> <li>Introduction in the thermal process engineering and to the main features of separation processes</li> <li>Simple equilibrium processes, several steps processes</li> <li>Distillation of binary mixtures, enthalpy-concentration diagrams</li> <li>Extractive and azeotrope distillation, water vapor distillation, stepwise distillation</li> <li>Extraction: separation ternary systems, ternary diagram</li> <li>Multiphase separation including complex mixtures</li> <li>Designing of separation devices without discrete stages</li> <li>Drying</li> <li>Chromatographic separation processes</li> <li>Membrane separation</li> <li>Energy demand of separation processes</li> <li>Advance overview of separation processes</li> <li>Selection of separation processes</li> </ul>
Literature	<ul> <li>G. Brunner: Skriptum Thermische Verfahrenstechnik</li> <li>J. King: Separation Processes, McGraw-Hill, 2. Aufl. 1980</li> <li>Sattler: Thermische Trennverfahren, VCH, Weinheim 1995</li> <li>J.D. Seader, E.J. Henley: Separation Process Principles, Wiley, New York, 1998.</li> <li>Mersmann: Thermische Verfahrenstechnik, Springer, 1980</li> <li>Grassmann, Widmer, Sinn: Einführung in die Thermische Verfahrenstechnik, 3. Aufl., Walter de Gruyter, Berlin 1997</li> <li>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.</li> <li>R. Goedecke (Hrsg.): Fluid-Verfahrenstechnik, Wiley-VCH Verlag, Weinheim, 2006.</li> <li>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</li> </ul>

rse L0141: Thermal Sepa	
Тур	Recitation Section (large)
Hrs/wk	
СР	1
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14
Lecturer	Prof. Irina Smirnova
Language	DE
Cycle	WiSe
Content	<ul> <li>Introduction in the thermal process engineering and to the main features of separation processes</li> <li>Simple equilibrium processes, several steps processes</li> <li>Distillation of binary mixtures, enthalpy-concentration diagrams</li> <li>Extractive and azeotrope distillation, water vapor distillation, stepwise distillation</li> <li>Extraction: separation ternary systems, ternary diagram</li> <li>Multiphase separation including complex mixtures</li> <li>Designing of separation devices without discrete stages</li> <li>Drying</li> <li>Chromatographic separation processes</li> <li>Membrane separation</li> <li>Energy demand of separation processes</li> <li>Advance overview of separation processes</li> <li>Selection of separation processes</li> </ul>
Literature	<ul> <li>G. Brunner: Skriptum Thermische Verfahrenstechnik</li> <li>J. King: Separation Processes, McGraw-Hill, 2. Aufl. 1980</li> <li>Sattler: Thermische Trennverfahren, VCH, Weinheim 1995</li> <li>J.D. Seader, E.J. Henley: Separation Process Principles, Wiley, New York, 1998.</li> <li>Mersmann: Thermische Verfahrenstechnik, Springer, 1980</li> <li>Grassmann, Widmer, Sinn: Einführung in die Thermische Verfahrenstechnik, 3. Aufl., Walter de Gruyter, Berlin 1997</li> <li>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.</li> <li>R. Goedecke (Hrsg.): Fluid-Verfahrenstechnik, Wiley-VCH Verlag, Weinheim, 2006.</li> <li>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</li> </ul>

ourse L1159: Separation Pr	ocesses
Тур	Practical Course
Hrs/wk	1
CP	1
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14
Lecturer	Prof. Irina Smirnova
Language	DE/EN
Cycle	WiSe
	The students work on eight different experiments in this practical course. For every one of the eight experiments, a colloquiun takes place in which the students explain and discuss the theoretical background and its translation into practice with staff and fellow students. The students work small groups with a high degree of division of labor. For every experiment, the students write a report. They 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
Literature	<ul> <li>Energy demand of separation processes</li> <li>Advance overview of separation processes</li> <li>Selection of separation processes</li> <li>Selection of separation processes</li> <li>G. Brunner: Skriptum Thermische Verfahrenstechnik</li> <li>J. King: Separation Processes, McGraw-Hill, 2. Aufl. 1980</li> <li>Sattler: Thermische Trennverfahren, VCH, Weinheim 1995</li> <li>J.D. Seader, E.J. Henley: Separation Process Principles, Wiley, New York, 1998.</li> <li>Mersmann: Thermische Verfahrenstechnik, Springer, 1980</li> <li>Grassmann, Widmer, Sinn: Einführung in die Thermische Verfahrenstechnik, 3. Aufl., Walter de Gruyter, Berlin 1997</li> <li>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.</li> <li>R. Goedecke (Hrsg.): Fluid-Verfahrenstechnik, Wiley-VCH Verlag, Weinheim, 2006.</li> <li>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</li> </ul>

Module M1235: Electr	ical Power Systems I: Introduction	to Electrical Power Systems		
Courses				
Title		Тур	Hrs/wk	СР
	tion to Electrical Power Systems (L1670)	Lecture	3	4
Electrical Power Systems I: Introduc	tion to Electrical Power Systems (L1671)	Recitation Section (small)	2	2
Module Responsible	Prof. Christian Becker			
Admission Requirements	None			
<b>Recommended Previous</b>	Fundamentals of Electrical Engineering			
Knowledge				
Educational Objectives	After taking part successfully, students have reach	ed the following learning results		
Professional Competence				
	Students are able to give an overview of convention evaluate technologies of electric power generation electric power systems.	, transmission, storage, and distribution as	well as integrati	on of equipment into
Skills	With completion of this module the students are able to apply the acquired skills in applications of the design, integration development of electric power systems and to assess the results.			
Personal Competence				
Social Competence	The students can participate in specialized and inte front of others.	erdisciplinary discussions, advance ideas a	nd represent thei	r own work results i
Autonomy	Students can independently tap knowledge of the	emphasis of the lectures.		
Workload in Hours	Independent Study Time 110, Study Time in Lectur	re 70		
Credit points	6			
Course achievement	None			
Examination	Written exam			
Examination duration and	90 - 150 minutes			
scale				
Assignment for the	General Engineering Science (German program, 7	semester): Specialisation Electrical Enginee	ering: Elective Co	mpulsory
Following Curricula	General Engineering Science (German program, 7	semester): Specialisation Green Technologi	es, Focus Renew	able Energy: Elective
	Compulsory			
	Data Science: Core Qualification: Elective Compuls	ory		
	Electrical Engineering: Core Qualification: Elective Compulsory			
	Energy Systems: Specialisation Energy Systems: Elective Compulsory			
	Engineering Science: Specialisation Electrical Engin	neering: Elective Compulsory		
	Green Technologies: Energy, Water, Climate: Spec	ialisation Energy Systems: Elective Compul	sory	
	Computer Science in Engineering: Specialisation II.	5 5	ive Compulsory	
	Integrated Building Technology: Core Qualification:			
	Renewable Energies: Core Qualification: Compulso	•		
	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				
Content				
	<ul> <li>fundamentals and current development trends in electric power engineering</li> </ul>			
	tasks and history of electric power systems			
	symmetric three-phase systems			
	<ul> <li>fundamentals and modelling of eletric power systems</li> </ul>			
	• lines			
	• transformers			
	synchronous machines			
	<ul> <li>induction machines</li> </ul>			
	<ul> <li>loads and compensation</li> </ul>			
	<ul> <li>grid structures and substations</li> </ul>			
	<ul> <li>fundamentals of energy conversion</li> </ul>			
	<ul> <li>electro-mechanical energy conversion</li> </ul>			
	<ul> <li>thermodynamics</li> </ul>			
	power station technology			
	renewable energy conversion systems			
	steady-state network calculation			
	network modelling			
	load flow calculation			
	<ul> <li>Induition Calculation</li> <li>(n-1)-criterion</li> </ul>			
	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	<ul> <li>fundamentals and current development trends in electric power engineering</li> </ul>
	tasks and history of electric power systems
	symmetric three-phase systems
	<ul> <li>fundamentals and modelling of eletric power systems</li> </ul>
	• lines
	• transformers
	<ul> <li>synchronous machines</li> </ul>
	<ul> <li>induction machines</li> </ul>
	<ul> <li>loads and compensation</li> </ul>
	<ul> <li>grid structures and substations</li> </ul>
	fundamentals of energy conversion
	<ul> <li>electro-mechanical energy conversion</li> </ul>
	<ul> <li>thermodynamics</li> </ul>
	<ul> <li>power station technology</li> </ul>
	<ul> <li>renewable energy conversion systems</li> </ul>
	steady-state network calculation
	network modelling
	<ul> <li>load flow calculation</li> </ul>
	• (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	
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	the following learning results	-		
Professional Competence					
Knowledge	This module deals with the foundations of the funct		's the layers from	n the assembly-le	
	programming down to gates. The module includes the	following topics.			
	Introduction				
	Combinational logic: Gates, Boolean algebra, B	oolean functions, hardware synthesis, c	ombinational net	works	
	<ul> <li>Sequential logic: Flip-flops, automata, systematical</li> </ul>	ic hardware design			
	Technological foundations				
	Computer arithmetic: Integer addition, subtract		a la sila la s		
	Basics of computer architecture: Programming     Momories: Memory biorarchitec SPAM, DRAM, c		pipelining		
	<ul> <li>Memories: Memory hierarchies, SRAM, DRAM, c</li> <li>Input/output: I/O from the perspective of the CF</li> </ul>		oint connections	hussos	
	• Input/output: 1/0 from the perspective of the Cr	o, principles of passing data, point-to-p	onic connections	, busses	
Skills	The students perceive computer systems from the are	chitect's perspective, i.e., they identify t	he internal struc:	ture and the physi	
	composition of computer systems. The students can a	analyze, how highly specific and individu	ual computers ca	n be built based o	
	collection of few and simple components. They are a		ain the different	abstraction layers	
	today's computing systems - from gates and circuits u	ip to complete processors.			
	After successful completion of the module, the students are able to judge the interdependencies between a physical compute				
	system and the software executed on it. In particular, they shall understand the consequences that the execution of software has				
	on the hardware-centric abstraction layers from the a	ssembly language down to gates. This	way, they will be	enabled to evalue	
	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		
Social competence		ra group and to present the results dee	ordingly.		
Autonomy	Students are able to acquire new knowledge from spe	cific literature and to associate this kno	wledge with othe	er classes.	
Workload in Hours	Independent Study Time 124, Study Time in Lecture 5	6			
Credit points	6				
Course achievement		scription			
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 sen	nester): Specialisation Computer Scienc	e: Compulsory		
Following Curricula	General Engineering Science (German program, 7	semester): Specialisation Mechanica	al Engineering,	Focus Mechatroni	
	Compulsory				
	General Engineering Science (German program, 7	semester): Specialisation Mechanical	Engineering, Foo	cus Aircraft Syste	
	Engineering: Compulsory				
	General Engineering Science (German program, 7 ser	nester): Specialisation Mechanical Engi	neering, Focus Th	neoretical Mechani	
	Engineering: Compulsory	7 competer), Creciplication Mart		Focus Material	
	General Engineering Science (German program, Engineering Sciences: Compulsory	v semester): Specialisation Mechanic	.ai Erigineering,	rocus Materials	
	General Engineering Science (German program, 7 se	mester): Specialisation Mechanical Eng	ineering Focus (	Product Developm	
	and Production: Compulsory	mestery. Specialisation Mechanical Eng	incernig, rocus i	Toddet Developing	
	General Engineering Science (German program, 7	semester): Specialisation Mechanical	Engineering, Foc	us Energy Syster	
	Compulsory		,	5, -, -	
	General Engineering Science (German program, 7	semester): Specialisation Mechanica	I Engineering, I	Focus Biomechani	
	Compulsory				
	General Engineering Science (German program, 7 sen	nester): Specialisation Electrical Engine	ering: Compulsor	У	
	General Engineering Science (German program, 7 sen	nester): 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				
	Electrical Engineering: Core Qualification: Compulsory				
	Computer Science in Engineering: Core Qualification:	Compulsory			
	Intermeted Duilding Technology C C C 20 10 11	a ative Campulation			
	Integrated Building Technology: Core Qualification: Ele Technomathematics: Specialisation II. Informatics: Ele				

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

Course L0324: Computer Eng	ourse 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		

## **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 (L016	54)	Lecture	2	3	
Discrete Algebraic Structures (L016	65)	Recitation Section (small)	2	3	
Module Responsible	Prof. Karl-Heinz Zimmermann				
Admission Requirements	None				
<b>Recommended Previous</b>	Mathematics from High School.				
Knowledge					
Educational Objectives	After taking part successfully, students have re	ached the following learning results			
Professional Competence					
Knowledge	The students know the important basics of discrete algebraic structures including elementary combinatorial structures, monoic groups, rings, fields, finite fields, and vector spaces. They also know specific structures like sub sum-, and quotient structures as homomorphisms.				
Skills	Students are able to formalize and analyze basic discrete algebraic structures.				
Personal Competence					
Social Competence	Students are able to solve specific problems alone 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 Le	cture 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 Computer Sc	ience: Compulsory		
Following Curricula	Computer Science: Core Qualification: Computer	sory			
	Data Science: Core Qualification: Compulsory				
	Computational Science and Engineering: Core Qualification: Compulsory				
	Orientation Studies: Core Qualification: Elective Compulsory				

Course L0164: Discrete Algebraic Structures		
Тур	Lecture	
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		
Literature		

Course 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			
<b>Recommended Previous</b>	Basic knowledge in electrical engineering			
Knowledge				
Educational Objectives		ed the following learning results		
Professional Competence				
Knowieage	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 following topics: <ul> <li>Introduction</li> </ul>			
	<ul> <li>Combinational logic: Gates, Boolean algebra, Boolean functions, hardware synthesis, combinational networks</li> <li>Sequential logic: Flip-flops, automata, systematic hardware design</li> <li>Technological foundations</li> <li>Computer arithmetic: Integer addition, subtraction, multiplication and division</li> <li>Basics of computer architecture: Programming models, MIPS single-cycle architecture, pipelining</li> <li>Memories: Memory hierarchies, SRAM, DRAM, caches</li> <li>Input/output: I/O from the perspective of the CPU, principles of passing data, point-to-point connections, busses</li> </ul>			
Skills	The students perceive computer systems from the architect's perspective, i.e., they identify the internal structure and the physic composition of computer systems. The students can analyze, how highly specific and individual computers can be built based on collection of few and simple components. They are able to distinguish between and to explain the different abstraction layers today's computing systems - from gates and circuits up to complete processors. After successful completion of the module, the students are able to judge the interdependencies between a physical computer system and the software executed on it. In particular, they shall understand the consequences that the execution of software he on the hardware-centric abstraction layers from the assembly language down to gates. This way, they will be enabled to evaluat the impact that these low abstraction levels have on an entire system's performance and to propose feasible options.			
Personal Competence		a in a subscript of the subscript block of th		
Social Competence	Students are able to solve similar problems alone of	or in a group and to present the results a	cordingly.	
Autonomy	Students are able to acquire new knowledge from s	pecific literature and to associate this k	nowledge with othe	r classes.
Workload in Hours	Independent Study Time 124, Study Time in Lectur	e 56		
Credit points				
Course achievement		Description		
	Yes 10 % Excercises			
Examination	Written exam			
Examination duration and	90 minutes, contents of course and labs			
scale				
Assignment for the				
Following Curricula				
	General Engineering Science (German program, 7 s			
	General Engineering Science (German program	, 7 semester): Specialisation Mechan	cal Engineering, I	Focus Mechatroni
	Compulsory	7 (Constaliantian Machanian	L Facilitation - Fac	Alizza (h. Currha
General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus A			us Aircraft Syste	
	Engineering: Compulsory General Engineering Science (German program, 7	semester): Specialisation Mechanical En	aineering Focus Th	eoretical Mechani
	Engineering: Compulsory	semestery. Specialisation Mechanical En	Jineering, rocus rin	
	General Engineering Science (German program	, 7 semester): Specialisation Mecha	nical Engineering,	Focus Materials
	Engineering Sciences: Compulsory			
	General Engineering Science (German program, 7	semester): Specialisation Mechanical E	ngineering, Focus P	roduct Developme
	and Production: Compulsory			
	General Engineering Science (German program, Compulsory	7 semester): Specialisation Mechanica	I Engineering, Foc	us Energy Syster
	General Engineering Science (German program,	7 semester): Specialisation Mechani	cal Engineering. F	ocus Biomechani
	Compulsory	· · · · · · · · · · · · · · · · · · ·		
	General Engineering Science (German program, 7 semester): Specialisation Naval Architecture: Compulsory General Engineering Science (German program, 7 semester): Specialisation Biomedical Engineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Bioprocess Engineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Electrical Engineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Green Technologies, Focus Renewable Energy: Electric Compulsory			
	Computer Science: Core Qualification: Compulsory			
	Data Science: Core Qualification: Elective Compulse	ory		
	Electrical Engineering: Core Qualification: Compulse	ory		
	General Engineering Science (English program, 7 s	emester): Specialisation Civil Engineering	g: Compulsory	
	General Engineering Science (English program,			ocus Biomechan
				ocus Biomechar

Engineering: Compulsory
General Engineering Science (English program, 7 semester): Specialisation Mechanical Engineering, Focus Materials in Engineering
Sciences: Compulsory
General Engineering Science (English program, 7 semester): Specialisation Mechanical Engineering, Focus Mechatronics:
Compulsory
General Engineering Science (English program, 7 semester): Specialisation Mechanical Engineering, Focus Product Development
and Production: Compulsory
General Engineering Science (English program, 7 semester): Specialisation Mechanical Engineering, Focus Theoretical Mechanical
Engineering: Compulsory
Computational Science and Engineering: Core Qualification: Compulsory
Mechatronics: Core Qualification: Compulsory
Technomathematics: Specialisation II. Informatics: Elective Compulsory

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

Course L0324: Computer Eng	Course 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	

Section (small) g results zation. They are ab They are capable o	Hrs/wk 2 2	CP 3 3	
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	le to explain the	m using appropriat	
They are capable of		in asing appropria	
They are capable of			
	of illustrating the	se connections wi	
with the help of t	ne concepts stu	died in this cours	
methods.	te etudiod in the	COURCO	
between the concep itable approach, an			
itable approach, an		lically evaluate t	
<ul> <li>Students are able to work together in teams. They are capable to use mathematics as a common language.</li> </ul>			
needs of their coope	erating partners.	Moreover, they ca	
ers.			
oncepts on their ov	vn They can spe	cify open question	
	in mey can spe	ieny open question	
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n Computer Science	: Compulsory		
sory			
e Compulsory			
pulsory			
	c for longer periods	Compulsory	

urse L1046: Graph Theory _	•
	Lecture
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	<ul> <li>Graphs, search algorithms for graphs, trees</li> <li>planar graphs</li> <li>shortest paths</li> <li>minimum spanning trees</li> <li>maximum flow and minimum cut</li> <li>theorems of Menger, König-Egervary, Hall</li> <li>NP-complete problems</li> <li>backtracking and heuristics</li> <li>linear programming</li> <li>duality</li> <li>integer linear programming</li> </ul>
Literature	<ul> <li>M. Aigner: Diskrete Mathematik, Vieweg, 2004</li> <li>T. Cormen, Ch. Leiserson, R. Rivest, C. Stein: Algorithmen - Eine Einführung, Oldenbourg, 2013</li> <li>J. Matousek und J. Nesetril: Diskrete Mathematik, Springer, 2007</li> <li>A. Steger: Diskrete Strukturen (Band 1), Springer, 2001</li> <li>A. Taraz: Diskrete Mathematik, Birkhäuser, 2012</li> <li>V. Turau: Algorithmische Graphentheorie, Oldenbourg, 2009</li> <li>KH. Zimmermann: Diskrete Mathematik, BoD, 2006</li> </ul>

Course L1047: Graph Theory and Optimization	
Тур	Recitation Section (small)
Hrs/wk	2
CP	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		Тур	Hrs/wk	СР
Stochastics (L0777)		Lecture	2	4
Stochastics (L0778)		Recitation Section (small)	2	2
Module Responsible				
Admission Requirements	None			
Recommended Previous	Calculus			
Knowledge	<ul> <li>Discrete algebraic structures (combinatorics)</li> </ul>			
	Propositional logic			
-	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	een these concepts. They are capable	of illustrating th	ese connections w
	the help of examples.			
	<ul> <li>They know proof strategies and can reproduce</li> </ul>	them.		
Skills				
Skins	<ul> <li>Students can model problems from stochasti</li> </ul>	cs with the help of the concepts studie	ed in this course	. Moreover, they a
	capable of solving them by applying establishe	ed methods.		
	<ul> <li>Students are able to discover and verify further</li> </ul>	5		
	<ul> <li>For a given problem, the students can devel</li> </ul>	op and execute a suitable approach, a	nd are able to c	ritically evaluate
	results.			
Personal Competence				
Social Competence				
	Students are able to work together (e.g. on their regular home work) in heterogeneously composed teams (in			
	different study programs and background know			
	<ul> <li>In doing so, they can communicate new concerned docign examples to check and docpon the uncerned doctors.</li> </ul>		peracing partners	. Moreover, triey c
	design examples to check and deepen the unc	lerstanding of their peers.		
Autonomy	. Chudanta are concluded the sheeting their under	standing of complex concepts on their .	They can an	acifu anon quactia
	<ul> <li>Students are capable of checking their under precisely and know where to get help in solvin</li> </ul>		wii. They can sp	ecity open questio
	<ul> <li>Students can put their knowledge in relation to</li> </ul>			
	<ul> <li>Students have developed sufficient persisten</li> </ul>		s in a goal-orien	ted manner on ha
	problems.		g	
	Independent Study Time 124, Study Time in Lecture	56		
Credit points Course achievement				
Examination				
Examination duration and scale	120 (((()			
	General Engineering Science (German program, 7 se	mester): Specialisation Computer Science	e: Compulsory	
Following Curricula	Computer Science: Core Qualification: Compulsory		2. compaisory	
	Data Science: Core Qualification: Compulsory			
	Computational Science and Engineering: Core Qualifi	cation: Compulsory		
	Logistics and Mobility: Specialisation Engineering Sci			
	Logistics and Mobility: Specialisation Information Tec	hnology: Elective Compulsory		
	Theoretical Mechanical Engineering: Core Qualification	n: Elective Compulsory		
	Engineering and Management - Major in Logistics and	Mobility: Specialisation Information Tec	hnology: Elective	Compulsory

Course L0777: Stochastics			
Тур	Lecture		
Hrs/wk			
CP			
Workload in Hours	ndependent Study Time 92, Study Time in Lecture 28		
Lecturer	Prof. Matthias Schulte		
Language	DE/EN		
Cycle	SoSe		
Content	<ul> <li>Definitions of probability, conditional probability</li> <li>Random variables, dependencies, independence assumptions,</li> <li>Marginal and joint probabilities</li> <li>Distributions and density functions</li> <li>Characteristics: expected values, variance, standard deviation, moments</li> <li>Multivariate distributions</li> <li>Law of large numbers and central limit theorem</li> <li>Basic notions of stochastic processes</li> <li>Basic concepts of statistics (point estimators, confidence intervals, hypothesis testing)</li> </ul>		
Literature	<ol> <li>Methoden der statistischen Inferenz, Likelihood und Bayes, Held, L., Spektrum 2008</li> <li>Stochastik für Informatiker, Dümbgen, L., Springer 2003</li> <li>Statistik: Der Weg zur Datenanalyse, Fahrmeir, L., Künstler R., Pigeot, I, Tutz, G., Springer 2010</li> <li>Stochastik, Georgii, HO., deGruyter, 2009</li> <li>Probability and Random Processes, Grimmett, G., Stirzaker, D., Oxford University Press, 2001</li> <li>Programmieren mit R, Ligges, U., Springer 2008</li> </ol>		

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	

C				
Courses				
Title	10000 (10000)	Typ	Hrs/wk	CP
Automata Theory and Formal Lang Automata Theory and Formal Lang		Lecture Recitation Section (small)	2	4 2
Module Responsible			-	-
Admission Requirements				
Recommended Previous	Participating students should be able to			
Knowledge		ures (such as, e.g., arrays) to solve computational p	oroblems	
	- apply propositional logic and predicate lo	ogic for specifying and understanding mathematical	l proofs	
	- apply the knowledge and skills taught in	the module Discrete Algebraic Structures		
Educational Objectives	After taking part successfully, students ha	ave reached the following learning results		
Professional Competence				
	kinds of temporal logic, and identify the automata and can identify relationships deterministic and nondeterministic finite formalism for which nondeterminism is r problems require which expressivity, and, problems w.r.t. other formalisms. They un	roblem. Students can also describe syntax, semant eir application areas. The participants of the cour to logic and formal grammars. The spectrum the a automata and pushdown automata to Turing n more expressive than determinism. They are also , in addition, students can transform decision proble aderstand that some formalisms easily induce algor es. Students can describe the relationships between	rse can define va at students can nachines. Studen able to demons ems w.r.t. one for ithms whereas of	arious kinds of fir explain ranges fr nts can name tho strate which decis rmalism into decis thers are best suit
Skills	problems in order to derive propositional which formalism is best suited for a part decision problems to specific formulas. St	well as predicate logic resolution to a given set of f logic, predicate logic, or temporal logic formulas t cicular application problem, and they can demonst tudents can also transform nondeterministic autom a. They can show how parsers work, and they ca ds.	to represent then trate the applicat nata into determin	n. They can evalu tion of algorithms nistic ones, or de
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	90 min			
scale				
Assignment for the	General Engineering Science (German pro	gram, 7 semester): Specialisation Computer Scienc	e: Compulsory	
Following Curricula	Computer Science: Core Qualification: Cor	mpulsory		
	Data Science: Core Qualification: Compuls	sory		
	Engineering Science: Specialisation Mecha			
		gram, 7 semester): Specialisation Mechatronics: Ele	ctive Compulsory	(
	Computational Science and Engineering: O	Core Oualification: Compulsory		
	Orientation Studies: Core Qualification: Ele			

Тур	Lecture		
	2		
111 <i>3</i> / WK	4		
-			
	Independent Study Time 92, Study Time in Lecture 28		
	rof. Matthias Mnich		
Language			
Cycle	ie		
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 expres		
	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, pum		
	lemma for context-free grammars, transformation of formalisms (from pushdown automata to context-free grammars		
	back)		
	12. Chomsky normal form		
	13. CYK algorithm for deciding the word problem for context-free grammrs		
	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		
	16. Regular grammars		
	17. Outlook: Turing machines and linear bounded automata vs general and context-sensitive grammars		
	18. Chomsky hierarchy		
	19. Mealy- and Moore automata:		
	Automata with output (w/o accepting states), infinite state sequences, automata networks		
	20. Omega automata: Automata for infinite input words, Büchi automata, representation of state transition systems, verifica		
	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			
Literature	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.		

Course L0507: Automata The	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		

Module M0803: Embe	edded Systems
Courses	
Title	Typ Hrs/wk CP
Embedded Systems (L0805)	Lecture 3 4
Embedded Systems (L0806)	Recitation Section (small) 1 2
Module Responsible	Prof. Heiko Falk
Admission Requirements	None
<b>Recommended Previous</b>	Computer Engineering
Knowledge	
Educational Objectives	After taking part successfully, students have reached the following learning results
Professional Competence	
Knowledge	Embedded systems can be defined as information processing systems embedded into enclosing products. This course teaches foundations of such systems. In particular, it deals with an introduction into these systems (notions, common characteristics) their specification languages (models of computation, hierarchical automata, specification of distributed systems, task gra specification of real-time applications, translations between different models).
Skills	Another part covers the hardware of embedded systems: Sonsors, A/D and D/A converters, real-time capable communical hardware, embedded processors, memories, energy dissipation, reconfigurable logic and actuators. The course also feature introduction into real-time operating systems, middleware and real-time scheduling. Finally, the implementation of embedd systems using hardware/software co-design (hardware/software partitioning, high-level transformations of specifications, energy discipation, reconsigurable logic and actuators. The course also feature introduction into real-time operating systems, middleware and real-time scheduling. Finally, the implementation of embedd systems using hardware/software co-design (hardware/software partitioning, high-level transformations of specifications, energicient realizations, compilers for embedded processors) is covered.
	which areas of embedded system design specific risks exist.
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	
Course achievement	Compulsory Bonus Form Description
	Yes 10 % Subject theoretical and
	practical work
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 Science: Compulsory
Following Curricula	Computer Science: Specialisation Computer and Software Engineering: Elective Compulsory
	Computer Science: Specialisation I. Computer and Software Engineering: Elective Compulsory
	Electrical Engineering: Core Qualification: Elective Compulsory
	Engineering Science: Specialisation Mechatronics: Elective Compulsory
	Aircraft Systems Engineering: Core Qualification: Elective Compulsory
	General Engineering Science (English program, 7 semester): Specialisation Mechatronics: Elective Compulsory
	Computational Science and Engineering: Core Qualification: Compulsory
	Mechatronics: Specialisation System Design: Elective Compulsory
	Mechatronics: Specialisation Intelligent Systems and Robotics: Elective Compulsory
	Mechatronics: Core Qualification: Elective Compulsory
	Microelectronics and Microsystems: Specialisation Embedded Systems: Elective Compulsory
Course L0805: Embedded Sy	/stems
Тур	Lecture
Hrs/wk	3
CP	4
Workload in Hours	Independent Study Time 78, Study Time in Lecture 42
Lecturer	Prof. Heiko Falk
Language	
	SoSe
eyele	1

Cycle	SoSe
Content	<ul> <li>Introduction</li> <li>Specifications and Modeling</li> <li>Embedded/Cyber-Physical Systems Hardware</li> <li>System Software</li> <li>Evaluation and Validation</li> <li>Mapping of Applications to Execution Platforms</li> <li>Optimization</li> </ul>
Literature	<ul> <li>Peter Marwedel. Embedded System Design - Embedded Systems Foundations of Cyber-Physical Systems. 2 <sup>nd</sup> Edition, Springer, 2012., Springer, 2012.</li> </ul>

Course L0806: Embedded Sy	ourse 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				
<b>Recommended Previous</b>	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			peers. They explain problems and solu	utions to their pee	er. They defend the
	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.
			dependently, 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 Pr	Course L0624: Functional Programming		
Тур	Lecture		
Hrs/wk	2		
CP	2		
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28		
Lecturer	of. Sibylle Schupp		
Language	N		
Cycle	liSe		
Content	<ul> <li>Functions, Currying, Recursive Functions, Polymorphic Functions, Higher-Order Functions</li> <li>Conditional Expressions, Guarded Expressions, Pattern Matching, Lambda Expressions</li> <li>Types (simple, composite), Type Classes, Recursive Types, Algebraic Data Type</li> <li>Type Constructors: Tuples, Lists, Trees, Associative Lists (Dictionaries, Maps)</li> <li>Modules</li> <li>Interactive Programming</li> <li>Lazy Evaluation, Call-by-Value, Strictness</li> <li>Design Recipes</li> <li>Testing (axiom-based, invariant-based, against reference implementation)</li> <li>Reasoning about Programs (equation-based, inductive)</li> <li>Idioms of Functional Programming</li> <li>Haskell Syntax and Semantics</li> </ul>		
Literature	Graham Hutton, Programming in Haskell, Cambridge University Press 2007.		

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

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

Courses				
<b>Title</b> Introductory Seminar Computer Sci	onco I (12262)	<b>Typ</b> Seminar	Hrs/wk 2	<b>СР</b> 3
Introductory Seminar Computer Sci		Seminar	2	3
Module Responsible			_	-
Admission Requirements	None			
Recommended Previous	Basic knowledge of Computer Science ar	ad Mathematics at the Rachelor's lovel		
Knowledge	basic knowledge of computer science a			
Educational Objectives	After taking part successfully, students h	ave reached the following learning results		
Professional Competence	After taking part successionly, students i	ave reached the following learning results		
•	The students are able to			
Knowledge	The students are able to			
	<ul> <li>explicate a specific topic in the field</li> </ul>	ld of Computer Science,		
	<ul> <li>describe complex issues,</li> </ul>			
	<ul> <li>present different views and evaluation</li> </ul>	ate in a critical way.		
Skills	The students are able to			
	<ul> <li>familiarize in a specific topic of Co</li> </ul>	mouter Science in limited time		
		specific topic and cite in a correct way,		
	<ul> <li>elaborate a presentation and give</li> </ul>			
	<ul> <li>sum up the presentation in 10-15</li> </ul>			
	<ul> <li>answer questions in the final discu</li> </ul>			
Personal Competence				
Social Competence	The students are able to			
	<ul> <li>elaborate and introduce a topic fo</li> </ul>	r a certain audience.		
		acture of the presentation with the instructor,		
	<ul> <li>discuss certain aspects with the a</li> </ul>			
	<ul> <li>as the lecturer listen and respond</li> </ul>			
Autonomv	The students are able to			
,				
	define the task in question in an a			
	<ul> <li>develop the necessary knowledge</li> </ul>			
	<ul> <li>use appropriate work equipment,</li> </ul>			
	<ul> <li>guided by an instructor critically c</li> </ul>	neck the working status.		
Workload in Hours	Independent Study Time 124, Study Tim	e in Lecture 56		
Credit points	6			
Course achievement	None			
Examination	Presentation			
Examination duration and	x			
scale				
Assignment for the	General Engineering Science (German pr	ogram, 7 semester): Specialisation Computer S	cience: Elective Comp	llsorv
-				
	Data Science: Core Qualification: Compu			
	Data Science: Core Qualification: Compu			
	Computer Science in Engineering: Core (	•		

Course L2362: Introductory	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		

Course L2361: Introductory	Course 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
Computer Networks and Internet S		Lecture	3	5
Computer Networks and Internet S		Recitation Section (small)	1	1
Module Responsible	Prof. Andreas Timm-Giel			
Admission Requirements	None			
<b>Recommended Previous</b>	Basics of Computer Science			
Knowledge				
Educational Objectives	After taking part successfully, students h	ave reached the following learning results		
Professional Competence				
Knowledge	Students are able to explain important a	and common Internet protocols in detail and class	ify them, in order t	to be able to anal
	and develop networked systems in furthe	er studies and job.		
CL/II-				
SKIIIS	Students are able to analyse common In	ternet protocols and evaluate the use of them in di	ifferent domains.	
Personal Competence				
Social Competence				
Autonomy	Students can select relevant parts out of	high amount of professional knowledge and can ir	ndependently learn	and understand it
Workload in Hours	Independent Study Time 124, Study Tim	e in Lecture 56		
Credit points	6			
Credit points Course achievement				
Course achievement				
Course achievement	None Written exam			
Course achievement Examination	None Written exam 120 min			
Course achievement Examination Examination duration and	None Written exam 120 min	rogram, 7 semester): Specialisation Computer Scie	nce: Elective Comp	ulsory
Course achievement Examination Examination duration and scale Assignment for the	None Written exam 120 min	ogram, 7 semester): Specialisation Computer Scie	nce: Elective Comp	ulsory
Course achievement Examination Examination duration and scale Assignment for the	None Written exam 120 min General Engineering Science (German pr Computer Science: Core Qualification: Co		nce: Elective Comp	ulsory
Course achievement Examination Examination duration and scale Assignment for the	None Written exam 120 min General Engineering Science (German pr Computer Science: Core Qualification: Co	ompulsory ics/Computer Science: Elective Compulsory	nce: Elective Comp	ulsory
Course achievement Examination Examination duration and scale Assignment for the	None Written exam 120 min General Engineering Science (German pr Computer Science: Core Qualification: Co Data Science: Specialisation I. Mathemat	ics/Computer Science: Elective Compulsory e Compulsory	nce: Elective Comp	ulsory
Course achievement Examination Examination duration and scale Assignment for the	None Written exam 120 min General Engineering Science (German pr Computer Science: Core Qualification: Co Data Science: Specialisation I. Mathemat Data Science: Core Qualification: Electivo	ompulsory ics/Computer Science: Elective Compulsory e Compulsory : Elective Compulsory	nce: Elective Comp	ulsory
Course achievement Examination Examination duration and scale Assignment for the	None Written exam 120 min General Engineering Science (German pr Computer Science: Core Qualification: Co Data Science: Specialisation I. Mathemat Data Science: Core Qualification: Electivo Electrical Engineering: Core Qualification	mpulsory ics/Computer Science: Elective Compulsory e Compulsory : Elective Compulsory rical Engineering: Elective Compulsory	nce: Elective Comp	ulsory
Course achievement Examination Examination duration and scale Assignment for the	None Written exam 120 min General Engineering Science (German pr Computer Science: Core Qualification: Cr Data Science: Specialisation I. Mathemat Data Science: Core Qualification: Elective Electrical Engineering: Core Qualification Engineering Science: Specialisation Elect	ompulsory ics/Computer Science: Elective Compulsory e Compulsory : Elective Compulsory rrical Engineering: Elective Compulsory natronics: Elective Compulsory	nce: Elective Comp	ulsory
Course achievement Examination Examination duration and scale Assignment for the	None Written exam 120 min General Engineering Science (German pr Computer Science: Core Qualification: Cc Data Science: Specialisation I. Mathemat Data Science: Core Qualification: Elective Electrical Engineering: Core Qualification Engineering Science: Specialisation Elect Engineering Science: Specialisation Mech Engineering Science: Specialisation Mech	ompulsory ics/Computer Science: Elective Compulsory e Compulsory : Elective Compulsory rrical Engineering: Elective Compulsory natronics: Elective Compulsory		
Course achievement Examination Examination duration and scale Assignment for the	None Written exam 120 min General Engineering Science (German pr Computer Science: Core Qualification: Cc Data Science: Specialisation I. Mathemat Data Science: Core Qualification: Elective Electrical Engineering: Core Qualification Engineering Science: Specialisation Elect Engineering Science: Specialisation Mech Engineering Science: Specialisation Mech	ompulsory ics/Computer Science: Elective Compulsory e Compulsory : Elective Compulsory rical Engineering: Elective Compulsory natronics: Elective Compulsory natronics: Elective Compulsory ogram, 7 semester): Specialisation Mechatronics: E		·

Course L1098: Computer Net	tworks and Internet Security
Тур	Lecture
Hrs/wk	3
CP	5
Workload in Hours	Independent Study Time 108, Study Time in Lecture 42
Lecturer	Prof. Andreas Timm-Giel, DrIng. Koojana Kuladinithi, Prof. Dieter Gollmann
Language	EN
Cycle	WiSe
Content	In this class an introduction to computer networks with focus on the Internet and its security is given. Basic functionality of complex protocols are introduced. Students learn to understand these and identify common principles. In the exercises these basic principles and an introduction to performance modelling are addressed using computing tasks and (virtual) labs. In the second part of the lecture an introduction to Internet security is given. This class comprises: • Application layer protocols (HTTP, FTP, DNS) • Transport layer protocols (TCP, UDP) • Network Layer (Internet Protocol, routing in the Internet) • Data link layer with media access at the example of Ethernet • Multimedia applications in the Internet • Network management • Internet security: IPSec • Internet security: Firewalls
Literature	<ul> <li>Kurose, Ross, Computer Networking - A Top-Down Approach, 6th Edition, Addison-Wesley</li> <li>Kurose, Ross, Computernetzwerke - Der Top-Down-Ansatz, Pearson Studium; Auflage: 6. Auflage</li> <li>W. Stallings: Cryptography and Network Security: Principles and Practice, 6th edition</li> </ul> Further literature is announced at the beginning of the lecture.

Course L1099: Computer Net	ourse 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	Prof. Andreas Timm-Giel, Prof. Dieter Gollmann		
Language	EN		
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			
<b>Recommended Previous</b>				
Knowledge	<ul> <li>Mathematik I + II for Engineering Students (german or english) or Analysis &amp; Linear Algorithms basic MATLAB/Python knowledge</li> </ul>	ebra I + II for Te	echnomathematici	
Educational Objectives	After taking part successfully, students have reached the following learning results			
Professional Competence				
Knowledge	Students are able to			
	<ul> <li>name numerical methods for interpolation, integration, least squares problems, eigenvalue problems, nonlinear root fi problems and to explain their core ideas,</li> <li>repeat convergence statements for the numerical methods,</li> <li>explain aspects for the practical execution of numerical methods with respect to computational and storage complexity</li> </ul>			
Skills	Students are able to			
	<ul> <li>implement, apply and compare numerical methods using MATLAB/Python,</li> <li>justify the convergence behaviour of numerical methods with respect to the problem an</li> <li>select and execute a suitable solution approach for a given problem.</li> </ul>	d solution algor	ithm,	
Personal Competence				
Social Competence	Students are able to			
	<ul> <li>work together in heterogeneously composed teams (i.e., teams from different study pro explain theoretical foundations and support each other with practical aspects regarding</li> </ul>			
Autonomy	Students are capable			
	<ul> <li>to assess whether the supporting theoretical and practical excercises are better solved</li> <li>to assess their individual progess and, if necessary, to ask questions and seek help.</li> </ul>	individually or i	n a 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	: Compulsory		
	General Engineering Science (German program, 7 semester): Specialisation Biomedical Engine		ory	
· ····································	General Engineering Science (German program, 7 semester): Specialisation Mechanical	5 1	5	
		Engineering,		
			Biomeenan	
	Compulsory	eering Focus T		
	Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engine	eering, Focus Tl		
	Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engine Engineering: Compulsory	-	heoretical Mechan	
	Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engine Engineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical E	-	heoretical Mechan	
	Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engine Engineering: Compulsory	ingineering, Fo	heoretical Mechan cus Aircraft Syste	
	Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engine Engineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical E Engineering: Elective Compulsory	ingineering, Fo	neoretical Mechan cus Aircraft Syste	
	Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engine Engineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical E Engineering: Elective Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engine	eering, Focus M	neoretical Mechan cus Aircraft Syste lechatronics: Elect	
	Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engine Engineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical E Engineering: Elective Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engine Compulsory	eering, Focus M	neoretical Mechan cus Aircraft Syste lechatronics: Elect	
	Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engine Engineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical E Engineering: Elective Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engin Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engin	ngineering, Fo eering, Focus M ngineering, Foc	neoretical Mechan cus Aircraft Syste lechatronics: Elect	
	Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engine Engineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical E Engineering: Elective Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engin Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engin Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical E Elective Compulsory	ingineering, For eering, Focus M ngineering, Foc	heoretical Mechan cus Aircraft Syste lechatronics: Elect cus Energy System	
	Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engine Engineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical E Engineering: Elective Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engin Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical E Elective Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical E Elective Compulsory General Engineering Science (German program, 7 semester): Specialisation Advanced Material	ingineering, For eering, Focus M ngineering, Foc	heoretical Mechan cus Aircraft Syste lechatronics: Elect cus Energy System	
	Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engine Engineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical E Engineering: Elective Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engin Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical E Elective Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical E Elective Compulsory General Engineering Science (German program, 7 semester): Specialisation Advanced Material General Engineering Science (German program, 7 semester): Specialisation Mechanical	eering, Focus M ngineering, Focus M ngineering, Foc ls: Compulsory al Engineering,	heoretical Mechan cus Aircraft Syste lechatronics: Elect cus Energy System	
	Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engine Engineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical E Engineering: Elective Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engin Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical E Elective Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical E Elective Compulsory General Engineering Science (German program, 7 semester): Specialisation Advanced Material General Engineering Science (German program, 7 semester): Specialisation Mechanicat Engineering Sciences: Compulsory	eering, Focus M ngineering, Focus M ngineering, Foc Is: Compulsory al Engineering, Y	heoretical Mechan cus Aircraft Syste lechatronics: Elect cus Energy System	
	Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engine Engineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical E Engineering: Elective Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engin Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical E Elective Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical E Elective Compulsory General Engineering Science (German program, 7 semester): Specialisation Advanced Material General Engineering Science (German program, 7 semester): Specialisation Mechanicat Engineering Sciences: Compulsory Bioprocess Engineering: Specialisation A - General Bioprocess Engineering: Elective Compulsor	eering, Focus M ngineering, Focus M ngineering, Foc Is: Compulsory al Engineering, Y	heoretical Mechan cus Aircraft Syste lechatronics: Elect cus Energy System	
	Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engine Engineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engine Engineering: Elective Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engin Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engin Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical E Elective Compulsory General Engineering Science (German program, 7 semester): Specialisation Advanced Material General Engineering Science (German program, 7 semester): Specialisation Mechanicat Engineering Sciences: Compulsory Bioprocess Engineering: Specialisation A - General Bioprocess Engineering: Elective Compulsor Computer Science: Specialisation II. Mathematics and Engineering Science: Elective Compulsor	eering, Focus M ngineering, Focus M ngineering, Foc Is: Compulsory al Engineering, Y	heoretical Mechan cus Aircraft Syste lechatronics: Elect cus Energy System	
	Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engine Engineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical E Engineering: Elective Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engin Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical E Elective Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical E Elective Compulsory General Engineering Science (German program, 7 semester): Specialisation Advanced Material General Engineering Science (German program, 7 semester): Specialisation Mechanicat Engineering Sciences: Compulsory Bioprocess Engineering: Specialisation A - General Bioprocess Engineering: Elective Compulsor Computer Science: Specialisation II. Mathematics and Engineering Science: Elective Compulsor	eering, Focus M ngineering, Focus M ngineering, Foc Is: Compulsory al Engineering, Y	heoretical Mechan cus Aircraft Syste lechatronics: Elect cus Energy System	
	Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engine Engineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical E Engineering: Elective Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engin Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical E Elective Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical E Elective Compulsory General Engineering Science (German program, 7 semester): Specialisation Advanced Material General Engineering Science (German program, 7 semester): Specialisation Mechanicat Engineering Sciences: Compulsory Bioprocess Engineering: Specialisation A - General Bioprocess Engineering: Elective Compulsor Computer Science: Specialisation II. Mathematics and Engineering Science: Elective Compulsor Data Science: Core Qualification: Compulsory Electrical Engineering: Core Qualification: Elective Compulsory	eering, Focus M ngineering, Focus M ngineering, Foc Is: Compulsory al Engineering, Y	heoretical Mechan cus Aircraft Syste lechatronics: Elect cus Energy System	
	Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engine Engineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical E Engineering: Elective Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engin Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical E Elective Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical E Elective Compulsory General Engineering Science (German program, 7 semester): Specialisation Advanced Material General Engineering Science (German program, 7 semester): Specialisation Mechanica Engineering Sciences: Compulsory Bioprocess Engineering: Specialisation A - General Bioprocess Engineering: Elective Compulsor Computer Science: Specialisation II. Mathematics and Engineering Science: Elective Compulsor Data Science: Core Qualification: Compulsory Electrical Engineering: Core Qualification: Elective Compulsory Engineering Science: Core Qualification: Compulsory	eering, Focus M ngineering, Focus M ngineering, Foc Is: Compulsory al Engineering, Y	heoretical Mechan cus Aircraft Syste lechatronics: Elec cus Energy Syste	
	Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engine Engineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical E Engineering: Elective Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engin Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical E Elective Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical E Elective Compulsory General Engineering Science (German program, 7 semester): Specialisation Advanced Material General Engineering Science (German program, 7 semester): Specialisation Mechanica Engineering Sciences: Compulsory Bioprocess Engineering: Specialisation A - General Bioprocess Engineering: Elective Compulsor Computer Science: Specialisation II. Mathematics and Engineering Science: Elective Compulsor Data Science: Core Qualification: Compulsory Electrical Engineering: Core Qualification: Elective Compulsory Engineering Science: Core Qualification: Compulsory Engineering Science: Core Qualification: Compulsory Engineering Science: Core Qualification: Compulsory	eering, Focus M ngineering, Focus M ngineering, Foc Is: Compulsory al Engineering, Y	heoretical Mechan cus Aircraft Syste lechatronics: Elec cus Energy Syste	
	Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engine Engineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical E Engineering: Elective Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engin Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical E Elective Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical E Elective Compulsory General Engineering Science (German program, 7 semester): Specialisation Advanced Material General Engineering Science (German program, 7 semester): Specialisation Mechanicat Engineering Sciences: Compulsory Bioprocess Engineering: Specialisation A - General Bioprocess Engineering: Elective Compulsor Computer Science: Specialisation II. Mathematics and Engineering Science: Elective Compulsor Data Science: Core Qualification: Compulsory Electrical Engineering: Core Qualification: Elective Compulsory Engineering Science: Core Qualification: Compulsory Computer Science: Core Qualification: Compulsory Mechanical Engineering: Specialisation Theoretical Mechanical Engineering: Compulsory Mechanical Engineering: Specialisation Energy Systems: Elective Compulsory	eering, Focus M ngineering, Foc Is: Compulsory al Engineering, ry	heoretical Mechan cus Aircraft Syste lechatronics: Elec cus Energy Syste	
	Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engine Engineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical E Engineering: Elective Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engin Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical E Elective Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical E Elective Compulsory General Engineering Science (German program, 7 semester): Specialisation Advanced Material General Engineering Science (German program, 7 semester): Specialisation Mechanicat Engineering Sciences: Compulsory Bioprocess Engineering: Specialisation A - General Bioprocess Engineering: Elective Compulsor Computer Science: Specialisation II. Mathematics and Engineering Science: Elective Compulsor Data Science: Core Qualification: Compulsory Electrical Engineering: Core Qualification: Elective Compulsory Engineering Science: Core Qualification: Compulsory Engineering Science: Core Qualification: Compulsory Computer Science in Engineering: Core Qualification: Compulsory Mechanical Engineering: Specialisation Theoretical Mechanical Engineering: Compulsory	eering, Focus M ngineering, Foc Is: Compulsory al Engineering, ry	heoretical Mechan cus Aircraft Syste lechatronics: Elect cus Energy System	

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	<ol> <li>Finite precision arithmetic, error analysis, conditioning and stability</li> <li>Linear systems of equations: LU and Cholesky factorization, condition</li> <li>Interpolation: polynomial, spline and trigonometric interpolation</li> <li>Nonlinear equations: fixed point iteration, root finding algorithms, Newton's method</li> <li>Linear and nonlinear least squares problems: normal equations, Gram Schmidt and Householder orthogonalization, singular value decomposition, regularizatio, Gauss-Newton and Levenberg-Marquardt methods</li> <li>Eigenvalue problems: power iteration, inverse iteration, QR algorithm</li> <li>Numerical differentiation</li> <li>Numerical integration: Newton-Cotes rules, error estimates, Gauss quadrature, adaptive quadrature</li> </ol>
Literature	<ul> <li>Gander/Gander/Kwok: Scientific Computing: An introduction using Maple and MATLAB, Springer (2014)</li> <li>Stoer/Bulirsch: Numerische Mathematik 1, Springer</li> <li>Dahmen, Reusken: Numerik f ür Ingenieure und Naturwissenschaftler, Springer</li> </ul>

Course L0418: Numerical Ma	ourse L0418: Numerical Mathematics I	
Тур	Recitation Section (small)	
Hrs/wk	2	
CP	3	
Workload in Hours	endent 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						
Гitle			Тур		Hrs/wk	СР
Computer Architecture (L0793)			Lectu	ire	2	3
Computer Architecture (L0794)			Proje	ct-/problem-based Learning	2	2
Computer Architecture (L1864)			Recit	ation Section (small)	1	1
Module Responsible	Prof. Heiko Falk					
Admission Requirements	None					
<b>Recommended Previous</b>	Module "Computer Er	igineering"				
Knowledge						
Educational Objectives	After taking part succ	essfully, students have r	eached the following lea	rning results		
<b>Professional Competence</b>						
-	various programming processors). Next, for so-called pipelining a	g models is given, both undational aspects of the nd the methods used fo	h for general-purpose micro-architecture of pr r the acceleration of ins	puter architecture. In the computers and for specia rocessors are covered. Here truction execution used in calar execution of machi	al-purpose ma e, the focus pa this context.	achines (e.g., sig articularly lies on The students get
Skills	models. The students analyze them w.r.t. c	examine various structu riteria like, e.g., performa	ires of pipelined process ance or energy efficience	v know the different archite or architectures and are ab y. They evaluate different s een instruction- and data-le	le to explain t structures of n	heir concepts and nemory hierarchie
Personal Competence						
Social Competence	Students are able to s	solve similar problems al	one or in a group and to	present the results accord	ingly.	
Autonomy	Students are able to a	acquire new knowledge f	rom specific literature ar	nd to associate this knowle	dge with othe	r classes.
Workload in Hours	Independent Study Ti	me 110, Study Time in L	ecture 70			
Credit points	6					
Course achievement	Compulsory Bonus No 15 %	Form Subject theoretical practical work	Description and			
Examination	Written exam					
Examination duration and	90 minutes, contents	of course and 4 attestat	ions from the PBL "Comp	outer architecture"		
scale						
Assignment for the	General Engineering	Science (German program	m, 7 semester): Specialis	ation Computer Science: E	lective Compu	llsory
Following Curricula						
2	Aircraft Systems Engineering: Core Qualification: Elective Compulsory					
		Engineering: Specialisati		Elective Compulsory		

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	<ul> <li>Introduction</li> <li>VHDL Basics</li> <li>Programming Models</li> <li>Realization of Elementary Data Types</li> <li>Dynamic Scheduling</li> <li>Branch Prediction</li> <li>Superscalar Machines</li> <li>Memory Hierarchies</li> </ul> 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	<ul> <li>D. Patterson, J. Hennessy. Rechnerorganisation und -entwurf. Elsevier, 2005.</li> <li>A. Tanenbaum, J. Goodman. Computerarchitektur. Pearson, 2001.</li> </ul>

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 Arc	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	
Statistics (L2430)		Lecture	3	4	
Statistics (L2431)		Recitation Section (small)	1	2	
Module Responsible	Prof. Matthias Schulte				
Admission Requirements	None				
<b>Recommended Previous</b>	Stochastics (or a comparable class)				
Knowledge					
Educational Objectives	After taking part successfully, students have reac	hed the following learning results			
Professional Competence					
Knowledge					
	Students can name the basic concepts in S     Chudents can discuss large a size large sticks			-	
	Students can discuss logical connections b	between these concepts. They are capable	of illustrating th	ese connections w	
	the help of examples.				
Skills					
	<ul> <li>Students can model statistical problems w</li> </ul>	ith the help of the concepts studied in this	course. Moreover	, they are capable	
	solving them by applying established meth	ods. They are able to use the statistical soft	ware R.		
	<ul> <li>Students are able to discover and verify fur</li> </ul>	rther logical connections between the conce	epts studied in the	e course.	
	<ul> <li>For a given problem, the students can de</li> </ul>	evelop and execute a suitable approach, a	ind are able to c	are able to critically evaluate t	
	results.				
Borconal Compotonco					
Personal Competence					
Social Competence	<ul> <li>Students are able to work together (e.g. of</li> </ul>	on their regular home work) in heterogened	ously composed t	eams and to pres	
	their results appropriately (e.g. during exe	rcise class).			
	<ul> <li>In doing so, they can communicate new concepts according to the needs of their cooperating partne</li> </ul>				
	design examples to check and deepen the	understanding of their peers.			
Autonomy	<ul> <li>Students are capable of checking their un</li> </ul>	derstanding of complex concepts on their o	own. They can sp	ecify open questio	
	precisely and know where to get help in so				
	<ul> <li>Students can put their knowledge in relation</li> </ul>				
			ls in a goal-orier	ted manner on ha	
	problems.	Students have developed sufficient persistence to be able to work for longer periods in a goal- problems.			
Workload in Hours Credit points	Independent Study Time 124, Study Time in Lectu	are or			
Course achievement					
Examination					
Examination duration and	90 min				
scale					
Assignment for the	General Engineering Science (German program, 7	semester): Specialisation Advanced Materi	als: Elective Com	pulsory	
Following Curricula	General Engineering Science (German program, 7	semester): Specialisation Computer Science	e: Elective Comp	ulsory	
	Computer Science: Specialisation II. Mathematics	and Engineering Science: Elective Compuls	ory		
	Data Science: Core Qualification: Compulsory				
	Engineering Science: Specialisation Advanced Ma	terials: Elective Compulsory			
	Logistics and Mobility: Specialisation Information	Technology: Elective Compulsory			
	Technomathematics: Specialisation I. Mathematic	s: Elective Compulsory			
	Theoretical Mechanical Engineering: Specialisatio		Compulsory		
	Engineering and Management - Major in Logistics				

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

Course L2431: Statistics	
Тур	Recitation Section (small)
Hrs/wk	1
СР	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

Courses				
Title		Тур	Hrs/wk	СР
Computability and Complexity The	prv (L0166)	Lecture	2	3
Computability and Complexity The		Recitation Section (smal	1) 2	3
Module Responsible	Prof. Martin Kliesch			
Admission Requirements	None			
<b>Recommended Previous</b>	Discrete Algebraic Structures, Automata Th	eory, Logic, and Formal Language Theory.		
Knowledge				
Educational Objectives	After taking part successfully, students hav	e reached the following learning results		
Professional Competence				
Knowledge	Pasic models of computation (finite s	tate machines. Turing machines)		
	<ul> <li>Basic models of computation (finite s</li> <li>Decision problems and formal language</li> </ul>			
	<ul> <li>Gödel numbering of computations</li> </ul>	ages		
	Universal computability			
	<ul> <li>Decidable and undecidable problems</li> </ul>			
	<ul> <li>Reductions, diagonalization, Rice's th</li> </ul>			
	Time and space complexity			
	The complexity classes P and NP			
	Hierarchy theorems			
	<ul> <li>Polynomial time reductions, NP-comp</li> </ul>	bleteness		
	Cook-Levin theorem			
	Uniform circuit families			
	<ul> <li>reproduce the knowledge taught in t</li> <li>reproduce simpler proofs of the court</li> <li>establish connections between the court</li> <li>apply the learned knowledge to concourt</li> </ul>	se and reproduce the ideas of the more com oncepts taught, and	plicated ones,	
Personal Competence				
Social Competence	Students are able to solve specific problem:	s alone or in a group and to present the resu	Its accordingly.	
Autonomy	Students are able to acquire new knowledg	e from newer literature and to associate the	acquired knowledge w	ith other classes
Workload in Hours	Independent Study Time 124, Study Time ir	n Lecture 56		
Credit points	6			
Course achievement	None			
Examination	Written exam			
Examination duration and scale	90 min			
	General Engineering Science (German prog	ram, 7 semester): Specialisation Computer S	cience: Elective Comp	ulsory
-	Computer Science: Core Qualification: Com		cience. Elective comp	
ytulu	Data Science: Core Qualification: Elective C			
	Data Science: Specialisation I. Mathematics			
		ation I. Computer Science: Elective Compuls	ory	
	Technomathematics: Specialisation II. Infor		-	
Course L0166: Computability				
	Lecture			
Hrs/wk	2			

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	SoSe
Content	
Literature	

Course L0167: Computability	rse L0167: Computability and Complexity Theory		
Тур	Recitation Section (small)		
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	SoSe		
Content	See interlocking course		
Literature	See interlocking course		

Module M0971: Opera	ating Systems			
Courses				
Title		Тур	Hrs/wk	СР
Operating Systems (L1153)		Lecture	2	3
Operating Systems (L1154)		Recitation Section (small)	2	3
Module Responsible	Prof. Volker Turau			
Admission Requirements	None			
<b>Recommended Previous</b>				
Knowledge	Object-oriented programming, algorithms, and dat	a structures		
	<ul> <li>Procedural programming</li> <li>Experience in using tools related to operating syst</li> </ul>	ome such as aditors linkars, compile		
	Experience in using Colibraries	ents such as eurors, inikers, complie	15	
	<ul> <li>Experience in using C-indianes</li> </ul>			
Educational Objectives	After taking part successfully, students have reached the	following learning results		
Professional Competence				
Knowledge	Students explain the main abstractions process, virtual	memory, deadlock, lifelock, and file	of operations sy	stems, describe the
	process states and their transitions, and paraphrase t	he architectural variants of operati	ng systems. The	ey give examples of
	existing operating systems and explain their architecture	s. The participants of the course writ	e concurrent pro	grams using threads,
	conditional variables and semaphores. Students can des	cribe the variants of realizing a file sy	stem. Students e	explain at least three
	different scheduling algorithms.			
Skills	Students are able to use the POSIX libraries for concurre	nt programming in a correct and effi	cient way. They a	are able to judge the
Skiis	efficiency of a scheduling algorithm for a given schedulin		cience way. They c	ine ubie to judge the
		5		
Personal Competence				
Social Competence				
Autonomy				
	Independent Study Time 124, Study Time in Lecture 56			
Credit points				
Course achievement				
Examination				
Examination duration and	90 min			
scale				
-	General Engineering Science (German program, 7 semes		-	ulsory
Following Curricula	Computer Science: Specialisation I. Computer and Softwa			
	Computer Science in Engineering: Specialisation I. Comp			
	Technomathematics: Specialisation II. Informatics: Elective	/e Compulsory		

Course L1153: Operating Sys	stems
Тур	Lecture
Hrs/wk	2
CP	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Prof. Volker Turau
Language	DE
Cycle	SoSe
Content	<ul> <li>Architectures for Operating Systems</li> <li>Processes</li> <li>Concurrency</li> <li>Deadlocks</li> <li>Memory organization</li> <li>Scheduling</li> <li>File systems</li> </ul>
Literature	<ol> <li>Operating Systems, William Stallings, Pearson International Edition</li> <li>Moderne Betriebssysteme, Andrew Tanenbaum, Pearson Studium</li> </ol>

Course L1154: Operating Sys	ourse L1154: 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. Volker Turau		
Language	DE		
Cycle	SoSe		
Content	See interlocking course		
Literature	See interlocking course		

Module M0732: Softw	are Engineerin	g				
Courses						
Fitle			Tree		Line (suls	СР
Software Engineering (L0627)			<b>Typ</b> Lecture		Hrs/wk	3
Software Engineering (L0628)			Recitation Secti	ion (small)		3
Module Responsible	Prof. Sibvlle Schupp					-
Admission Requirements						
Recommended Previous						
Knowledge	<ul> <li>Automata theo</li> </ul>	ory and formal language	jes			
	<ul> <li>Procedural pro</li> </ul>	gramming or Functior	al programming			
	<ul> <li>Object-orientee</li> </ul>	d programming, algor	thms, and data structures			
Educational Objectives	After taking part succ	essfully, students hav	e reached the following learning resu	ults		
Professional Competence						
Knowledge	Students explain the	e phases of the sof	tware life cycle, describe the fun	damental termino	plogy and co	oncepts of softw
	engineering, and para	aphrase the principles	of structured software development	. They give examp	oles of softwa	re-engineering ta
	of existing large-sca	le systems. They wri	te test cases for different test stra	tegies and devise	e specificatio	ns or models us
	different notations, a	and critique both. Th	ey explain simple design patterns a	and the major act	tivities in rec	quirements analy
	maintenance, and pro	oject planning.				
Skills	-	-	e, students identify the correspondir			
			urance. They design tests for realist	-		
		evels. They apply ar	id modify non-executable artifacts.	They integrate	components	based on interf
	specifications.					
Personal Competence						
Social Competence	Students practice pee	er programming. They	explain problems and solutions to th	eir peer. They con	nmunicate in	English.
Autonomy	Using on-line quizzes	and accompanying	naterial for self study, students can	access their leve	al of knowled	ae continuously :
hatohomy			e problems, they receive additional f			ge continuously i
		,				
	Independent Study Ti	me 124, Study Time i	n Lecture 56			
Credit points		_				
Course achievement	Compulsory Bonus Yes 15 %	Form Excercises	Description			
Examination	Written exam	Excercises				
Examination duration and						
scale	90 min					
	General Engineering	Science (German proc	ram, 7 semester): Specialisation Con	nputer Science: El	ective Compu	ulsory
Following Curricula						
y carrieda			computer Science: Elective Compul	sorv		
			ation I. Computer Science: Elective C	-		
	Technomathematics:					

	ineering
	Lecture
Hrs/wk	2
СР	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Prof. Sibylle Schupp
Language	EN
Cycle	SoSe
Content	
	Model-based software engineering
	<ul> <li>Information modeling (use case diagrams)</li> </ul>
	<ul> <li>Behavioral modeling (finite state machines, Petri Nets, behavioral UML diagrams)</li> </ul>
	<ul> <li>Structural modeling (OOA, UML class diagrams, OCL)</li> </ul>
	<ul> <li>Model-based testing</li> </ul>
	Engineering software products
	Agile processes
	Architecture
	<ul> <li>Code-based testing</li> </ul>
	<ul> <li>System-level testing</li> </ul>
	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	Independent Study Time 62, Study Time in Lecture 28		
Lecturer	Prof. Sibylle Schupp		
Language	EN		
Cycle	SoSe		
Content	See interlocking course		
Literature	See interlocking course		

Courses			
Title	Тур	Hrs/wk	СР
Lab Cyber-Physical Systems (L174	0) Project-/problem-based Learning	4	6
Module Responsible	Prof. Heiko Falk		
Admission Requirements	None		
<b>Recommended Previous</b>	Module "Embedded Systems"		
Knowledge			
Educational Objectives	After taking part successfully, students have reached the following learning results		
Professional Competence			
Knowledge	Cyber-Physical Systems (CPS) are tightly integrated with their surrounding environment, via sense	ors, A/D and	D/A converters, a
	actors. Due to their particular application areas, highly specialized sensors, processors and actor	s are commo	n. Accordingly, the
	is a large variety of different specification approaches for CPS - in contrast to classical software en	ngineering ap	proaches.
	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 teo	chniques (mo	dels of computation
	hierarchical automata, data flow models, petri nets, imperative approaches). Since CPS frequent	ly perform co	ntrol tasks, the la
	experiments will base on simple control applications. The experiments will use state-of-the-	art industria	I specification to
	(MATLAB/Simulink, LabVIEW, NXC) in order to model cyber-physical models that interact with t	he environm	ent via sensors a
	actors.		
Skills	After successful attendance of the lab, students are able to develop simple CPS. They understand	the interdep	endencies betwee
	CPS and its surrounding processes which stem from the fact that a CPS interacts with the environ		
	digital processors, D/A converters and actors. The lab enables students to compare modellin		
	advantages and limitations, and to decide which technique to use for a concrete task. They will h		
	to practical problems. They obtain first experiences in hardware-related software development,	in industry-r	elevant specificat
	tools and in the area of simple control applications.		
Personal Competence		l	
Social Competence	Students are able to solve similar problems alone or in a group and to present the results accordin	ngiy.	
Autonomy	Students are able to acquire new knowledge from specific literature and to associate this knowled	lge with othe	r classes.
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56		
Credit points			
Course achievement			
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: El	ective Compu	ulsory
Following Curricula	Computer Science: Specialisation II. Mathematics and Engineering Science: Elective Compulsory		
	Computer Science in Engineering: Specialisation II. Mathematics & Engineering Science: Elective (	Compulsory	
	Mechatronics: Specialisation Intelligent Systems and Robotics: Elective Compulsory		
	Mechatronics: Specialisation System Design: Elective Compulsory		
	Mechatronics: Technical Complementary Course: Elective Compulsory		

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

## **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

Courses					
Title			Тур	Hrs/wk	СР
Embodiment Design and 3D-CAD (I			Lecture	2	1
Mechanical Design Project I (L0695			Project-/problem-based Lear		2
Mechanical Design Project II (L0592			Project-/problem-based Lear		2
Team Project Design Methodology			Project-/problem-based Lear	ning 2	1
Module Responsible	Prof. Dieter Krau	JSe			
Admission Requirements	None				
<b>Recommended Previous</b>	Eundame	ntals of Mechanical Engineer	ing Design		
Knowledge	Mechanic				
		ntals of Materials Science			
		n Engineering			
		5 5			
Educational Objectives	After taking par	t successfully, students have	reached the following learning results		
Professional Competence					
Knowledge	After passing th	e module, students are able f	to:		
	<ul> <li>explain d</li> </ul>	esian quidelines for machine	ry parts e.g. considering load situation, materia	Is and manufactur	rina requirement
		basics of 3D CAD,			ing requirement
		asics methods of engineering	designing.		
Skills	After passing th	e module, students are able t	to:		
	<ul> <li>independ</li> </ul>	ently create sketches, techni	cal drawings and documentations e.g. using 3	CAD,	
		mponents based on design g			
	_	n (calculate) used componen			
			neering design tasks systamtically and solution	-oriented,	
	<ul> <li>apply cre</li> </ul>	ativity techniques in teams.			
Personal Competence					
Social Competence	After passing th	e module, students are able t	to:		
	<ul> <li>develop a</li> </ul>	and evaluate solutions in grou	ups including making and documenting decision	ıs,	
	<ul> <li>moderate</li> </ul>	the use of scientific method	s,		
	<ul> <li>present a</li> </ul>	nd discuss solutions and tech	nnical drawings within groups,		
	<ul> <li>reflect th</li> </ul>	e own results in the work gro	ups of the course.		
Autonomy	Students are ab	le			
	• to optime	ato thoir lovel of knowledge u	ising activating methods within the lectures (e	a with clickors)	
		engineering design tasks syst		.g. with thereis),	
	• 10 50172	engineering design tusks syst	conditionly.		
Workload in Hours	Independent Stu	udy Time 40, Study Time in L	ecture 140		
Credit points					
Course achievement			Description		
	Yes Non		3D-CAD-Praktikum		
	Yes Non		Teamprojekt Konstruktionsmethodik		
	Yes Non		Konstruktionsprojekt 1		
	Yes Non	e Written elaboration	Konstruktionsprojekt 2		
Examination	Written exam				
Examination duration and	180				
scale	a				
-	-		am, 7 semester): Specialisation Mechanical Eng	÷ .	-
Following Curricula	_		am, 7 semester): Specialisation Biomedical Eng		
	_		am, 7 semester): Specialisation Biomedical Eng	meering: Compuls	ory
	-	cal Engineering: Core Qualific ironmental Engineering: Core			
		ironmental Engineering: Core ence: Core Qualification: Corr			
			npuisory m, 7 semester): Specialisation Biomedical Engi	peering: Computer	nrv.
	Seneral Enginee	and a second (English progra	, , semester, specialisation biomedical Engl		,

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

ourse L0268: Embodiment D	Design and 3D-CAD
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	<ul> <li>Basics of 3D CAD technology</li> <li>Practical course to apply a 3D CAD system <ul> <li>Introduction to the system</li> <li>Sketching and creation of components</li> <li>Creation of assemblies</li> <li>Deriving technical drawings</li> </ul> </li> </ul>
Literature	<ul> <li>CAx für Ingenieure eine praxisbezogene Einführung; Vajna, S., Weber, C., Bley, H., Zeman, K.; Springer-Verlag, aktuelle Auflage.</li> <li>Handbuch Konstruktion; Rieg, F., Steinhilper, R.; Hanser; aktuelle Auflage.</li> <li>Dubbel, Taschenbuch für den Maschinenbau; Grote, KH., Feldhusen, J.(Hrsg.); Springer-Verlag, aktuelle Auflage.</li> <li>Technisches Zeichnen: Grundlagen, Normen, Beispiele, Darstellende Geometrie, Hoischen, H; Hesser, W; Cornelsen, aktuelle Auflage.</li> <li>Maschinenelemente, Band I-III; Niemann, G., Springer-Verlag, aktuelle Auflage.</li> <li>Maschinen- und Konstruktionselemente; Steinhilper, W., Röper, R., Springer Verlag, aktuelle Auflage.</li> <li>Konstruktionslehre, Pahl, G.; Beitz, W., Springer-Verlag, aktuelle Auflage.</li> <li>Maschinenelemente 1-2; Schlecht, B., Pearson Verlag, aktuelle Auflage.</li> <li>Maschinenelemente - Gestaltung, Berechnung, Anwendung; Haberhauer, H., Bodenstein, F., Springer-Verlag, aktuelle Auflage.</li> <li>Roloff/Matek Maschinenelemente; Wittel, H., Muhs, D., Jannasch, D., Voßiek, J., Springer Vieweg, aktuelle Auflage.</li> </ul>

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

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

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	<ul> <li>Introduction to engineering designing methodology</li> <li>Team Project Design Methodology         <ul> <li>Creating requirement lists</li> <li>Problem formulation</li> <li>Creating functional structures</li> <li>Finding solutions</li> <li>Evaluation of the found concepts</li> <li>Documentation of the taken methodological steps and the concepts using presentation slides</li> </ul> </li> </ul>
Literature	<ul> <li>Dubbel, Taschenbuch für den Maschinenbau; Grote, KH., Feldhusen, J.(Hrsg.); Springer-Verlag, aktuelle Auflage.</li> <li>Maschinenelemente, Band I-III; Niemann, G., Springer-Verlag, aktuelle Auflage.</li> <li>Maschinen- und Konstruktionselemente; Steinhilper, W., Röper, R., Springer Verlag, aktuelle Auflage.</li> <li>Einführung in die DIN-Normen; Klein, M., Teubner-Verlag.</li> <li>Konstruktionslehre, Pahl, G.; Beitz, W., Springer-Verlag, aktuelle Auflage.</li> <li>Maschinenelemente 1-2; Schlecht, B., Pearson Verlag, aktuelle Auflage.</li> <li>Maschinenelemente - Gestaltung, Berechnung, Anwendung; Haberhauer, H., Bodenstein, F., Springer-Verlag, aktuelle Auflage.</li> <li>Roloff/Matek Maschinenelemente; Wittel, H., Muhs, D., Jannasch, D., Voßiek, J., Springer Vieweg, aktuelle Auflage.</li> <li>Sowie weitere Bücher zu speziellen Themen</li> </ul>

	amentals of Materials Science					
Courses						
Title		Тур	Hrs/wk	СР		
Fundamentals of Materials Science	I (L1085)	Lecture	2	2		
	II (Advanced Ceramic Materials, Polymers and Composites) (L0506)	Lecture	2	2		
Physical and Chemical Basics of Ma		Lecture	2	2		
Module Responsible	Prof. Jörg Weißmüller					
Admission Requirements	None					
Recommended Previous Knowledge	Highschool-level physics, chemistry und mathematics					
Educational Objectives	After taking part successfully, students have reached the follow	ing learning results				
Professional Competence						
	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	ne students know abo aracterizing specific	out the key aspects of char	acterization meth		
Skills	The students are able to trace materials phenomena back to phenomena here refers to mechanical properties such as strear resistance, and to phase transformations such as solidification between processing conditions and the materials microstructur material's behavior.	ngth, ductility, and s n, precipitation, or r	tiffness, chemical propertie melting. 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						
Course achievement	None					
	Written exam					
Examination duration and	180 min					
scale						
Assignment for the	General Engineering Science (German program, 7 semester): S	pecialisation Mechan	ical Engineering: Compulso	prv		
	General Engineering Science (German program, 7 semester): S					
	General Engineering Science (German program, 7 semester): S			5		
	Data Science: Specialisation Materials Science: Compulsory	•				
	Digital Mechanical Engineering: Core Qualification: Compulsory					
	Energy and Environmental 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 Engineering Science: Lieutive Compution y					
	Mechanical Engineering: Core Qualification: Compulsory					
	Mechatronics: Core Qualification: Compulsory					
	Naval Architecture: Core Qualification: Compulsory					
	Naval Architecture: Core Qualification: Compulsory Technomathematics: Specialisation III. Engineering Science: Ele	ective Compulsory				

**Course L1085: Fundamentals of Materials Science I** Тур Lecture Hrs/wk СР 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 C	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, Prof. Stefan Fritz Müller
Language	DE
Cycle	WiSe
Content	<ul> <li>Motivation: "Atoms in Mechanical Engineering?"</li> <li>Basics: Force and Energy</li> <li>The electromagnetic Interaction</li> <li>"Detour": Mathematics (complex e-funktion etc.)</li> <li>The atom: Bohr's model of the atom</li> <li>Chemical bounds</li> <li>The multi part problem: Solutions and strategies</li> <li>Descriptions of using statistical thermodynamics</li> <li>Elastic theory of atoms</li> <li>Consequences of atomar properties on makroskopic Properties: Discussion of examples (metals, semiconductors, hybrid systems)</li> </ul>
Literature	<ul> <li>Für den Elektromagnetismus:</li> <li>Bergmann-Schäfer: "Lehrbuch der Experimentalphysik", Band 2: "Elektromagnetismus", de Gruyter</li> <li>Für die Atomphysik:</li> <li>Haken, Wolf: "Atom- und Quantenphysik", Springer</li> <li>Für die Materialphysik und Elastizität:</li> <li>Hornbogen, Warlimont: "Metallkunde", Springer</li> </ul>

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		Recitation Section (large)	2	1		
Module Responsible		-				
Admission Requirements						
Recommended Previous						
Knowledge	<ul> <li>Fundamentals of Mechanical Engineeri</li> </ul>	ng Design				
Kilomeuge	Mechanics					
	<ul> <li>Fundamentals of Materials Science</li> </ul>					
	Production Engineering					
	After taking part successfully, students have	reached the following learning results				
Professional Competence	After persing the medule students are able to	-				
Knowledge	After passing the module, students are able t	0:				
	<ul> <li>explain complex working principles and</li> </ul>	d functions of machine elements and of basic ele	ements of fluidics	5,		
	<ul> <li>explain requirements, selection criteria</li> </ul>	a, application scenarios and practical examples	of complex mach	ine elements,		
	<ul> <li>indicate the background of dimensioning</li> </ul>	ng calculations.				
Skills	After passing the module, students are able t	0:				
	<ul> <li>accomplish dimensioning calculations of covered machine elements,</li> <li>transfer knowledge learned in the module to new requirements and tasks (problem solving skills),</li> </ul>					
	<ul> <li>recognize the content of technical drawings and schematic sketches,</li> </ul>					
	<ul> <li>evaluate complex designs, technically.</li> </ul>					
Personal Competence						
Social Competence						
	<ul> <li>Students are able to discuss technical</li> </ul>	information in the lecture supported by activation	ng methods.			
Autonomy						
Autonomy	<ul> <li>Students are able to independently deepen their acquired knowledge in exercises.</li> </ul>					
	• Students are able to acquire additional knowledge and to recapitulate poorly understood content e.g. by using the vide					
	recordings of the lectures.					
	Independent Study Time 68, Study Time in Le	ecture 112				
Credit points Course achievement						
Examination						
Examination duration and						
scale	120					
Assignment for the	General Engineering Science (German progra	m 7 semester): Specialisation Mechanical Engli	neering: Compuls	orv		
	<ul> <li>General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering: Compulsory</li> <li>General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Energy System</li> </ul>					
i onowing curricula	General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Energy Compulsory					
		Qualification: Elective Compulsory				
Energy and Environmental Engineering: Core Qualification: Elective Compulsory Energy Systems: Technical Complementary Course Core Studies: Elective Compulsory						
	Engineering Science: Specialisation Mechanic					
		n, 7 semester): Specialisation Mechanical Engin		-		
		ram, 7 semester): Specialisation Mechanical	Engineering, Foo	us Energy System		
	Compulsory					
	Mechanical Engineering: Core Qualification: C	Compulsory				
	Naval Architecture: Core Qualification: Compu	de electro de la construcción de la				

Typ       Lecture         Hrsjivk       2         Workload in Hours       Independent Study Time 32, Study Time in Lecture 28         Lecture       Frof. Dieter Knause, Prof. Otto von Estorff         Languago       DE         Cycle       SoSe         Content       Advanced Mechanical Engineering Design 1 & II         Lecture       • Fundamentals of the following machine elements:         • Linear rolling bearings       • Axes & shafts         • Geard Tives       • Geard Tives         • Geard Tives       • Elements of fluidics         • Elements of fluidics       • Elements of fluidics         • Linear rolling bearings       • Axes & shafts         • Geard Tives       • Elements of fluidics         • Elements of fluidics       • Elements of fluidics         • Elements of fluidics       • Clackation methods of the following machine elements:         • Clackation methods of the following machine elements:       • Clackation fluidics         • Clackation methods of the following machine elements:       • Clackation fluidics         • Clackation methods of the following machine elements:       • Clackation fluidics         • Clackation methods of the following machine elements:       • Clackation fluidics         • Clackation methods of the following machine elements:       • Clackating bea	Course L0264: Advanced Med	chanical Engineering Design II				
co       2         Worklaad in Hours       Independent Study Time 32, Study Time in Lecture 28         Lecturer       Prof. Ditter Krause, Prof. Otto von Estorff         Languag       DE         Cycle       SoSe         Content       Advanced Mechanical Engineering Design 1 & 1         Lecture <ul> <li>Fundamentals of the following machine elements:</li> <li>Linear rolling bearings</li> <li>Axes &amp; shafts</li> <li>Seals</li> <li>Clutches &amp; brakes</li> <li>Belt &amp; chain drives</li> <li>Gear drives</li> <li>Elements of fluidics</li> <li>Exercise</li> <li>Calculation methods of the following machine elements:</li> <li>Linear rolling bearings</li> <li>Elements of fluidics</li> <li>Exercise</li> <li>Calculation methods of the following machine elements:</li> <li>Linear rolling bearings</li> <li>Axes &amp; shafts</li> <li>Clackets &amp; brakes</li> <li>Belt &amp; chain drives</li> <li>Gear drives</li> <li>Elements of fluidics</li> <li>Exercise</li> <li>Calculation methods of the following machine elements:</li> <li>Linear rolling bearings</li> <li>Axes &amp; shafts</li> <li>Clutches &amp; brakes</li> <li>Belt &amp; chain drives</li> <li>Gear drives</li> <li>Eleptic gears</li> <li>Cank gears</li> <li>Siding bearings</li> <li>Calculations of hydrostatic systems (fluidics)</li> <li>Literature</li> <li>Dubbel, Taschenbuch für den Maschinenbau; Grote, K-H., Felchusen, J (Hrsg.); Springer-Verlag, aktuelle Auflage.</li> <li>Maschinenelemente, Band I-II; Niemann, G., Springer-Verlag, aktuelle Auflage.</li> <li>Maschinenelemente, Rishin, Tis, Breinson-Verlag, aktuelle Auflage.</li></ul>						
Workload in Hours         Independent Study Time 32, Study Time in Lecture 28           Lecture         Prof. Diteter Krause, Prof. Otto von Estorff           Language         Dit           Cycet         SoSe           Content         Advanced Mechanical Engineering Design 1 & I           Lecture <ul> <li>Fundamentals of the following machine elements:</li> <li>Linear rolling bearings</li> <li>Ares &amp; shafts</li> <li>Seals</li> <li>Clutches &amp; brakes</li> <li>Belt &amp; Chain drives</li> <li>Elements of fluidics</li> <li>Exercise</li> <li>Clucher s &amp; trakes</li> <li>Siding bearings</li> <li>Ares &amp; shafts</li> <li>Seals</li> <li>Clutches &amp; brakes</li> <li>Belt &amp; Chain drives</li> <li>Siding bearings</li> <li>Elements of fluidics</li> <li>Exercise</li> <li>Claculation methods of the following machine elements:</li> <ul> <li>Linear rolling bearings</li> <li>Ares &amp; shafts</li> <li>Clucher &amp; Sorakes</li> <li>Belt &amp; chain drives</li> <li>Geard drives</li> <li>Silding bearings</li> <li>Calculations of hydrostack systems (fluidics)</li> <li>Cluthers &amp; brakes</li> <li>Belt &amp; chain drives</li> <li>Geard drives</li> <li>Geard drives</li> <li>Silding bearings</li> <li>Calculations of hydrostack systems (fluidics)</li></ul></ul>	Hrs/wk	2				
Lecture         Prof. Dieter Krause, Prof. Otto von Estorff           Language         DE           Cycle         SoSe           Context         Advanced Mechanical Engineering Design I & II           Lecture         • Fundamentals of the following machine elements: • Linear rolling bearings • Axes & shafts • Seals • Ottothes & brakes • Betts & Chain drives • Gear drives • Canch drives • Canch drives • Stating bearings • Crank drives • Stating bearings • Crank drives • Stating bearings • Canch drives • Stating bearings • Calculation methods of the following machine elements: • Linear rolling bearings • Canch drives • Stating bearings • Calculation methods of the following machine elements: • Linear rolling bearings • Calculation methods of the following machine elements: • Linear rolling bearings • Axes & shafts • Clutches & brakes • Bett & Chain drives • Gear drives • Gear drives • Gear drives • Calculation methods of the following machine elements: • Linear rolling bearings • Calculations of hydrostatic systems (fluidics)           Literature         • Dubbel, Taschenbuch für den Maschinenbau; Grote, KH., Feldhusen, J.(Hrsg.): Springer-Verlag, aktuelle Auflage. • Stating bearings • Calculations of hydrostatic systems (fluidics)           Literature         • Dubbel, Taschenbuch für den Maschinenbau; Grote, KH., Feldhusen, J.(Hrsg.): Springer-Verlag, aktuelle Auflage. • Maschineneidemente, Steinhilger, W., Röper, R., Springer-Verlag, aktuelle Auflage. • Maschineneidemente, Steinhilger, W., Röper, R., Springer-Verlag, aktuelle Auflage. • Maschineneidemente, Steinhilger, W., Springer-Verlag, aktuelle Auflage. • Maschineneidemente, Steinhilber, Wrag, aktuelle Auflage. • Maschineneidemente 1-2: Schlecht, B., Pearson Verlag, aktuelle Auflage. • Maschineneidemente 1-2: Schle	CP	2				
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             • Crark drives             • Sliding bearings             • Clutches & the following machine elements:             • Clutches & brakes             • Sliding bearings             • Clutches & brakes             • Gear drives             • Clutches & brakes             • Clutches & brakes             • Clutches & brakes             • Geard drives             • Geard drives             • Clutches & brakes             • Clucluations of hydrostatic systems (fluidics)             • Clutches & brakes             • Clucluations of hydrostatic systems (fluidics)             • Dubbel, Taschenbuch für den Maschinenbau; Grote, KH., Feldhusen, J.(Hrsg.); Springer-Verlag, aktuelle Auflage.             • Maschinenelemente, Band I-III; Niemann, G., Springer-Verlag, aktuelle Auflage.             • Maschinenelementence there, Steinhilper, W., Röper, R., Springer Verlag, aktuelle Auflage.             • Konstruktionselemente, Steinhilper, W., Röper, R., Sp	Workload in Hours	Independent Study Time 32, Study Time in Lecture 28				
Cycle         SoSe           Content         Advanced Mechanical Engineering Design I & II           Lecture <ul> <li>Fundamentals of the following machine elements:</li> <ul> <ul> <ul></ul></ul></ul></ul>	Lecturer	Prof. Dieter Krause, Prof. Otto von Estorff				
Content       Advanced Machanical Engineering Design 1 & II         Lecture <ul> <li>Fundamentals of the following machine elements:</li> <li>Linear rolling bearings</li> <li>Axes &amp; shafts</li> <li>Seals</li> <li>Clutches &amp; brakes</li> <li>Gear drives</li> <li>Epicyclic gears</li> <li>Crank drives</li> <li>Sliding bearings</li> <li>Linear rolling bearings</li> <li>Elements of fluidics</li> <li>Exercise</li> <li>Clutches &amp; brakes</li> <li>Gear drives</li> <li>Sliding bearings</li> <li>Elements of fluidics</li> <li>Exercise</li> <li>Clutches &amp; brakes</li> <li>Gear drives</li> <li>Sliding bearings</li> <li>Literature</li> <li>Clutches &amp; brakes</li> <li>Gear drives</li> <li>Gear drives</li> <li>Sliding bearings</li> <li>Literature</li> <li>Clutches &amp; brakes</li> <li>Gear drives</li> <li>Geard drives</li> <li>Geard drives</li> <li>Geard drives</li> <li>Geard drives</li> <li>Geard drives</li> <li>Sliding bearings</li> <li>Clutches &amp; brakes</li> <li>Sliding bearings</li> <li>Clackubines of hydrostatic systems (fluidics)</li> <li>Clackubine- drives</li> <li>Sliding bearings</li> <li>Sliding bearings</li> <li>Clackubine- drives</li> <li>Sliding bearings</li> <li>Sliding bearings</li> <li>Clackubinselemente: Steinhinger, W.,</li></ul>	Language	DE				
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<ul> <li>Clutches &amp; brakes</li> <li>Belt &amp; chain drives</li> <li>Gear drives</li> <li>Epicyclic gears</li> <li>Crank gears</li> <li>Sliding bearings</li> <li>Calculations of hydrostatic systems (fluidics)</li> </ul> Literature <ul> <li>Dubbel, Taschenbuch für den Maschinenbau; Grote, KH., Feldhusen, J.(Hrsg.); Springer-Verlag, aktuelle Auflage.</li> <li>Maschinenelemente, Band I-III; Niemann, G., Springer-Verlag, aktuelle Auflage.</li> <li>Maschinen- und Konstruktionselemente; Steinhilper, W., Röper, R., Springer Verlag, aktuelle Auflage.</li> <li>Einführung in die DIN-Normen; Klein, M., Teubner-Verlag, aktuelle Auflage.</li> <li>Konstruktionslehre, Pahl, G.; Beitz, W., Springer-Verlag, aktuelle Auflage.</li> <li>Maschinenelemente 1-2; Schlecht, B., Pearson Verlag, aktuelle Auflage.</li> <li>Maschinenelemente 1-2; Schlecht, B., Pearson Verlag, aktuelle Auflage.</li> </ul>		Linear rolling bearings				
<ul> <li>Belt &amp; chain drives</li> <li>Gear drives</li> <li>Epicyclic gears</li> <li>Crank gears</li> <li>Sliding bearings</li> <li>Calculations of hydrostatic systems (fluidics)</li> </ul> Literature <ul> <li>Dubbel, Taschenbuch für den Maschinenbau; Grote, KH., Feldhusen, J.(Hrsg.); Springer-Verlag, aktuelle Auflage.</li> <li>Maschinenelemente, Band I-III; Niemann, G., Springer-Verlag, aktuelle Auflage.</li> <li>Maschinen- und Konstruktionselemente; Steinhilper, W., Röper, R., Springer Verlag, aktuelle Auflage.</li> <li>Einführung in die DIN-Normen; Klein, M., Teubner-Verlag.</li> <li>Konstruktionslehre, Pahl, G.; Beitz, W., Springer-Verlag, aktuelle Auflage.</li> <li>Maschinenelemente 1-2; Schlecht, B., Pearson Verlag, aktuelle Auflage.</li> <li>Maschinenelemente 1-2; Schlecht, B., Pearson Verlag, Atuelle Auflage.</li> <li>Maschinenelemente - Gestaltung, Berechnung, Anwendung; Haberhauer, H., Bodenstein, F., Springer-Verlag, aktuelle</li> </ul>		• Axes & shafts				
<ul> <li>Gear drives         <ul> <li>Epicyclic gears</li> <li>Crank gears</li> <li>Sliding bearings</li> <li>Calculations of hydrostatic systems (fluidics)</li> </ul> </li> <li>Literature         <ul> <li>Dubbel, Taschenbuch für den Maschinenbau; Grote, KH., Feldhusen, J.(Hrsg.); Springer-Verlag, aktuelle Auflage.</li> <li>Maschinenelemente, Band I-III; Niemann, G., Springer-Verlag, aktuelle Auflage.</li> <li>Maschinen- und Konstruktionselemente; Steinhilper, W., Röper, R., Springer Verlag, aktuelle Auflage.</li> <li>Einführung in die DIN-Normen; Klein, M., Teubner-Verlag.</li> <li>Konstruktionslehre, Pahl, G.; Beitz, W., Springer-Verlag, aktuelle Auflage.</li> <li>Maschinenelemente 1-2; Schlecht, B., Pearson Verlag, aktuelle Auflage.</li> <li>Maschinenelemente - Gestaltung, Berechnung, Anwendung; Haberhauer, H., Bodenstein, F., Springer-Verlag, aktuelle</li> </ul> </li> </ul>		Clutches & brakes				
<ul> <li>Epicyclic gears         <ul> <li>Crank gears</li> <li>Crank gears</li> <li>Sliding bearings</li> </ul> </li> <li>Calculations of hydrostatic systems (fluidics)</li> </ul> Literature <ul> <li>Dubbel, Taschenbuch für den Maschinenbau; Grote, KH., Feldhusen, J.(Hrsg.); Springer-Verlag, aktuelle Auflage.</li> <li>Maschinenelemente, Band I-III; Niemann, G., Springer-Verlag, aktuelle Auflage.</li> <li>Maschinen- und Konstruktionselemente; Steinhilper, W., Röper, R., Springer Verlag, aktuelle Auflage.</li> <li>Einführung in die DIN-Normen; Klein, M., Teubner-Verlag.</li> <li>Konstruktionslehre, Pahl, G.; Beitz, W., Springer-Verlag, aktuelle Auflage.</li> <li>Maschinenelemente 1-2; Schlecht, B., Pearson Verlag, aktuelle Auflage.</li> <li>Maschinenelemente - Gestaltung, Berechnung, Anwendung; Haberhauer, H., Bodenstein, F., Springer-Verlag, aktuelle</li> </ul>						
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<ul> <li>Sliding bearings</li> <li>Calculations of hydrostatic systems (fluidics)</li> <li>Literature</li> <li>Dubbel, Taschenbuch für den Maschinenbau; Grote, KH., Feldhusen, J.(Hrsg.); Springer-Verlag, aktuelle Auflage.</li> <li>Maschinenelemente, Band I-III; Niemann, G., Springer-Verlag, aktuelle Auflage.</li> <li>Maschinen- und Konstruktionselemente; Steinhilper, W., Röper, R., Springer Verlag, aktuelle Auflage.</li> <li>Einführung in die DIN-Normen; Klein, M., Teubner-Verlag.</li> <li>Konstruktionslehre, Pahl, G.; Beitz, W., Springer-Verlag, aktuelle Auflage.</li> <li>Maschinenelemente 1-2; Schlecht, B., Pearson Verlag, aktuelle Auflage.</li> <li>Maschinenelemente - Gestaltung, Berechnung, Anwendung; Haberhauer, H., Bodenstein, F., Springer-Verlag, aktuelle</li> </ul>						
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<ul> <li>Maschinenelemente, Band I-III; Niemann, G., Springer-Verlag, aktuelle Auflage.</li> <li>Maschinen- und Konstruktionselemente; Steinhilper, W., Röper, R., Springer Verlag, aktuelle Auflage.</li> <li>Einführung in die DIN-Normen; Klein, M., Teubner-Verlag.</li> <li>Konstruktionslehre, Pahl, G.; Beitz, W., Springer-Verlag, aktuelle Auflage.</li> <li>Maschinenelemente 1-2; Schlecht, B., Pearson Verlag, aktuelle Auflage.</li> <li>Maschinenelemente - Gestaltung, Berechnung, Anwendung; Haberhauer, H., Bodenstein, F., Springer-Verlag, aktuelle</li> </ul>	Literature	Dubbal Teachadach für den Maashingdass Costa IV. I. Feldburge L(Uner.) Cosinger Verlag, alter He Auflage				
<ul> <li>Maschinen- und Konstruktionselemente; Steinhilper, W., Röper, R., Springer Verlag, aktuelle Auflage.</li> <li>Einführung in die DIN-Normen; Klein, M., Teubner-Verlag.</li> <li>Konstruktionslehre, Pahl, G.; Beitz, W., Springer-Verlag, aktuelle Auflage.</li> <li>Maschinenelemente 1-2; Schlecht, B., Pearson Verlag, aktuelle Auflage.</li> <li>Maschinenelemente - Gestaltung, Berechnung, Anwendung; Haberhauer, H., Bodenstein, F., Springer-Verlag, aktuelle</li> </ul>						
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Roloff/Matek Maschinenelemente; Wittel, H., Muhs, D., Jannasch, D., Voßiek, J., Springer Vieweg, aktuelle Auflage.		Roloff/Matek Maschinenelemente; Wittel, H., Muhs, D., Jannasch, D., Voßiek, J., Springer Vieweg, aktuelle Auflage.				
Sowie weitere Bücher zu speziellen Themen		Sowie weitere Bücher zu speziellen Themen				

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

ourse L0262: Advanced Me	chanical Engineering Design I			
Тур	Lecture			
Hrs/wk				
CP	2			
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28			
Lecturer				
Language	DE			
Cycle	WiSe			
Content				
	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:			
	Circulation methods of the following machine elements: <ul> <li>Linear rolling bearings</li> </ul>			
	Axes & shafts			
	Clutches & brakes			
	Belt & chain drives			
	Gear drives			
	Epicyclic gears			
	Crank gears			
	<ul> <li>Sliding bearings</li> </ul>			
	Calculations of hydrostatic systems (fluidics)			
Literature	Dubbel, Taschenbuch für den Maschinenbau; Grote, KH., Feldhusen, J.(Hrsg.); Springer-Verlag, aktuelle Auflage.			
	<ul> <li>Bubbel, Taschenbuch für den Maschnenbau, Glote, KH., Feldhäsen, J.(1139.), Springer-Verlag, actuene Auhage.</li> <li>Maschinenelemente, Band I-III; Niemann, G., Springer-Verlag, actuelle Auflage.</li> </ul>			
	<ul> <li>Maschinen- und Konstruktionselemente; Steinhilper, W., Röper, R., Springer Verlag, aktuelle Auflage.</li> </ul>			
	<ul> <li>Einführung in die DIN-Normen; Klein, M., Teubner-Verlag.</li> </ul>			
	<ul> <li>Konstruktionslehre, Pahl, G.; Beitz, W., Springer-Verlag, aktuelle Auflage.</li> </ul>			
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	<ul> <li>Roloff/Matek Maschinenelemente; Wittel, H., Muhs, D., Jannasch, D., Voßiek, J., Springer Vieweg, aktuelle Auflage.</li> </ul>			
	Sowie weitere Bücher zu speziellen Themen			

Course L0263: Advanced Me	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		

Module M0680: Fluid	Dynamics				
Courses					
Title		Тур		Hrs/wk	СР
Fluid Mechanics (L0454)		Lectur		3	4
Fluid Mechanics (L0455)		Recita	tion Section (large)	2	2
Module Responsible	Prof. Thomas Rung				
Admission Requirements	None				
<b>Recommended Previous</b>	Sound knowledge of engineering mathe	matics, engineering mechanics	and thermodynamics.		
Knowledge					
Educational Objectives	After taking part successfully, students I	have reached the following lear	ning results		
Professional Competence					
Knowledge	Students will have the required sound knowledge to explain the general principles of fluid engineering and physics of fluids. Students can scientifically outline the rationale of flow physics using mathematical models and are familiar with methods for the performance analysis and the prediciton of fluid engineering devices.				
Skills	Students are able to apply fluid-engineering principles and flow-physics models for the analysis of technical systems. The lecture 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 problems and jointly develop solution strategies.				
Autonomy	The students are able to develop solution strategies for complex problems self-consistent and crtically analyse results.				
Workload in Hours	Independent Study Time 110, Study Tim	ne in Lecture 70			
Credit points					
Course achievement					
	Written exam				
Examination duration and					
scale					
Assignment for the	General Engineering Science (German p	rogram, 7 semester); Specialisa	tion Mechanical Engir	neering: Compuls	orv
-	General Engineering Science (German p	- ,	-		-
	General Engineering Science (German p	- ,	-		
	Mechanical Engineering: Core Qualificat	- ,			
	Naval Architecture: Core Qualification: C				
	Technomathematics: Specialisation III. E		mpulsory		

Course L0454: Fluid Mechanics		
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	<ul> <li>continuum physics definition of fluids, difference to solids/structures and material properties of fluids</li> <li>dimensional analysis and similitude</li> <li>fluid forces and fluid statics</li> <li>transport and conservation of mass, momentum &amp; energy</li> <li>fluid kinematics</li> <li>technically relevant flow models for incompressible fluids         <ul> <li>control volume &amp; stream tube analysis</li> <li>vortical flow models</li> <li>potential flows</li> <li>boundary layer flows</li> <li>different types of conservation equations and their realm (Navier-Stokes/Euler/Bernoulli equations)</li> <li>analytical solutions for Navier-Stokes systems</li> </ul> </li> <li>Analysis of internal flows (channels, pipes, open channels) and external flows, fundamentals of wing aerodynamics</li> <li>turbulent flows</li> <li>fundamentals of gas dynamics (1D compressible flows)</li> </ul>	
Literature	<ul> <li>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 &amp; Sons.</li> <li>Spurk, J.; Aksel, N.: Strömungslehre, Springer.</li> <li>Schade, H.; Kunz, E., Kameier, F.; Paschereit, C.O.: Strömungslehere, De Gruyter.</li> <li>Herwig, H.: Strömungsmechanik, Springer.</li> <li>Herwig, H.: Strömungsmechanik von A-Z, Vieweg.</li> </ul>	

Course 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		Түр	Hrs/wk	СР
	al Mechanics, Numerical Mechanics) (L1137)	Lecture	3	3
	al Mechanics, Numerical Mechanics) (L1138)	Recitation Section (small)	2	2
Mechanics IV (Oscillations, Analytic	al Mechanics, Numerical Mechanics) (L1139)	Recitation Section (large)	1	1
Module Responsible	Prof. Robert Seifried			
Admission Requirements	None			
<b>Recommended Previous</b>	Mathematics I-III and Mechanics I-III			
Knowledge				
Educational Objectives	After taking part successfully, students have reach	ed the following learning results		
Professional Competence				
Knowledge	The students can			
	describe the axiomatic procedure used in m	echanical contexts;		
	explain important steps in model design;			
	<ul> <li>present technical knowledge.</li> </ul>			
Skills	The students can			
	<ul> <li>explain the important elements of mathematical / mechanical analysis and model formation, and apply it to the their own problems;</li> </ul>			
	apply basic methods to engineering problem			
	<ul> <li>estimate the reach and boundaries of the m</li> </ul>	ethods and extend them to be applicable t	o 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 own stre	ngths and weaknesses and to organize the	eir 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 program, 7	semester): Specialisation Mechanical Engir	neering: Compuls	sory
Following Curricula	General Engineering Science (German program, 7	semester): Specialisation Biomedical Engir	neering: Compuls	sory
	General Engineering Science (German program, 7	semester): Specialisation Naval Architectu	re: Compulsory	
	Energy Systems: Technical Complementary Course	Core Studies: Elective Compulsory		
	Mechanical Engineering: Core Qualification: Compu	lsory		
	Mechatronics: Core Qualification: Compulsory			
	Naval Architecture: Core Qualification: Compulsory			
	Technomathematics: Specialisation III. Engineering	Science: Elective Compulsory		

Course L1137: Mechanics IV	(Oscillations, Analytical Mechanics, Numerical Mechanics)
Тур	Lecture
Hrs/wk	3
СР	3
Workload in Hours	Independent Study Time 48, Study Time in Lecture 42
Lecturer	Prof. Robert Seifried
Language	DE
Cycle	SoSe
Content	
	<ul> <li>Elements of vibration theory</li> <li>Vibration of Multi-degree of freedom systems</li> <li>Analytical Mechanics</li> <li>Multibody Systems</li> <li>Numerical methods for time integration</li> <li>Introduction to Matlab</li> </ul>
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 L1138: Mechanics IV	(Oscillations, Analytical Mechanics, Numerical Mechanics)
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	SoSe
Content	See interlocking course
Literature	See interlocking course
Course L1139: Mechanics IV	(Oscillations, Analytical Mechanics, Numerical Mechanics)
Тур	Recitation Section (large)
Hrs/wk	1
СР	1
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14
Locturor	Draf Dahart Saifriad

Lecturer	Prof. Robert Seifried
Language	DE
Cycle	SoSe
Content	See interlocking course
Literature	See interlocking course

Courses				
Title Practical Course: Measurement and	l Control Systems (L1119)	<b>Typ</b> Practical Course	Hrs/wk	<b>CP</b> 2
Measurement Technology for Mech		Lecture	2	3
Measurement Technology for Mech	anical Engineering (L1118)	Recitation Section (large)	1	1
Module Responsible	Prof. Thorsten Kern			
Admission Requirements	None			
Recommended Previous Knowledge	Basic knowledge of physics, chemistry and electrical engineering			
Educational Objectives	After taking part successfully, students have reach	ned the following learning results		
Professional Competence Knowledge	Students are able to name the most important fu Calibration, Static and Dynamic Properties of Sens They can outline the most important measuring	sors and Systems).		
	Temperature, mechanical quantities, Flow, Time,			
	They can describe important methods of chemical	Analysis (Gas Sensors, Spectroscopy, Gas	Chromatography)	
Skills Students can select suitable measuring methods to given problems and can use refering measurement de			asurement device	s in practice.
	The students are able to orally explain issues in t place the issues into the right context and applicat	•	gy and solution a	oproaches as wel
Personal Competence Social Competence	e Students can arrive at work results in groups and document them in a common report.			
Autonomy	Students are able to familiarize themselves with n	ew measurement technologies.		
Workload in Hours	Independent Study Time 110, Study Time in Lectu	re 70		
Credit points	6			
Course achievement	Compulsory Bonus Form Yes None Subject theoretical and practical work	Description d		
Examination	Subject theoretical and practical work			
Examination duration and scale				
Assignment for the Following Curricula	General Engineering Science (German program, 7 General Engineering Science (German program, 7 General Engineering Science (German program, 7 Digital Mechanical Engineering: Core Qualification:	semester): Specialisation Biomedical Engi semester): Specialisation Advanced Mater	neering: Compulso	bry
	Energy and Environmental Engineering: Core Qual Engineering Science: Specialisation Mechatronics: Engineering Science: Specialisation Mechanical En Engineering Science: Specialisation Biomedical En-	Compulsory gineering: Compulsory		
	Engineering Science: Specialisation biometical En Engineering Science: Specialisation Advanced Mat General Engineering Science (English program, 7 s General Engineering Science (English program, 7 s Logistics and Mobility: Specialisation Production M Mechanical Engineering: Core Qualification: Comp	erials: Elective Compulsory semester): Specialisation Mechatronics: Co semester): Specialisation Mechanical Engin semester): Specialisation Biomedical Engin anagement and Processes: Elective Compu	eering: Compulso eering: Elective C	
	Mechatronics: Core Qualification: Compulsory Engineering and Management - Major in Logistic Compulsory		Management and	Processes: Elect

	Practical Course
Hrs/wk	
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Prof. Thorsten Kern
Language	DE
Cycle	WiSe/SoSe
Content	Experiment 1: Emission and immission measurement of gaseous pollutants: different technologies to determine different gaseou pollutants in automotive exhaust are used.
	Experiment 2: Simulation and measurement of asynchrone engine and rotary pump: the dynamic behaviour of e pump engine w be investigated. The starting will be simulated on a PC and compared with measurement.
	Experiment 3: Michelson interferometer and fiber optic: fundamental optical phenonema will be understood and applications wi Michelson interferometer and optical fibers demonstrated.
	Experiment 4:Identification of the parameters of a control system and optimal control parameters
Literature	Versuch 1:
	<ul> <li>Leith, W.: Die Analyse der Luft und ihrer Verunreinigung in der freien Atmosphäre und am Arbeitsplatz. 2. Auf Wissenschaftliche Verlagsgesellschaft, Stuttgart, 1974</li> <li>Birkle, M.: Meßtechnik für den Immissionsschutz, Messen der gas- und partikelförmigen Luftverunreinigungen. R. Oldenbu Verlag, München-Wien, 1979</li> <li>Luftbericht 83/84, Freie und Hansestadt Hamburg, Behörde für Bezirksangelegenheiten, Naturschutz und Umweltgestaltun Gebrauchs- und Bedienungsanweisungen</li> <li>VDI-Handbuch Reinhaltung der Luft, Band 5: VDI-Richtlinien 2450 Bl.1, 2451 Bl.4, 2453 Bl.5, 2455 Bl.1</li> <li>Versuch 2:</li> <li>Grundlagen über elektrische Maschinen, speziell: Asynchronmotoren</li> <li>Simulationsmethoden, speziell: Verwendung von Blockschaltbildern</li> <li>Betriebsverhalten von Kreispumpen, speziell: Kennlinien, Ähnlichkeitsgesetze</li> <li>Versuch 3:</li> <li>Unger, HG.: Optische Nachrichtentechnik, Teil 1: Optische Wellenleiter. Hüthing Verlag, Heidelberg, 1984</li> <li>Dakin, J., Cushaw, B.: Optical Fibre Sensors: Principles and Components. Artech House Boston, 1988</li> <li>Culshaw, B., Dakin, J.: Optical Fibre Sensors: Systems and Application. Artech House Boston, 1989</li> <li>Versuch 4:</li> <li>Leonhard: Einführung in die Regelungstechnik. Vieweg Verlag, Braunschweig-Wiesbaden</li> <li>Jan Lunze: Systemtheoretische Grundlagen, Analyse und Entwurf einschleifiger Regelungen</li> </ul>

Course L1116: Measurement	Technology for Mechanical Engineering	
Тур	Lecture	
Hrs/wk	2	
СР	3	
	Independent Study Time 62, Study Time in Lecture 28	
	Prof. Thorsten Kern, Dennis Kähler	
Language		
Cycle	WiSe 1 Fundamentals	
Content	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	ourse L1118: Measurement Technology for Mechanical Engineering	
Тур	Recitation Section (large)	
Hrs/wk	1	
CP	1	
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14	
Lecturer	Prof. Thorsten Kern	
Language	EN	
Cycle	WiSe	
Content	See interlocking course	
Literature	See interlocking course	

## Focus Biomechanics

	omechanics get in addition to their core engi ables them to understand operational plannin			
Module M1277: MED	: Introduction to Anatomy			
Courses				
Title		Тур	Hrs/wk	СР
Introduction to Anatomy (L0384)		Lecture	2	3
Module Responsible	Prof. Udo Schumacher			
Admission Requirements	None			
<b>Recommended Previous</b>	None			
Knowledge				
Educational Objectives	After taking part successfully, students have rea	ched the following learning results		
Professional Competence				
Knowledge	The students can describe basal structures and	functions of internal organs and the m	usculoskeletal system.	
	The students can describe the basic macroscopy	and microscopy of those systems.		
Skills	The students can recognize the relationship bet	ween given anatomical facts and the d	levelopment of some co	mmon diseases: the
D.M.D	can explain the relevance of structures and thei			
Personal Competence				
Social Competence	The students can participate in current discussion	ons in biomedical research and medicin	ne on a professional leve	el.
Autonomy	The students are able to access anatomical kn	owledge by themselves, can participa	te in conversations on t	he topic and acquire
	the relevant knowledge themselves.			
Workload in Hours	Independent Study Time 62, Study Time in Lect	Ire 28		
Credit points				
Course achievement				
Examination				
Examination duration and				
scale				
Assignment for the	General Engineering Science (German program,	7 semester): Specialisation Biomedica	al Engineering: Compulso	ory
Following Curricula	General Engineering Science (German progra	am, 7 semester): Specialisation Me	chanical Engineering, F	ocus Biomechanics
	Compulsory			
	Data Science: Specialisation Medicine: Compulse	bry		
	Electrical Engineering: Specialisation Medical Te			
	Engineering Science: Specialisation Biomedical		Fasianaia, C. i	
	General Engineering Science (English program,		Engineering: Compulso	ry
	Mechanical Engineering: Specialisation Biomech Biomedical Engineering: Specialisation Medical		e Compulsory	
	Biomedical Engineering: Specialisation Medical Biomedical Engineering: Specialisation Manager			
	Biomedical Engineering: Specialisation Artificial			
	Biomedical Engineering: Specialisation Implants			
	Technomathematics: Specialisation III. Engineer		-	

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

Courses					
Title		Тур	Hrs/wk	СР	
Introduction to Radiology and Radi	ation Therapy (L0383)	Lecture	2	3	
Module Responsible	Prof. Ulrich Carl				
Admission Requirements	None				
Recommended Previous	None				
Knowledge Educational Objectives	After taking part successfully, students have	reached the following learning results			
Professional Competence		· · · · · · · · · · · · · · · · · · ·			
Knowledge	Therapy				
	The students can distinguish different types	of currently used equipment with respect t	to its use in radiation the	erapy.	
	The students can explain treatment plans us	ed in radiation therapy in interdisciplinary	contexts (e.g. surgery, i	nternal medicine).	
	The students can describe the patients'	passage from their initial admittance	through to follow-up	care.	
	Diagnostics				
	-				
	The students can illustrate the technical bas well as sectional imaging techniques (CT, MR		cluding angiography and	d mammography, a	
	The students can explain the diagnostic as w techniques.	vell as therapeutic use of imaging techniq	ues, as well as the tech	nical basis for tho	
	The students can choose the right treatment	method depending on the patient's clinica	al history and needs.		
	The student can explain the influence of tech	nnical errors on the imaging techniques.			
	The student can draw the right conclusions based on the images' diagnostic findings or the error protocol.				
		used on the images and nostic infanties of	the error protocol.		
Skills	Therapy The students can distinguish curative and palliative situations and motivate why they came to that conclusion.				
	The students can develop adequate therapy	concepts and relate it to the radiation biol	ogical aspects.		
	The students can use the therapeutic princip	le (effects vs adverse effects)			
	The students can distinguish different kinds of radiation, can choose the best one depending on the situation (location of the tumor) and choose the energy needed in that situation (irradiation planning).				
	The student can assess what an individual groups, self-help groups, social services, psy		.g. follow-up treatment	, sports, social he	
	Diagnostics				
	The students can suggest solutions for repair	rs of imaging instrumentation after having	done error analyses		
	The students can classify results of imaging techniques according to different groups of diseases based on their knowledge of				
	anatomy, pathology and pathophysiology.	g techniques according to different group	os 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, of measures and can meet them appropriately.	ten fear-dominated behavior of sick peo		-	
Autonomy	The students can apply their new knowledge				
Autonomy	The students can introduce younger students				
	The students are able to access anatomical and acquire the relevant knowledge themsel		e competently in conve	rsations on the top	
Workload in House	Independent Study Time 62, Study Time in L	acture 28			
Credit points	Independent Study Time 62, Study Time in Li 3	CCC016 20			
Course achievement					
Examination	Written exam				
Examination duration and	90 minutes				
scale	Conoral Engineering Science (Corman progra	7 comostor): Specialization Riomodica	Engineering: Compulse	r)/	
Following Curricula	General Engineering Science (German progra General Engineering Science (German pro				
-	Compulsory				
	Data Science: Specialisation Medicine: Comp				
	Electrical Engineering: Specialisation Medical Engineering Science: Specialisation Biomedic				
	General Engineering Science (English progra		Engineering: Compulsor	У	
	Mechanical Engineering: Specialisation Biom		_ ·		
	Biomedical Engineering: Specialisation Medic Biomedical Engineering: Specialisation Mana				
	Biomedical Engineering: Specialisation Maria Biomedical Engineering: Specialisation Artific				
	Biomedical Engineering: Specialisation Impla				
	Biomedical Engineering: Specialisation Artific	ial Organs and Regenerative Medicine: Ele	ective Compulsory		

	Technomathematics: Specialisation III. Engineering Science: Elective Compulsory			
Course L0383: Introduction to Radiology and Radiation Therapy				
Тур	Lecture			
Hrs/wk				
CP				
	Independent Study Time 62, Study Time in Lecture 28 Prof. Ulrich Carl, Prof. Thomas Vestring			
Language				
Cycle	SoSe			
Content	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		
Title	Typ Hrs/wk	СР
Numerical Mathematics I (L0417)	<b>2</b>	3
Numerical Mathematics I (L0418)	) Recitation Section (small) 2	3
Module Responsible	le Prof. Sabine Le Borne	
Admission Requirements	ts None	
<b>Recommended Previous</b>		
Knowledge	<ul> <li>Mathematik I + II for Engineering Students (german or english) or Analysis &amp; Linear Algebra I + II for Technologie</li> <li>basic MATLAB/Python knowledge</li> </ul>	omathematici
Educational Objectives	After taking part successfully, students have reached the following learning results	
Professional Competence	e	
Knowledge	7e Students are able to	
	<ul> <li>name numerical methods for interpolation, integration, least squares problems, eigenvalue problems, nonliproblems and to explain their core ideas,</li> <li>repeat convergence statements for the numerical methods,</li> <li>explain aspects for the practical execution of numerical methods with respect to computational and storage</li> </ul>	
Skills	//s Students are able to	
	<ul> <li>implement, apply and compare numerical methods using MATLAB/Python,</li> <li>justify the convergence behaviour of numerical methods with respect to the problem and solution algorithm</li> <li>select and execute a suitable solution approach for a given problem.</li> </ul>	۱,
Personal Competence	e	
Social Competence	ce Students are able to	
	<ul> <li>work together in heterogeneously composed teams (i.e., teams from different study programs and backgro explain theoretical foundations and support each other with practical aspects regarding the implementation</li> </ul>	
Autonomy	ην Students are capable	
	<ul> <li>to assess whether the supporting theoretical and practical excercises are better solved individually or in a te</li> <li>to assess their individual progess and, if necessary, to ask questions and seek help.</li> </ul>	eam,
Workload in Hours	rs Independent Study Time 124, Study Time in Lecture 56	
Credit points	ts 6	
Course achievement	nt None	
Examination	n Written exam	
Examination duration and	d 90 minutes	
scale	le	
Assignment for the	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: Compulsory	
Following Curricula	la General Engineering Science (German program, 7 semester): Specialisation Biomedical Engineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus	s Biomechan
Following Curricula		
Following Curricula	General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Theore Engineering: Compulsory	etical Mechan
Following Curricula	General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Theorem	etical Mechan
Following Curricula	General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Theore Engineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus 7 Engineering: Elective Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus 7 Engineering: Elective Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Mechanical	etical Mechan Aircraft Syste
Following Curricula	General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Theore Engineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus 7 Engineering: Elective Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus 7 Engineering: Elective Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Mechan Compulsory	etical Mechan Aircraft Syste atronics: Elect
Following Curricula	General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Theore Engineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus 7 Engineering: Elective Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus 7 Engineering: Elective Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Mechanical	etical Mechan Aircraft Syste atronics: Elect
Following Curricula	General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus         Compulsory         General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Theore         Engineering: Compulsory         General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Theore         Engineering: Compulsory         General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus A         Engineering: Elective Compulsory         General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Mechanical         Compulsory         General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Mechanical         Compulsory         General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Mechanical         Compulsory         General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Mechanical	etical Mechan Aircraft Syste atronics: Elect
Following Curricula	General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Theore Engineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus 7 Engineering: Elective Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus 7 General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Mecha Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Mecha Elective Compulsory	etical Mechani Aircraft Syste atronics: Elect Energy Syster
Following Curricula	<ul> <li>General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Compulsory</li> <li>General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Theore Engineering: Compulsory</li> <li>General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus 7 Engineering: Elective Compulsory</li> <li>General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus 7 Engineering: Elective Compulsory</li> <li>General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Mechanical Engineering, Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus 8 Elective Compulsory</li> <li>General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus 8 Elective Compulsory</li> <li>General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus 9 Elective Compulsory</li> <li>General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus 9 Elective Compulsory</li> <li>General Engineering Science (German program, 7 semester): Specialisation Advanced Materials: Compulsory</li> </ul>	etical Mechani Aircraft Syste atronics: Elect Energy Syster
Following Curricula	General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Compulsory         General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Theore         Engineering: Compulsory         General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Theore         Engineering: Compulsory         General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus A         Engineering: Elective Compulsory         General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Mecha         Compulsory         General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Mecha         Compulsory         General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus E         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 Mechanical Engineering, Focus P	etical Mechani Aircraft Syste atronics: Elect Energy Syster
Following Curricula	General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Compulsory         General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Theore Engineering: Compulsory         General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Theore Engineering: Elective Compulsory         General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Mechanical Engineering, Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Mechanicory         General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Mechanicory         General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Elective Compulsory         General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus 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 Mechanical Engineering, Focus         Engineering Science (German program, 7 semester): Specialisation Advanced Materials: Compulsory         General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus	etical Mechani Aircraft Syste atronics: Elect Energy Syster
Following Curricula	<ul> <li>General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Compulsory</li> <li>General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Theore Engineering: Compulsory</li> <li>General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus 7 Engineering: Elective Compulsory</li> <li>General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus 7 Engineering: Elective Compulsory</li> <li>General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Mecha</li> <li>Compulsory</li> <li>General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Mecha</li> <li>Compulsory</li> <li>General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Period</li> <li>General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Period</li> <li>General Engineering Science (German program, 7 semester): Specialisation Advanced Materials: Compulsory</li> <li>General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Period</li> <li>Engineering Science: Compulsory</li> <li>General Engineering Science (German program, 7 semester): Specialisation Advanced Materials: Compulsory</li> <li>General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus</li> <li>Engineering Sciences: Compulsory</li> <li>Bioprocess Engineering: Specialisation A - General Bioprocess Engineering: Elective Compulsory</li> </ul>	etical Mechani Aircraft Syste atronics: Elect Energy Syster
Following Curricula	General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Compulsory         General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Theore         Engineering: Compulsory         General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus 7         Engineering: Compulsory         General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus 7         Engineering: Elective Compulsory         General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Mecha         Compulsory         General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Mecha         Compulsory         General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus E         Elective Compulsory         General Engineering Science (German program, 7 semester): Specialisation Advanced Materials: Compulsory         General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus         Engineering Science: Compulsory         Bioprocess Engineering: Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus         Engineering Science: Compulsory         Bioprocess Engineering: Specialisation A - General Bioprocess Engineering: Elective Compulsory         Computer Science	etical Mechani Aircraft Syste atronics: Elect Energy Syster
Following Curricula	General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Compulsory         General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Theore         Engineering: Compulsory         General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus 7         Engineering: Compulsory         General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus 7         Engineering: Elective Compulsory         General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Mecha         Compulsory         General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Mecha         Compulsory         General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus E         Elective Compulsory         General Engineering Science (German program, 7 semester): Specialisation Advanced Materials: Compulsory         General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus         Engineering Science: Compulsory         Bioprocess Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus         Engineering Science: Compulsory         Bioprocess Engineering: Specialisation A - General Bioprocess Engineering: Elective Compulsory         Computer Science:	etical Mechan Aircraft Syste atronics: Elect Energy Syster
Following Curricula	General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Compulsory         General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Theore         Engineering: Compulsory         General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus 7         Engineering: Compulsory         General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus 7         Engineering: Elective Compulsory         General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Mecha         Compulsory         General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Mecha         Compulsory         General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus E         Elective Compulsory         General Engineering Science (German program, 7 semester): Specialisation Advanced Materials: Compulsory         General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus         Elective Compulsory         General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus         Engineering Science: Compulsory         Bioprocess Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus         Engineering Science:	etical Mechan Aircraft Syste atronics: Elect Energy Syster
Following Curricula	General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Compulsory         General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Theore         Engineering: Compulsory         General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus 7         Engineering: Compulsory         General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus 7         Engineering: Elective Compulsory         General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Mecha         Compulsory         General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Mecha         Compulsory         General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Elective Compulsory         General Engineering Science (German program, 7 semester): Specialisation Advanced Materials: Compulsory         General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Engineering Science: Compulsory         Bioprocess Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Engineering Science: Compulsory         Computer Science: Specialisation A - General Bioprocess Engineering: Elective Compulsory         Computer Science: Core Qualification: Compulsory         Electrical Engineering: Core Qualification:	etical Mechan Aircraft Syste atronics: Elect Energy Syster
Following Curricula	General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Compulsory         General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Theore         Engineering: Compulsory         General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus 7         Engineering: Compulsory         General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus 7         Engineering: Elective Compulsory         General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Mecha         Compulsory         General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Mecha         Compulsory         General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus E         Elective Compulsory         General Engineering Science (German program, 7 semester): Specialisation Advanced Materials: Compulsory         General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus         Elective Compulsory         General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus         Engineering Science: Compulsory         Bioprocess Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus         Engineering Science:	etical Mechan Aircraft Syste atronics: Elect Energy Syster
Following Curricula	General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Compulsory         General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Theore         Engineering: Compulsory         General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus 7         Engineering: Compulsory         General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus 7         Engineering: Elective Compulsory         General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Mecha         Compulsory         General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Mecha         Compulsory         General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Elective Compulsory         General Engineering Science (German program, 7 semester): Specialisation Advanced Materials: Compulsory         General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Engineering Science: Compulsory         Bioprocess Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Engineering Science: Compulsory         Computer Science: Specialisation A - General Bioprocess Engineering: Elective Compulsory         Computer Science: Core Qualification: Compulsory         Electrical Engineering: Core Qualification:	etical Mechan Aircraft Syste atronics: Elect Energy Syster

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	<ol> <li>Finite precision arithmetic, error analysis, conditioning and stability</li> <li>Linear systems of equations: LU and Cholesky factorization, condition</li> <li>Interpolation: polynomial, spline and trigonometric interpolation</li> <li>Nonlinear equations: fixed point iteration, root finding algorithms, Newton's method</li> <li>Linear and nonlinear least squares problems: normal equations, Gram Schmidt and Householder orthogonalization, singular value decomposition, regularizatio, Gauss-Newton and Levenberg-Marquardt methods</li> <li>Eigenvalue problems: power iteration, inverse iteration, QR algorithm</li> <li>Numerical differentiation</li> </ol>
Literature	<ul> <li>8. Numerical integration: Newton-Cotes rules, error estimates, Gauss quadrature, adaptive quadrature</li> <li>Gander/Gander/Kwok: Scientific Computing: An introduction using Maple and MATLAB, Springer (2014)</li> <li>Stoer/Bulirsch: Numerische Mathematik 1, Springer</li> <li>Dahmen, Reusken: Numerik für Ingenieure und Naturwissenschaftler, Springer</li> </ul>

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				
Title		Тур	Hrs/wk	СР
Introduction to Biochemistry and M	olecular Biology (L0386)	Lecture	2	3
Module Responsible	Prof. Hans-Jürgen Kreienkamp			
Admission Requirements	None			
	None			
Knowledge				
Educational Objectives	After taking part successfully, students	have reached the following learning results		
Professional Competence				
Knowledge	The students can			
	describe basic biomolecules;			
	<ul> <li>explain how genetic information</li> <li>explain the connection between</li> </ul>			
	<ul> <li>explain the connection between</li> </ul>	DNA and proteins;		
Skills	The students can			
	<ul> <li>recognize the importance of me</li> </ul>	locular parameters for the course of a disease.		
	describe selected molecular-diag	lecular parameters for the course of a disease;		
	<ul> <li>explain the relevance of these p</li> </ul>			
Personal Competence				
Social Competence	The students can participate in discuss	ions in research and medicine on a technical lev	el.	
	Students will have an improved unde	rstanding of current medical problems (e.g. Co	rona pandemic)and wil	be able to expla
	these issues to others.	· · · · · · · · · · · · · · · · · · ·		
Autonomy	The students can develop an understa	nding of topics from the course, using technical I	iterature, by themselves	5.
	Students will be better equipped to rec	ognize fake news in the media regarding medica	al research topics.	
	Independent Study Time 62, Study Tim	ie in Lecture 28		
Credit points				
Course achievement	None			
	Written exam			
Examination duration and	60 minutes			
scale				
		program, 7 semester): Specialisation Biomedical		
Following Curricula	Compulsory	an program, 7 semester): Specialisation Mec	nanicai Engineering, F	ocus biomechani
		ledical Technology: Elective Compulsory		
	Engineering Science: Specialisation Bio			
	5	program, 7 semester): Specialisation Biomedical	Engineering: Compulsor	y
	Mechanical Engineering: Specialisation	-		-
		Management and Business Administration: Elect	tive Compulsory	
	Biomedical Engineering: Specialisation	Artificial Organs and Regenerative Medicine: Ele	ctive Compulsory	
	Biomedical Engineering: Specialisation	Medical Technology and Control Theory: Elective	e Compulsory	
	Biomedical Engineering: Specialisation	Implants and Endoprostheses: Elective Compuls	ory	
	Technomathematics: Specialisation III.	Engineering Science: Elective Compulsory		

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	

Module M1333: BIO I:	Implants and Fracture Heali	ina		
Courses				
Title		Тур	Hrs/wk	СР
Implants and Fracture Healing (L03	76)	Lecture	2	3
Module Responsible	Prof. Michael Morlock			
Admission Requirements	None			
<b>Recommended Previous</b>	It is recommended to participate in "Intro	duction into Anatomie" before attending "Imp	lants and Fracture Heal	ing".
Knowledge				
Educational Objectives	After taking part successfully, students ha	ave reached the following learning results		
Professional Competence				
Knowledge	The students can describe the different w	ays how bones heal, and the requirements for	r their existence.	
	The students can name different treatment	nts for the spine and hollow bones under give	n fracture morphologies	
Skills	The students can determine the forces ac	ting within the human body under guasi-statio	c situations under speci	fic assumptions
SKIIS	The stadents can accomme the forces ac	and we have been body and er quasi station	e situations ander speer	ne assumptions.
Personal Competence				
Social Competence	The students can, in groups, solve basic n	numerical modeling tasks for the calculation o	f internal forces.	
Autonomy	The students can in groups, solve basic n	numerical modeling tasks for the calculation o	f internal forces	
Autonomy	The students can, in groups, solve basic in	americal modeling tasks for the calculation o	rinternariorces.	
Workload in Hours	Independent Study Time 62, Study Time i	n 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 Mec	hanical Engineering, F	ocus Biomechanic
Following Curricula	Compulsory			
	General Engineering Science (German pro	ogram, 7 semester): Specialisation Biomedical	Engineering: Compulso	ory
	Engineering Science: Specialisation Biome	edical Engineering: Compulsory		
	General Engineering Science (English prog	gram, 7 semester): Specialisation Biomedical	Engineering: Compulso	гy
	Mechanical Engineering: Specialisation Big	omechanics: Compulsory		
	Biomedical Engineering: Specialisation Im	plants and Endoprostheses: Elective Compuls	sory	
	Biomedical Engineering: Specialisation Art	tificial Organs and Regenerative Medicine: Ele	ective Compulsory	
	Biomedical Engineering: Specialisation Ma	anagement and Business Administration: Elect	tive Compulsory	
	Biomedical Engineering: Specialisation Me	edical Technology and Control Theory: Elective	e Compulsory	
	Orientation Studies: Core Qualification: El	ective Compulsory		
	Technomathematics: Specialisation III. En			

Course L0376: Implants and	Fracture Healing
-	Lecture
CP	3
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		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 function		's the layers from	n the assembly-le
	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
	<ul> <li>Sequential logic: Flip-flops, automata, systemati</li> </ul>	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	
	<ul> <li>Memories: Memory hierarchies, SRAM, DRAM, ca</li> <li>Input/output: I/O from the perspective of the CPU</li> </ul>		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 consequence	es that the exec	ution of software I
	on the hardware-centric abstraction layers from the as	sembly language down to gates. This	way, they will be	e enabled to evalu
	the impact that these low abstraction levels have on a	entire system's performance and to p	propose feasible of	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	<ul> <li>Introduction</li> <li>Combinational Logic</li> <li>Sequential Logic</li> <li>Technological Foundations</li> <li>Representations of Numbers, Computer Arithmetics</li> <li>Foundations of Computer Architecture</li> <li>Memories</li> <li>Input/Output</li> </ul>
Literature	<ul> <li>A. Clements. The Principles of Computer Hardware. 3. Auflage, Oxford University Press, 2000.</li> <li>A. Tanenbaum, J. Goodman. Computerarchitektur. Pearson, 2001.</li> <li>D. Patterson, J. Hennessy. Rechnerorganisation und -entwurf. Elsevier, 2005.</li> </ul>

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 Introduction to Physiology (L0385)	Typ         Hrs/wk         CP           Lecture         2         3	
Module Responsible	Dr. Roger Zimmermann	
Admission Requirements	None	
<b>Recommended Previous</b>	None	
Knowledge		
Educational Objectives	After taking part successfully, students have reached the following learning results	
Professional Competence		
Knowledge	The students can	
	<ul> <li>describe the basics of the energy metabolism;</li> </ul>	
	<ul> <li>describe the basics of the energy metabolism,</li> <li>describe physiological relations in selected fields of muscle, heart/circulation, neuro- and sensory physiology.</li> </ul>	
	- describe physiological relations in selected netas of mascle, nearly chedidation, nearly and sensory physiology.	
Skills	The students can describe the effects of basic bodily functions (sensory, transmission and processing of information, develop	me
	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 literatu	e, I
,	themselves.	
	Independent Study Time 62, Study Time in Lecture 28	
Credit points		
Course achievement		
Examination	Written exam	
Examination duration and		
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 Biomech	anic
	Compulsory	
	Data Science: Specialisation Medicine: 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	
	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	
	biomedical Engineering, opecialisation implants and Endoprosatises Elective comparisony	

Course L0385: Introduction t	co 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	
	The United CD
Title Experimental Methods in Biomecha	Typ         Hrs/wk         CP           anics (L0377)         Lecture         2         3
Module Responsible	
Admission Requirements	
Recommended Previous	It is recommended to participate in "Implantate und Frakturheilung" before attending "Experimentelle Methoden".
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 f 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 divisio 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 cha 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 relate 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	
Assignment for the	General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Biomechar
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
	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/

Module M0934: Adva	nced Materials for Sustainability	у			
Courses					
Title			Тур	Hrs/wk	CP
Advanced Materials Characterizatio	n (I 1087)		Lecture	2	2
Advanced Materials for Sustainabili			Lecture	2	2
Advanced Materials for Sustainabili	ty (L1092)		Recitation Section (large)	2	2
Module Responsible	Prof. Patrick Huber				
Admission Requirements	None				
Recommended Previous	Fundamentals of Materials Science (I and II)				
Knowledge					
Educational Objectives	After taking part successfully, students have r	eached the followin	g learning results		
Professional Competence					
Knowledge	The students will be able to explain the proper metallic, ceramic, polymeric, semiconductor, n				nology, in particula
Skills	The students will be able to select material configurations according to the technical needs and, if necessary, to design new materials considering architectural principles from the micro- to the macroscale. The students will also gain an overview on modern materials science, which enables them to select optimum materials combinations depending on the technical applications.				
Personal Competence					
Social Competence	The students are able to present solutions to specialists and to develop ideas further.				
Autonomy	The students are able to <ul> <li>assess their own strengths and weaknesses.</li> <li>define tasks independently.</li> </ul>				
Workload in Hours	Independent Study Time 96, Study Time in Le	cture 84			
Credit points	6				
Course achievement	None				
Examination	Written exam				
Examination duration and					
scale					
Assignment for the					
Following Curricula	Compulsory			2 0.	
-	General Engineering Science (German program	m, 7 semester): Spe	cialisation Advanced Materia	lls: Compulsory	
	General Engineering Science (German pro				Focus Materials ir
	Engineering Sciences: Compulsory		-	2 5.	
	Engineering Science: Specialisation Mechanica	al Engineering: Elec	tive Compulsory		
	Engineering Science: Specialisation Advanced				
	Mechanical Engineering: Core Qualification: El				
	gi core quamedion El				

Course L1087: Advanced Materials 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 Materials 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. Gerold Schneider, Prof. Jörg Weißmüller, Prof. Patrick Huber, Prof. Stefan Fritz Müller	
Language	DE/EN	
Cycle	SoSe	
Content		
Literature	Vorlesungsunterlagen	

Course L1092: Advanced Ma	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		

## 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.

Module M0684: Heat	Transfer			
Courses				
Title		Тур	Hrs/wk	СР
Heat Transfer (L0458)		Lecture	3	4
Heat Transfer (L0459)	[	Recitation Section (large)	2	2
Module Responsible				
Admission Requirements				
Recommended Previous Knowledge	Technical Thermodynamics I, II and Fluid Dynamics			
Educational Objectives	After taking part successfully, students have reached the fo	llowing learning results		
Professional Competence		in a magnetic management of the second se		
•	The students can			
	- explain the technical terms,			
	- classify the various physical processes of heat transfer in	terms of conduction-based and rad	iation-based mec	hanisms,
	- simplify and critically analyze complex heat transfer proce	esses using models,		
	- methodically develop solutions to tasks.			
Skille	The students are able to			
JKIIIS				
	- describe the physics of the different Heat Transfer mechan	nism,		
	- 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 ex- manner, develop a solution and present it. Within the exe 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 and discuss answers in exchange with the other students. In the exercises, the students work in small groups on the methods taught in 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				
Course achievement				
Examination				
Examination duration and				
scale				
Assignment for the	General Engineering Science (German program, 7 seme	ster): Specialisation Mechanical E	ingineering, Focu	is Energy Systems
Following Curricula				
	General Engineering Science (German program, 7 semester		÷ ,	-
	General Engineering Science (German program, 7 semeste Engineering: Compulsory	i). Specialisation Mechanical Engin	eening, rocus The	
	Energy Systems: Technical Complementary Course Core St	udies: Elective Compulsory		
	Integrated Building Technology: Core Qualification: Compul			
	Mechanical Engineering: Specialisation Energy Systems: Co	mpulsory		
	1			

Mechanical 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	<ul> <li>Herwig, H.; Moschallski, A.: Wärmeübertragung, 4. Auflage, Springer Vieweg Verlag, Wiesbaden, 2019</li> <li>Herwig, H.: Wärmeübertragung von A-Z, Springer- Verlag, Berlin, Heidelberg, 2000</li> <li>Baehr, H.D.; Stephan, K.: Wärme- und Stoffübertragung, 2. Auflage, Springer Verlag, Berlin, Heidelberg, 1996</li> </ul>

Course L0459: Heat Transfer	ourse 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	

Module M1022: Recip	rocating Machinery			
Courses				
Title		Тур	Hrs/wk	СР
Fundamentals of Reciprocating Engines and Turbomachinery - Part Reciprocating Engines (L0633)		Lecture	1	1
Fundamentals of Reciprocating Eng	ines and Turbomachinery - Part Reciprocating Engines (L0634)	Recitation Section (large)	1	1
nternal Combustion Engines I (L00	59)	Lecture	2	2
Internal Combustion Engines I (L06	39)	Recitation Section (large)	1	2
Module Responsible	Prof. Christopher Friedrich Wirz			
Admission Requirements	None			
<b>Recommended Previous</b>	Thermodynamics, Mechanics, Machine Elements			
Knowledge				
Educational Objectives	After taking part successfully, students have reached the foll	lowing learning results		
Professional Competence				
Knowledge	As a result of the part module "Fundamentals of Reciprocatin	ng Machinery", the students are a	able to reflect fur	ndamentals regardi
	power and working machinery and describe the qualitative a	and quantitative correlations of	operating method	ds and efficiencies
	multiple types of engines, compressors and pumps. They a	are able to utilize technical term	s and parameter	rs as well as aspec
	regarding the development of power density and efficience	cy, furthermore to give an over	view of charging	g systems, fuels a
	emissions. The students are able to select specific types of m	nachinery and assess design rela	ted and operation	nal problems.
	As a result of the part module "Internal Combustion Engi	nes I", the students are able r	eflect and utilize	e the state-of-the-a
	regarding efficiency limits. In addition, they are able to	utilize their knowledge of desi	gn, mechanical	and thermodynan
	characteristics and the approach of similarity. They are able	to explain, assess and develop	engines as well a	as charging systen
	Detailed knowledge is present regarding computer-aided pro	ocess design.		
SKIIIS	The students are skilled to employ basic and detail knowled		-	
	They are further able to assess, analyse and solve tec	chnical and operational problem	ns and to perfo	orm mechanical a
	thermodynamic design.			
Personal Competence				
-	The students are able to communicate and cooperate in a professional environment in the field of machinery design and			
	application.			jj
Autonomy	The widespread scope of gained knowledge enables the stud	dents to handle situations in thei	r future professio	on independently a
	confidently.			
Workload in Hours	Independent Study Time 110, Study Time in Lecture 70			
Credit points				
Course achievement				
Examination	Written exam			
Examination duration and	120 min			
scale				
Assignment for the	General Engineering Science (German program 7 semest	ter): Specialisation Mechanical	Engineering For	us Energy System
Following Curricula				
i onowing curriculd	Energy and Environmental Engineering: Core Qualification: E	lective Compulsory		
	Energy Systems: Technical Complementary Course Core Stud		nulaanu	
	Green Technologies: Energy, Water, Climate: Specialisation E Mechanical Engineering: Specialisation Energy Systems: Corr		puisory	

	s of Reciprocating Engines and Turbomachinery - Part Reciprocating Engines
Тур	Lecture
Hrs/wk	1
СР	1
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14
Lecturer	Prof. Christopher Friedrich Wirz
Language	DE
Cycle	WiSe
Content	<ul> <li>Verbrennungsmotoren</li> <li>Historischer Rückblick</li> <li>Einteilung der Verbrennungsmotoren</li> </ul>
	<ul> <li>Arbeitsverfahren</li> <li>Vergleichsprozesse</li> <li>Arbeit, Mitteldrücke, Leistungen</li> </ul>
	<ul> <li>Arbeitsprozess des wirklichen Motors</li> <li>Wirkungsgrade</li> <li>Gemischbildung und Verbrennung</li> </ul>
	<ul> <li>Motorkennfeld und Betriebskennlinien</li> <li>Abgasentgiftung</li> </ul>
	<ul> <li>Gaswechsel</li> <li>Aufladung</li> <li>Kühl- und Schmiersystem</li> </ul>
	Kräfte im Triebwerk     Kolbenverdichter     Thermodynamik des Kolbenverdichters     Fisteliung und Verwordung
	<ul> <li>Einteilung und Verwendung</li> <li>Kolbenpumpen</li> <li>Prinzip der Kolbenpumpen</li> <li>Einteilung und Verwendung</li> </ul>
Literature	<ul> <li>A. Urlaub: Verbrennungsmotoren</li> <li>W. Kalide: Kraft- und Arbeitsmaschinen</li> </ul>

Course L0634: Fundamentals	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 Comb	oustion Engines I			
Тур	re			
Hrs/wk	2			
CP				
Workload in Hours	endent Study Time 32, Study Time in Lecture 28			
Lecturer	Wolfgang Thiemann			
Language				
Cycle	SoSe			
Content	<ul> <li>The beginnings of engine development</li> <li>Design of of motors</li> <li>Real process calculation</li> <li>Charging methods</li> <li>Kinematics of the crank mechanism</li> <li>Forces in the engine</li> </ul>			
Literature	<ul> <li>Vorlesungsskript</li> <li>Übungsaufgaben mit Lösungsweg</li> <li>Literaturliste</li> </ul>			

Course L0639: Internal Comb	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. Wolfgang Thiemann		
Language	DE		
Cycle	SoSe		
Content	See interlocking course		
Literature	See interlocking course		

Co					
Courses Title		Tur	Line (sult	СР	
Computer Engineering (L0321)		<b>Typ</b> Lecture	Hrs/wk 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	the following learning results			
Professional Competence		5 5			
Knowledge	This module deals with the foundations of the funct programming down to gates. The module includes the		s the layers fror	n the assembly-le	
	Introduction				
	<ul> <li>Combinational logic: Gates, Boolean algebra, B</li> </ul>	oolean functions, hardware synthesis, c	ombinational net	works	
	<ul> <li>Sequential logic: Flip-flops, automata, systema</li> </ul>	tic hardware design			
	<ul> <li>Technological foundations</li> </ul>				
	Computer arithmetic: Integer addition, subtract				
	Basics of computer architecture: Programming		pipelining		
	Memories: Memory hierarchies, SRAM, DRAM, of the second seco		-later it	h	
	<ul> <li>Input/output: I/O from the perspective of the CF</li> </ul>	<ul><li>principles of passing data, point-to-p</li></ul>	oint connections	, DUSSES	
Skills	The students perceive computer systems from the arc composition of computer systems. The students can a				
	collection of few and simple components. They are a	able to distinguish between and to expl	ain the different	abstraction layers	
	today's computing systems - from gates and circuits u	up to complete processors.			
	After successful completion of the module, the stud	ents are able to judge the interdepend	encies between	a physical compu	
	After successful completion of the module, the students are able to judge the interdependencies between a physical compute system and the software executed on it. In particular, they shall understand the consequences that the execution of software has				
	on the hardware-centric abstraction layers from the a				
	the impact that these low abstraction levels have on a				
Personal Competence	Chudanta ang abla ta ankar similar maklama alam ang		- and a set of		
Social Competence	Students are able to solve similar problems alone or in	n a group and to present the results acc	oraingiy.		
	Students are able to acquire new knowledge from spe	cific literature and to associate this kno	wledge with othe	er classes.	
Workload in Hours	Independent Study Time 124, Study Time in Lecture 5	56			
Credit points	6				
Course achievement	Compulsory         Bonus         Form         De           Yes         10 %         Excercises	scription			
Examination					
Examination					
	90 minutes, contents of course and labs				
scale	Concret Engineering Ediance (Cormon program 7 or	nester), Cresislication Computer Coince	a. Camanulaanu		
Assignment for the Following Curricula	General Engineering Science (German program, 7 ser General Engineering Science (German program, 7			Focus Mochatroni	
Following curricula	Compulsory	semester). Specialisation Mechanica	in Engineering,	Focus Mechacioni	
	General Engineering Science (German program, 7	semester): Specialisation Mechanical	Engineering For	cus Aircraft Syste	
	Engineering: Compulsory	semester). Specialisation mechanical	Engineering, 100	and Anerone Syste	
	General Engineering Science (German program, 7 ser	mester): Specialisation Mechanical Engi	neering, Focus Th	neoretical Mechani	
	Engineering: Compulsory	· · · · · · · · · · · · · · · · · · ·	J		
	General Engineering Science (German program,	7 semester): Specialisation Mechanic	al Engineering,	Focus Materials	
	Engineering Sciences: Compulsory				
	General Engineering Science (German program, 7 se	mester): Specialisation Mechanical Eng	ineering, Focus F	Product Developme	
	and Production: Compulsory				
	General Engineering Science (German program, 7	semester): Specialisation Mechanical	Engineering, Foc	us Energy Syster	
	Compulsory			_	
	General Engineering Science (German program, 7	semester): Specialisation Mechanica	I Engineering, I	Focus Biomechani	
	Compulsory				
	General Engineering Science (German program, 7 ser				
	General Engineering Science (German program, 7 ser	nester): 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				
	Electrical Engineering: Core Qualification: Compulsory				
	Computer Science in Engineering: Core Qualification:	Compulsory			

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

Course L0324: Computer Eng	jineering
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		
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				
<b>Recommended Previous</b>					
Knowledge	<ul> <li>Mathematik I + II for Engineering Students (german or english) or Analysis &amp; Linear Alg</li> <li>basic MATLAB/Python knowledge</li> </ul>	jebra I + II for Te	echnomathematici		
Educational Objectives	After taking part successfully, students have reached the following learning results				
Professional Competence					
Knowledge	Students are able to				
	<ul> <li>name numerical methods for interpolation, integration, least squares problems, eigenvalue problems, nonlinear root find problems and to explain their core ideas,</li> <li>repeat convergence statements for the numerical methods,</li> <li>explain aspects for the practical execution of numerical methods with respect to computational and storage complexitx.</li> </ul>				
Skills	Students are able to				
5445	<ul> <li>implement, apply and compare numerical methods using MATLAB/Python,</li> <li>justify the convergence behaviour of numerical methods with respect to the problem ar</li> <li>select and execute a suitable solution approach for a given problem.</li> </ul>	nd solution algor	ithm,		
Personal Competence					
Social Competence	Students are able to				
	<ul> <li>work together in heterogeneously composed teams (i.e., teams from different study prexplain theoretical foundations and support each other with practical aspects regarding</li> </ul>				
Autonomy	Students are capable				
	<ul> <li>to assess whether the supporting theoretical and practical excercises are better solved</li> <li>to assess their individual progess and, if necessary, to ask questions and seek help.</li> </ul>	individually or in	n a 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			
Following Curricula	General Engineering Science (German program, 7 semester): Specialisation Biomedical Engine		ory		
Gen Corr	General Engineering Science (German program, 7 semester): Specialisation Mechanical	Engineering, I	Focus Biomechan		
	Compulsory	ooring Focus Th	poorotical Mochan		
	Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engin Engineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical E	-			
	General Engineering Science (German program, 7 semester): Specialisation Mechanical Engin Engineering: Compulsory	Engineering, Fo	cus Aircraft Syste		
	General Engineering Science (German program, 7 semester): Specialisation Mechanical Engin Engineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical E Engineering: Elective Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engin Compulsory	Engineering, Foo neering, Focus M	cus Aircraft Syste		
	General Engineering Science (German program, 7 semester): Specialisation Mechanical Engin Engineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical E Engineering: Elective Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engin Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engin	Engineering, Foo neering, Focus M	cus Aircraft Syste		
	General Engineering Science (German program, 7 semester): Specialisation Mechanical Engin Engineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical E Engineering: Elective Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engin Compulsory	Engineering, Foo neering, Focus M Engineering, Foo	cus Aircraft Syste lechatronics: Elect		
	General Engineering Science (German program, 7 semester): Specialisation Mechanical Engin Engineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical E Engineering: Elective Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engin Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engin Elective Compulsory	Engineering, Foo neering, Focus M Engineering, Foo als: Compulsory	cus Aircraft Syste lechatronics: Elect cus Energy System		
	General Engineering Science (German program, 7 semester): Specialisation Mechanical Engin Engineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical E Engineering: Elective Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engin Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical E Elective Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical E Elective Compulsory General Engineering Science (German program, 7 semester): Specialisation Advanced Materia	Engineering, Foo neering, Focus M Engineering, Foo als: Compulsory	cus Aircraft Syste lechatronics: Elect cus Energy System		
	General Engineering Science (German program, 7 semester): Specialisation Mechanical Engin Engineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical E Engineering: Elective Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engin Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical E Elective Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical E Elective Compulsory General Engineering Science (German program, 7 semester): Specialisation Advanced Materia General Engineering Science (German program, 7 semester): Specialisation Mechanical	Engineering, Foo neering, Focus M Engineering, Foo als: Compulsory al Engineering,	cus Aircraft Syste lechatronics: Elect cus Energy System		
	General Engineering Science (German program, 7 semester): Specialisation Mechanical Engin Engineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical E Engineering: Elective Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engin Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical E Elective Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical E Elective Compulsory General Engineering Science (German program, 7 semester): Specialisation Advanced Materia General Engineering Science (German program, 7 semester): Specialisation Mechanicat Engineering Science (German program, 7 semester): Specialisation Mechanicat General Engineering Science (German program, 7 semester): Specialisation Mechanicat	Engineering, Foo neering, Focus M Engineering, Foo Ils: Compulsory al Engineering, ry	cus Aircraft Syste lechatronics: Elect cus Energy System		
	General Engineering Science (German program, 7 semester): Specialisation Mechanical Engin Engineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical E Engineering: Elective Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engin Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical E Elective Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical E Elective Compulsory General Engineering Science (German program, 7 semester): Specialisation Advanced Materia General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering Sciences: Compulsory Bioprocess Engineering: Specialisation A - General Bioprocess Engineering: Elective Compulso	Engineering, Foo neering, Focus M Engineering, Foo Ils: Compulsory al Engineering, ry	cus Aircraft Syste lechatronics: Elect cus Energy System		
	General Engineering Science (German program, 7 semester): Specialisation Mechanical Engin Engineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical E Engineering: Elective Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engin Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical E Elective Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical E Elective Compulsory General Engineering Science (German program, 7 semester): Specialisation Advanced Materia General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering Sciences: Compulsory Bioprocess Engineering: Specialisation A - General Bioprocess Engineering: Elective Compulso Computer Science: Specialisation II. Mathematics and Engineering Science: Elective Compulso	Engineering, Foo neering, Focus M Engineering, Foo Ils: Compulsory al Engineering, ry	cus Aircraft Syste lechatronics: Elect cus Energy System		
	General Engineering Science (German program, 7 semester): Specialisation Mechanical Engin Engineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engin Engineering: Elective Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engin Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engin Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical E Elective Compulsory General Engineering Science (German program, 7 semester): Specialisation Advanced Materia General Engineering Science (German program, 7 semester): Specialisation Mechanicat Engineering Sciences: Compulsory Bioprocess Engineering: Specialisation A - General Bioprocess Engineering: Elective Compulso Computer Science: Specialisation II. Mathematics and Engineering Science: Elective Compulso Data Science: Core Qualification: Compulsory Electrical Engineering: Core Qualification: Elective Compulsory Engineering Science: Core Qualification: Elective Compulsory	Engineering, Foo neering, Focus M Engineering, Foo Ils: Compulsory al Engineering, ry	cus Aircraft Syste lechatronics: Elect cus Energy System		
	General Engineering Science (German program, 7 semester): Specialisation Mechanical Engin Engineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engin Engineering: Elective Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engin Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engin Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical E Elective Compulsory General Engineering Science (German program, 7 semester): Specialisation Advanced Materia General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering Sciences: Compulsory Bioprocess Engineering: Specialisation A - General Bioprocess Engineering: Elective Compulso Computer Science: Specialisation II. Mathematics and Engineering Science: Elective Compulso Data Science: Core Qualification: Compulsory Electrical Engineering: Core Qualification: Elective Compulsory Engineering Science: Core Qualification: Compulsory Engineering Science: Core Qualification: Compulsory Engineering Science: Core Qualification: Compulsory	Engineering, Foo neering, Focus M Engineering, Foo Ils: Compulsory al Engineering, ry	cus Aircraft Syste lechatronics: Elect cus Energy System		
	General Engineering Science (German program, 7 semester): Specialisation Mechanical Engin Engineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engin Engineering: Elective Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engin Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engin Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical E Elective Compulsory General Engineering Science (German program, 7 semester): Specialisation Advanced Materia General Engineering Science (German program, 7 semester): Specialisation Mechanicat Engineering Sciences: Compulsory Bioprocess Engineering: Specialisation A - General Bioprocess Engineering: Elective Compulso Computer Science: Specialisation II. Mathematics and Engineering Science: Elective Compulso Data Science: Core Qualification: Compulsory Electrical Engineering: Core Qualification: Elective Compulsory Engineering Science: Core Qualification: Compulsory Engineering Science: Core Qualification: Compulsory Computer Science in Engineering: Core Qualification: Compulsory	Engineering, Foo neering, Focus M Engineering, Foo Ils: Compulsory al Engineering, ry	cus Aircraft Syste lechatronics: Elect		
	General Engineering Science (German program, 7 semester): Specialisation Mechanical Engin Engineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engin Engineering: Elective Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engin Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engin Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical E Elective Compulsory General Engineering Science (German program, 7 semester): Specialisation Advanced Materia General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering Sciences: Compulsory Bioprocess Engineering: Specialisation A - General Bioprocess Engineering: Elective Compulso Computer Science: Specialisation II. Mathematics and Engineering Science: Elective Compulso Data Science: Core Qualification: Compulsory Electrical Engineering: Core Qualification: Elective Compulsory Engineering Science: Core Qualification: Compulsory Engineering Science: Core Qualification: Compulsory Computer Science in Engineering: Core Qualification: Compulsory Mechanical Engineering: Specialisation Theoretical Mechanical Engineering: Compulsory	Engineering, Foo neering, Focus M Engineering, Foo Ils: Compulsory al Engineering, ry	cus Aircraft Syste lechatronics: Elect		
	General Engineering Science (German program, 7 semester): Specialisation Mechanical Engin Engineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engin Engineering: Elective Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engin Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engin Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical E Elective Compulsory General Engineering Science (German program, 7 semester): Specialisation Advanced Materia General Engineering Science (German program, 7 semester): Specialisation Mechanicat Engineering Sciences: Compulsory Bioprocess Engineering: Specialisation A - General Bioprocess Engineering: Elective Compulso Computer Science: Specialisation II. Mathematics and Engineering Science: Elective Compulso Data Science: Core Qualification: Compulsory Electrical Engineering: Core Qualification: Elective Compulsory Engineering Science: Core Qualification: Compulsory Engineering Science: Core Qualification: Compulsory Computer Science in Engineering: Core Qualification: Compulsory	Engineering, Focus M Engineering, Focus Ils: Compulsory al Engineering, ry pry	cus Aircraft Syste lechatronics: Elect		

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

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	

d knowledge of engineering mathematics ( tial/ordinary differential equations. They so ly, students have reached the following lea quired combined knowledge of thermo-/f engineering into discrete algorithms or unctions. They are familiar with the simi or investigating coupled systems of non- applying them. Students have the required ated to the solution of thermofluid dynam mic fields, in particular their realms and lir se and apply appropriate numerical proce	titation Section (large) (series expansions, intersions) (series expansions, intersions) (should also be familiar arning results fluid dynamics and nu in the basis of local (if ilarities and difference -linear, convective pa d background knowled nic PDEs. They are fami mitations.	r with engineering umerical analysis f finite differences/v is between differen rtial differential ed ge to develop, codo	fluid mechanics a to translate gene volumes) and glo nt discretisation a quations (PDE), a e, explain and ap
Lect Reci d knowledge of engineering mathematics ( tial/ordinary differential equations. They ly, students have reached the following lea quired combined knowledge of thermo-// engineering into discrete algorithms or unctions. They are familiar with the simi or investigating coupled systems of non- applying them. Students have the required ated to the solution of thermofluid dynam mic fields, in particular their realms and lin se and apply appropriate numerical proce	titation Section (large) (series expansions, intersions) (series expansions, intersions) (should also be familiar arning results fluid dynamics and nu in the basis of local (if ilarities and difference -linear, convective pa d background knowled nic PDEs. They are fami mitations.	2 2 ernal & vector calcur with engineering umerical analysis f finite differences/v is between differen rtial differential eo ge to develop, codo	3 3 ulus), and be fam fluid mechanics a to translate gene volumes) and glo nt discretisation a quations (PDE), a e, explain and ap
Reci d knowledge of engineering mathematics ( tial/ordinary differential equations. They s ly, students have reached the following lea quired combined knowledge of thermo-// engineering into discrete algorithms or unctions. They are familiar with the simi or investigating coupled systems of non- applying them. Students have the required ated to the solution of thermofluid dynam mic fields, in particular their realms and lir se and apply appropriate numerical proce	itation Section (large) (series expansions, inte should also be familiar arning results fluid dynamics and nu n the basis of local (i ilarities and difference -linear, convective pa d background knowled nic PDEs. They are fami mitations.	2 ernal & vector calcu r with engineering umerical analysis f finite differences/v is between differen rtial differential ed ge to develop, codo	3 ulus), and be fam fluid mechanics a to translate gene volumes) and glo nt discretisation a quations (PDE), a e, explain and ap
d knowledge of engineering mathematics ( tial/ordinary differential equations. They so ly, students have reached the following lea quired combined knowledge of thermo-/f engineering into discrete algorithms or unctions. They are familiar with the simi or investigating coupled systems of non- applying them. Students have the required ated to the solution of thermofluid dynam mic fields, in particular their realms and lir se and apply appropriate numerical proce	(series expansions, inte should also be familiar arning results fluid dynamics and nu n the basis of local (i larities and difference -linear, convective pa d background knowled hic PDEs. They are fami mitations.	ernal & vector calcu r with engineering umerical analysis f finite differences/v s between differen rtial differential eo ge to develop, cod	ulus), and be fam fluid mechanics a to translate gene volumes) and glo nt discretisation a quations (PDE), a e, explain and ap
tial/ordinary differential equations. They support the second sec	should also be familiar arning results fluid dynamics and nu in the basis of local (ti ilarities and difference -linear, convective pa d background knowled nic PDEs. They are fami mitations.	r with engineering umerical analysis f finite differences/v is between differen rtial differential ed ge to develop, codo	fluid mechanics a to translate gene volumes) and glo nt discretisation a quations (PDE), a e, explain and ap
tial/ordinary differential equations. They support the second sec	should also be familiar arning results fluid dynamics and nu in the basis of local (ti ilarities and difference -linear, convective pa d background knowled nic PDEs. They are fami mitations.	r with engineering umerical analysis f finite differences/v is between differen rtial differential ed ge to develop, codo	fluid mechanics a to translate gene volumes) and glo nt discretisation a quations (PDE), a e, explain and ap
tial/ordinary differential equations. They support the second sec	should also be familiar arning results fluid dynamics and nu in the basis of local (ti ilarities and difference -linear, convective pa d background knowled nic PDEs. They are fami mitations.	r with engineering umerical analysis f finite differences/v is between differen rtial differential ed ge to develop, codo	fluid mechanics a to translate gene volumes) and glo nt discretisation a quations (PDE), a e, explain and ap
ly, students have reached the following lea quired combined knowledge of thermo-// engineering into discrete algorithms or unctions. They are familiar with the simi or investigating coupled systems of non- applying them. Students have the required ated to the solution of thermofluid dynam mic fields, in particular their realms and lin se and apply appropriate numerical proce	arning results fluid dynamics and nu n the basis of local (i ilarities and difference -linear, convective pa d background knowled nic PDEs. They are fami mitations.	umerical analysis f finite differences/v is between differen rtial differential ed ge to develop, codo	to translate gene volumes) and glo nt discretisation a quations (PDE), a e, explain and ap
quired combined knowledge of thermo-// engineering into discrete algorithms or unctions. They are familiar with the simi or investigating coupled systems of non- applying them. Students have the required ated to the solution of thermofluid dynam mic fields, in particular their realms and lin se and apply appropriate numerical proce	fluid dynamics and nu n the basis of local (i llarities and difference -linear, convective pa d background knowled nic PDEs. They are fami mitations.	finite differences/v s between differen rtial differential ed ge to develop, cod	volumes) and glo nt discretisation a quations (PDE), a e, explain and ap
engineering into discrete algorithms or unctions. They are familiar with the simi or investigating coupled systems of non- applying them. Students have the required ated to the solution of thermofluid dynam mic fields, in particular their realms and lin se and apply appropriate numerical proce-	n the basis of local (i ilarities and difference -linear, convective pa d background knowled nic PDEs. They are fami mitations.	finite differences/v s between differen rtial differential ed ge to develop, cod	volumes) and glo nt discretisation a quations (PDE), a e, explain and ap
engineering into discrete algorithms or unctions. They are familiar with the simi or investigating coupled systems of non- applying them. Students have the required ated to the solution of thermofluid dynam mic fields, in particular their realms and lin se and apply appropriate numerical proce-	n the basis of local (i ilarities and difference -linear, convective pa d background knowled nic PDEs. They are fami mitations.	finite differences/v s between differen rtial differential ed ge to develop, cod	volumes) and glo nt discretisation a quations (PDE), a e, explain and ap
	duran that into arota th		
students are able choose and apply appropriate numerical procedures that integrate the governing thermofluid dynamic PD pace and time. They can apply/optimise numerical analysis concepts to/for fluid dynamic applications. They can co putational algorithms in a structured way, apply these codes for parameter investigations and supplement interfaces ct simulation data for an engineering analysis.			
	ir own analysis, and jo	intly develop, imple	ement and report
		g problems. They a	are able to critic
4, Study Time in Lecture 56			
ulsory e (German program, 7 semester): Speciali ce (German program, 7 semester): Spe Complementary Course Core Studies: Elec ecialisation Energy Systems: Elective Com	isation Naval Architectu cialisation Mechanical ctive Compulsory	ure: Compulsory	
	dress given technical reference problems. I as external data with regards to the plaus 24, Study Time in Lecture 56 24, Study Time in Lecture 56 Ance (German program, 7 semester): Special for	dress given technical reference problems. I as external data with regards to the plausibility and reliability. 24, Study Time in Lecture 56 Acce (German program, 7 semester): Specialisation Mechanica pulsory ce (German program, 7 semester): Specialisation Naval Architect face (German program, 7 semester): Specialisation Mechanical Complementary Course Core Studies: Elective Compulsory becialisation Energy Systems: Elective Compulsory	I as external data with regards to the plausibility and reliability. 24, Study Time in Lecture 56 24, Study Time in Lecture 56 Ance (German program, 7 semester): Specialisation Mechanical Engineering, Foctoulsory ce (German program, 7 semester): Specialisation Naval Architecture: Compulsory the (German program, 7 semester): Specialisation Mechanical Engineering, Foctoulsory the (German program)

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

Course L0419: Computationa	al 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	СР
Electrical Machines and Actuators (	L0293)	<b>Typ</b> Lecture	BIS/WK 3	4
Electrical Machines and Actuators (		Recitation Section (large)	2	2
Module Responsible	Prof. Thorsten Kern			
Admission Requirements	None			
<b>Recommended Previous</b>	Basics of mathematics, in particular comp	lexe numbers, integrals, differentials		
Knowledge	Basics of electrical engineering and mech			
	basics of electrical engineering and mech			
Educational Objectives	After taking part successfully, students ha	we reached the following learning results		
Professional Competence				
Knowledge	Students can to draw and explain the bas	ic principles of electric and magnetic fields.		
	They can describe the function of the	standard types of electric machines and pr	esent the correspor	nding equations a
	-	rives they can explain the major parameters of t		
	from the power grid to the driven engine.			
Skille	Students are able to calculate two dimer	nsional electric and magnetic fields in particula	r forromagnotic circ	wite with air gap
SKIIIS	this they apply the usual methods of the o		ierromagnetic circ	uits with all gap. r
		mance of electric machines from their given ch		id selected quantit
	and characteristic curves. They apply the	usual equivalent circuits and graphical methods		
Barran I Carrantena				
Personal Competence				
Social Competence		late electric and magnatic fields for applications	They are able to a	nalyca indonandar
Autonomy		late electric and magnatic fields for applications nachines from the charactersitic data and they		
	and characteristic curves.	indenines from the characteristic data and they		
Workload in Hours	Independent Study Time 110, Study Time	in Lecture 70		
Credit points	6			
Course achievement	None			
Examination	Subject theoretical and practical work			
Examination duration and	Design of four machines and actuators, re	eview of design files		
scale				
		ogram, 7 semester): Specialisation Electrical Eng		
Following Curricula	5 5	program, 7 semester): Specialisation Mechanic	al Engineering, Foo	cus Energy Systen
	Compulsory	program 7 competer), Englishing Macha	nical Engineering	Focus Mochatroni
	Compulsory	program, 7 semester): Specialisation Mecha	filcar Engineering,	Focus Mechacioni
		ogram, 7 semester): Specialisation Mechanical E	naineerina. Focus Ti	heoretical Mechani
	Engineering: Elective Compulsory		J -	
	Digital Mechanical Engineering: Core Qua	lification: Compulsory		
	Electrical Engineering: Core Qualification:	Elective Compulsory		
	Engineering Science: Specialisation Electr	ical Engineering: Elective Compulsory		
		ate: Specialisation Energy Technology: Elective C	Compulsory	
	Logistics and Mobility: Specialisation Engi			
		ic Planning and Systems: Elective Compulsory	nnulcon	
		uction Management and Processes: Elective Con	ipulsory	
	Mechanical Engineering: Core Qualificatio Mechatronics: Core Qualification: Compute			
	Technomathematics: Specialisation III. En			
		Jan Sectore company		
	Engineering and Management - Maior in L	ogistics and Mobility: Specialisation Traffic Plann	ing and Systems: El	lective Compulsorv
		ogistics and Mobility: Specialisation Traffic Planr Logistics and Mobility: Specialisation Production		

Course L0293: Electrical Machines 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

<b>itle</b> ower Industry (L0316) nergy Systems and Energy Industr				
		Тур	Hrs/wk	СР
nergy Systems and Energy Industr		Lecture	1	1
	y (L0315)	Lecture	2	2
enewable Energy (L0313)		Lecture	2	2
enewable Energy (L1434)		Recitation Section (small)	1	1
Module Responsible	Prof. Martin Kaltschmitt			
Admission Requirements	None			
<b>Recommended Previous</b>	none			
Knowledge				
<b>Educational Objectives</b>	After taking part successfully, student	s have reached the following learning results		
<b>Professional Competence</b>				
Skills	distribution and power trading wih applicable to many energy systems i the students can explain the environn Students are able to apply methodolo energy systems. Furthermore, they ca under certain given conditions. The	s occurring in this context. Furthermore, they can ex regard to subject-related contexts. The students n general, especially for renewable energy systems nental benefits from the use of such systems. Or gies for detailed determination of energy demand of an evaluate energy systems technically, environment erefore, they can choose the necessary subject-	can explain these and critical discuss r energy production tally and economic	aspects, which s them. Furthermo n for various types ally and design th
	standardized solutions of a problem. The students are able to explain que and to put them them into the right co	stions and possible approaches to its processing fro ontext.	m the field of rene	wable energies or
Personal Competence				
-	The students are able to analyze suitable technical alternatives and to assess them with technical, economical and ecologic criteria under sustainability aspects. This allows them to make an effective contribuition to a more sustainable power supply.			
Autonomy	Students can independently exploit s questions.	sources , acquire the particular knowledge about th	e subject area and	l transform it to r
Workload in Hours	Independent Study Time 96, Study Tir	me in Lecture 84		
Credit points	6			
Course achievement	None			
Examination	Written exam			
Examination duration and scale	3 hours written exam			
Assignment for the	General Engineering Science (Germa	an program, 7 semester): Specialisation Mechanic	al Engineering, Foo	us Energy Syster
Following Curricula	Elective Compulsory			

Course L0316: Power Industry			
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	<ul> <li>Electrical energy in the energy system</li> <li>Demand and use of electrical energy (households, industry, "new" buyers (including e-mobility))</li> <li>Electricity generation <ul> <li>electricity generation technologies using fossil fuels and their characteristics</li> <li>combined heat and power technologies and their production characteristics</li> <li>electricity generation from renewable energy technologies and their characteristics</li> <li>electricity generation of electrical energy</li> <li>challenges of fluctuating electricity generation by distributed systems (electricity market, electricity stock exchange, emissions trading)</li> </ul> </li> <li>District heating industry</li> <li>Legal and administrative aspects <ul> <li>Energy Act</li> <li>Support instruments for renewable energy</li> <li>ChP Act</li> </ul> </li> <li>Cost and efficiency calculation</li> </ul>		
Literature	Folien der Vorlesung		

Course L0315: Energy Systems 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	<ul> <li>Energy: development and significance</li> <li>Fundamentals and basic concepts</li> <li>Energy demand and future trends (heat, electricity, fuels)</li> <li>Energy reserve and sources</li> <li>Cost and efficiency calculation</li> <li>Final and effective energy from petroleum, natural gas, coal, uranium and other</li> <li>Legal, administrative and organizational aspects of energy systems</li> <li>Energy systems as a permanent optimization task</li> </ul>	
Literature	• Kopien der Folien	

Course L0313: Renewable Energy			
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	<ul> <li>introduction</li> <li>solar energy for heat and power generation</li> <li>wind power for electricity generation</li> <li>hydropower for electricity generation</li> <li>ocean energy for electricity generation</li> <li>geothermal energy for heat and electricity generation</li> </ul>		
Literature	<ul> <li>Kaltschmitt, M.; Streicher, W.; Wiese, A. (Hrsg.): Erneuerbare Energien - Systemtechnik, Wirtschaftlichkeit, Umweltaspekte; Springer, Berlin, Heidelberg, 2006, 4. Auflage</li> <li>Kaltschmitt, M.; Streicher, W.; Wiese, A. (Hrsg.): Renewable Energy - Technology, Economics and Environment; Springer, Berlin, Heidelberg, 2007</li> </ul>		

Course L1434: Renewable Er	lergy
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	<ul> <li>Kaltschmitt, M.; Streicher, W.; Wiese, A. (Hrsg.): Erneuerbare Energien - Systemtechnik, Wirtschaftlichkeit, Umweltaspekte Springer, Berlin, Heidelberg, 2006, 4. Auflage</li> <li>Kaltschmitt, M.; Streicher, W.; Wiese, A. (Hrsg.): Renewable Energy - Technology, Economics and Environment; Springer Berlin, Heidelberg, 2007</li> </ul>

## **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.

Courses	
Title	Typ Hrs/wk CP
Advanced Mechanical Design Proje	ct (L0266) Project-/problem-based Learning 4 6
Module Responsible	Dr. Jens Schmidt
Admission Requirements	None
<b>Recommended Previous</b>	
Knowledge	Mechanical Engineering: Design
	Advanced 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 decign tasks
	<ul> <li>complex design tasks ,</li> <li>describe working principles, their use and combination possibilities,</li> </ul>
	<ul> <li>explain guidelines for designing for function and manufacturing,</li> </ul>
	<ul> <li>explain guidelines for designing for function and manufacturing,</li> <li>explain advanced use-oriented knowledge of machine elements.</li> </ul>
	• explain advanced use-oriented knowledge of machine elements.
Skills	After passing the module, students are able to:
	<ul> <li>analyze complex tasks and develop principle solutions using sketches,</li> </ul>
	<ul> <li>convert principle solutions into a detailed design,</li> </ul>
	<ul> <li>use methods to design and solve engineering design tasks systematically and solution-oriented,</li> </ul>
	<ul> <li>create a technical documentation including all necessary technical drawings to understand the functions of the system,</li> </ul>
	<ul> <li>document calculations of selected machine elements clearly and in detail.</li> </ul>
Personal Competence	
Social Competence	After passing the module, students are able to:
	<ul> <li>present and discuss solutions and technical drawings within groups,</li> </ul>
	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 selecti
	appropriate methods,
	<ul> <li>to independently solve problems.</li> </ul>
Workload in Harris	Independent Study Time 124, Study Time in Lecture 56
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56
Credit points	6 Compulsory Bonus Form Description
Course achievement	Yes None Attestation
Examination	Written exam
Examination duration and	180
scale	
Assignment for the	General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Aircraft Syster
Following Curricula	Engineering: Compulsory
	General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Product Developme
	and Production: Compulsory
	Mechanical Engineering: Core Qualification: Compulsory

Course L0266: Advanced Med	hanical 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	<ul> <li>Dubbel, Taschenbuch für den Maschinenbau; Grote, KH., Feldhusen, J.(Hrsg.); Springer-Verlag, aktuelle Auflage.</li> <li>Maschinenelemente, Band I-III; Niemann, G., Springer-Verlag, aktuelle Auflage.</li> <li>Maschinen- und Konstruktionselemente; Steinhilper, W., Röper, R., Springer Verlag, aktuelle Auflage.</li> <li>Einführung in die DIN-Normen; Klein, M., Teubner-Verlag.</li> <li>Konstruktionslehre, Pahl, G.; Beitz, W., Springer-Verlag, aktuelle Auflage.</li> <li>Maschinenelemente 1-2; Schlecht, B., Pearson Verlag, aktuelle Auflage.</li> <li>Maschinenelemente - Gestaltung, Berechnung, Anwendung; Haberhauer, H., Bodenstein, F., Springer-Verlag, aktuelle Auflage.</li> <li>Roloff/Matek Maschinenelemente; Wittel, H., Muhs, D., Jannasch, D., Voßiek, J., Springer Vieweg, aktuelle Auflage.</li> <li>Sowie weitere Bücher zu speziellen Themen</li> </ul>

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

	buter Engineering			
Courses				
Title	Тур		Hrs/wk	СР
Computer Engineering (L0321)	Lecture		3	4
Computer Engineering (L0324)	Recitation Sect	ion (small)	1	2
Module Responsible	Prof. Heiko Falk			
Admission Requirements				
Recommended Previous	5 5 5			
Knowledge				
Educational Objectives		ults		
Professional Competence				
Knowledge		tems. It covers	the layers from	n the assembly-lev
	programming down to gates. The module includes the following topics:			
	Introduction			
	Combinational logic: Gates, Boolean algebra, Boolean functions, hardwar	re synthesis, com	nbinational net	works
	Sequential logic: Flip-flops, automata, systematic hardware design			
	Technological foundations			
	Computer arithmetic: Integer addition, subtraction, multiplication and div			
	Basics of computer architecture: Programming models, MIPS single-cycle     Momories: Momory biorarchies: SPAM_DPAM_caches	architecture, pi	pelining	
	<ul> <li>Memories: Memory hierarchies, SRAM, DRAM, caches</li> <li>Input/output: I/O from the perspective of the CPU, principles of passing d</li> </ul>	lata noint to noi	nt connections	husses
	- inpugouque, yo nom the perspective of the CPO, principles of passing 0.	aca, point-to-poil	ine confidentions,	200000
Skills	The students perceive computer systems from the architect's perspective, i.e.,	they identify the	e internal struct	ure and the physi
	composition of computer systems. The students can analyze, how highly specif	fic and individual	l computers ca	n be built based or
	collection of few and simple components. They are able to distinguish betwee		n the different	abstraction layers
	today's computing systems - from gates and circuits up to complete processors	÷.		
	After successful completion of the module, the students are able to judge th	ie interdepender	ncies between	a physical compu
	system and the software executed on it. In particular, they shall understand th	ne consequences	that the exect	ution of software h
	on the hardware-centric abstraction layers from the assembly language down t	to gates. This wa	ay, they will be	enabled to evaluate
	the impact that these low abstraction levels have on an entire system's perform	nance and to pro	pose feasible o	ptions.
Personal Competence				
	Students are able to solve similar problems alone or in a group and to present t	the results accor	dinaly	
boelar competence			angiji	
Autonomy	Students are able to acquire new knowledge from specific literature and to asso	ociate this knowl	edge with othe	r classes.
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56			
Credit points				
Course achievement				
	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 Cor	mputer Science:	Compulsory	
Following Curricula	General Engineering Science (German program, 7 semester): Specialisation	on Mechanical	Engineering, I	ocus Mechatroni
	Compulsory			
	General Engineering Science (German program, 7 semester): Specialisation	1 Mechanical En	ngineering, Foo	us Aircraft Syste
	Engineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Me	achanical Engine	oring Focus Th	enetical Machani
	General Engineering Science (German program, 7 semester): Specialisation Me Engineering: Compulsory	chanical Engine	enny, rocus Ir	eorencar Mechani
	General Engineering Science (German program, 7 semester): Specialisat	tion Mechanical	Engineering	Focus Materials
	Engineering Sciences: Compulsory			
	General Engineering Science (German program, 7 semester): Specialisation M	lechanical Engine	eering, Focus F	roduct Developme
	and Production: Compulsory			
		Mechanical En	igineering, Foc	us Energy System
	General Engineering Science (German program, 7 semester): Specialisation			
	General Engineering Science (German program, 7 semester): Specialisation Compulsory			us Energy Syster
			Engineering, F	
	Compulsory		Engineering, F	
	Compulsory General Engineering Science (German program, 7 semester): Specialisatio Compulsory General Engineering Science (German program, 7 semester): Specialisation Elec	on Mechanical	ng: Compulsor	ocus Biomechani
	Compulsory General Engineering Science (German program, 7 semester): Specialisatio Compulsory General Engineering Science (German program, 7 semester): Specialisation Ele General Engineering Science (German program, 7 semester): Specialisation Gree	on Mechanical	ng: Compulsor	ocus Biomechani
	Compulsory General Engineering Science (German program, 7 semester): Specialisatio Compulsory General Engineering Science (German program, 7 semester): Specialisation Ele General Engineering Science (German program, 7 semester): Specialisation Gre Compulsory	on Mechanical	ng: Compulsor	ocus Biomechani
	Compulsory General Engineering Science (German program, 7 semester): Specialisatio Compulsory General Engineering Science (German program, 7 semester): Specialisation Ele General Engineering Science (German program, 7 semester): Specialisation Gre Compulsory Computer Science: Core Qualification: Compulsory	on Mechanical	ng: Compulsor	ocus Biomechani
	Compulsory General Engineering Science (German program, 7 semester): Specialisatio Compulsory General Engineering Science (German program, 7 semester): Specialisation Ele- General Engineering Science (German program, 7 semester): Specialisation Gre Compulsory Computer Science: Core Qualification: Compulsory Data Science: Core Qualification: Elective Compulsory	on Mechanical ectrical Engineerii een Technologies	ng: Compulsor	ocus Biomechani
	Compulsory General Engineering Science (German program, 7 semester): Specialisatio Compulsory General Engineering Science (German program, 7 semester): Specialisation Ele General Engineering Science (German program, 7 semester): Specialisation Gre Compulsory Computer Science: Core Qualification: Compulsory Data Science: Core Qualification: Elective Compulsory Data Science: Specialisation I. Mathematics/Computer Science: Elective Compul	on Mechanical ectrical Engineerii een Technologies	ng: Compulsor	ocus Biomechani
	Compulsory General Engineering Science (German program, 7 semester): Specialisatio Compulsory General Engineering Science (German program, 7 semester): Specialisation Ele- General Engineering Science (German program, 7 semester): Specialisation Gre Compulsory Computer Science: Core Qualification: Compulsory Data Science: Core Qualification: Elective Compulsory Data Science: Specialisation I. Mathematics/Computer Science: Elective Compul Electrical Engineering: Core Qualification: Compulsory	on Mechanical ectrical Engineerii een Technologies	ng: Compulsor	ocus Biomechani
	Compulsory General Engineering Science (German program, 7 semester): Specialisatio Compulsory General Engineering Science (German program, 7 semester): Specialisation Ele General Engineering Science (German program, 7 semester): Specialisation Gre Compulsory Computer Science: Core Qualification: Compulsory Data Science: Core Qualification: Elective Compulsory Data Science: Specialisation I. Mathematics/Computer Science: Elective Compul	on Mechanical ectrical Engineerii een Technologies	ng: Compulsor	ocus Biomechani

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

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				
		<b>T</b>	Have for de	67
Fitle Computational Fluid Dynamics I (LC	1235)	<b>Typ</b> Lecture	Hrs/wk 2	<b>СР</b> 3
Computational Fluid Dynamics I (LC		Recitation Section (large)	2	3
Module Responsible		-		
Admission Requirements	None			
	Students should have sound knowledge of end	gineering mathematics (series expansions, inte	ernal & vector calc	ulus), and be fami
	Students should have sound knowledge of engineering mathematics (series expansions, internal & vector calculus), and be famili with the foundations of partial/ordinary differential equations. They should also be familiar with engineering fluid mechanics ar thermodynamics.			
Educational Objections				
Educational Objectives	After taking part successfully, students have r	eached the following learning results		
Professional Competence	Students will have the required combined l			
	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 ar approximation concepts for investigating coupled systems of non-linear, convective partial differential equations (PDE), ar explain the motivation for applying them. Students have the required background knowledge to develop, code, explain and app 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 appropriate numerical procedures that integrate the governing thermofluid dynamic PD in space and time. They can apply/optimise numerical analysis concepts to/for fluid dynamic applications. They can co computational algorithms in a structured way, apply these codes for parameter investigations and supplement interfaces extract simulation data for an engineering analysis.			
Personal Competence Social Competence	The students are able to discuss problems, pr solution strategies that address given technica		ntly develop, impl	ement and report
Autonomy	The students can independently analyse numerical methods to solving fluid engineering problems. They are able to critica 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 L	ecture 56		
Credit points				
Course achievement				
Examination duration and scale				
Assignment for the Following Curricula		m, 7 semester): Specialisation Naval Architectu ram, 7 semester): Specialisation Mechanical	ire: Compulsory	-

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	<ol> <li>Fundamentals of computational modelling of thermofluid dynamic problems. Development of numerical algorithms.</li> <li>Partial differential equations</li> <li>Foundations of finite numerical approximations</li> <li>Computation of potential flows</li> <li>Introduction of finite-differences</li> <li>Approximation of convective, diffusive and transient transport processes</li> <li>Formulation of boundary conditions and initial conditions</li> <li>Assembly and solution of algebraic equation systems</li> <li>Facets of weighted -residual approaches</li> <li>Finite volume methods</li> <li>Basics of grid generation</li> </ol>
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		Түр	Hrs/wk	СР
Simulation and Design of Mechatro	nic Systems (I 1822)	Lecture	2	2
Simulation and Design of Mechatro	-	Recitation Section (large)	1	2
Simulation and Design of Mechatro		Practical Course	1	2
Module Responsible	NN			
Admission Requirements	None			
<b>Recommended Previous</b>	Fundatmentals of mechanics, control the	ory and electrical engineering		
Knowledge				
Educational Objectives	After taking part successfully, students ha	ave reached the following learning results		
Professional Competence				
Knowledge	Students are able to describe methods and calculations for design, modeling, simulation and optimization of mechatronic system			
Skills	Students are able to apply modern algorit	thms for modeling of mechatronic systems. They	an identify cimula	to and docian cim
SKIIIS	systems and implement those in laborato		an identity, simula	ite and design sim
	systems and implement those in laborato	ny conditions.		
Personal Competence				
Social Competence	Students are able to work goal-oriented ir	n small mixed groups and present results to targe	groups.	
Autonomy	Students are able to recognize and impro	we knowledge deficits independently.		
	With instructor assistance, students are a	able to evaluate their own knowledge level and de	ine a further cours	e of study.
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	90 min			
scale				
Assignment for the	General Engineering Science (German pr	ogram, 7 semester): Specialisation Mechanical Er	gineering, Focus M	lechatronics: Elect
Following Curricula	Compulsory			
	General Engineering Science (German	program, 7 semester): Specialisation Mechanica	l Engineering, Fo	cus Aircraft Syste
	Engineering: Elective Compulsory			
	Digital Mechanical Engineering: Core Qua	lification: Compulsory		
	Mechanical Engineering: Specialisation Ai	ircraft Systems Engineering: Compulsory		
	Mechanical Engineering: Specialisation M	echatronics: Compulsory		
	Mechatronics: Core Qualification: Comput	sorv		

Course L1822: Simulation and Design of Mechatronic Systems		
Тур	Lecture	
Hrs/wk	2	
CP	2	
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28	
Lecturer	NN	
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 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	NN
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	endent Study Time 46, Study Time in Lecture 14		
Lecturer	NN		
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			
<b>Recommended Previous</b>				
Knowledge	<ul> <li>Mathematik I + II for Engineering Students (german or english) or Analysis &amp; Linear Alge</li> <li>basic MATLAB/Python knowledge</li> </ul>	ebra I + II for To	echnomathematic	
Educational Objectives	After taking part successfully, students have reached the following learning results			
Professional Competence				
Knowledge	Students are able to			
	<ul> <li>name numerical methods for interpolation, integration, least squares problems, eigenvalue problems, nonlinear root find problems and to explain their core ideas,</li> <li>repeat convergence statements for the numerical methods,</li> <li>explain aspects for the practical execution of numerical methods with respect to computational and storage complexitx.</li> </ul>			
Skills	Students are able to			
	<ul> <li>implement, apply and compare numerical methods using MATLAB/Python,</li> <li>justify the convergence behaviour of numerical methods with respect to the problem and</li> <li>select and execute a suitable solution approach for a given problem.</li> </ul>	d solution algor	rithm,	
Personal Competence				
Social Competence	Students are able to			
	<ul> <li>work together in heterogeneously composed teams (i.e., teams from different study pro explain theoretical foundations and support each other with practical aspects regarding to</li> </ul>			
Autonomy	Students are capable			
	<ul> <li>to assess whether the supporting theoretical and practical excercises are better solved in</li> <li>to assess their individual progess and, if necessary, to ask questions and seek help.</li> </ul>	ndividually or i	n a 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				
	General Engineering Science (German program, 7 semester): Specialisation Computer Science:	: Compulsory		
Assignment for the				
Assignment for the	General Engineering Science (German program, 7 semester): Specialisation Biomedical Engineer	ering. Compuls	orv	
	General Engineering Science (German program, 7 semester): Specialisation Biomedical Engineer		-	
	General Engineering Science (German program, 7 semester): Specialisation Mechanical		-	
	General Engineering Science (German program, 7 semester): Specialisation Mechanical Compulsory	Engineering,	Focus Biomechan	
	General Engineering Science (German program, 7 semester): Specialisation Mechanical Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engine	Engineering,	Focus Biomechan	
	General Engineering Science (German program, 7 semester): Specialisation Mechanical Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engine Engineering: Compulsory	Engineering, eering, Focus T	Focus Biomechan	
	General Engineering Science (German program, 7 semester): Specialisation Mechanical Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engine	Engineering, eering, Focus T	Focus Biomechan	
	General Engineering Science (German program, 7 semester): Specialisation Mechanical Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engine Engineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engine	Engineering, eering, Focus T ngineering, Fo	Focus Biomechan heoretical Mechan cus Aircraft Syste	
	General Engineering Science (German program, 7 semester): Specialisation Mechanical Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engine Engineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engine Engineering: Elective Compulsory	Engineering, eering, Focus T ngineering, Fo	Focus Biomechan heoretical Mechan cus Aircraft Syste	
	General Engineering Science (German program, 7 semester): Specialisation Mechanical Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engine Engineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engine Engineering: Elective Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engine	Engineering, eering, Focus Ti ngineering, Fo eering, Focus M	Focus Biomechan heoretical Mechan cus Aircraft Syste Aechatronics: Elect	
	General Engineering Science (German program, 7 semester): Specialisation Mechanical Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engine Engineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical En- Engineering: Elective Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engine Compulsory	Engineering, eering, Focus Ti ngineering, Fo eering, Focus M	Focus Biomechan heoretical Mechan cus Aircraft Syste Aechatronics: Elect	
	General Engineering Science (German program, 7 semester): Specialisation Mechanical Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engine Engineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical En- Engineering: Elective Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engine Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engine Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engine	Engineering, eering, Focus Ti ngineering, Fo eering, Focus N ngineering, Foc	Focus Biomechan heoretical Mechan cus Aircraft Syste Aechatronics: Elect	
	General Engineering Science (German program, 7 semester): Specialisation Mechanical Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engine Engineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical En- Engineering: Elective Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engine Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engine Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engine Elective Compulsory	Engineering, eering, Focus Ti ngineering, Fo eering, Focus N ngineering, Foc s: Compulsory	Focus Biomechan heoretical Mechan cus Aircraft Syste Mechatronics: Eleci cus Energy Syste	
	General Engineering Science (German program, 7 semester): Specialisation Mechanical Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engine Engineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engine Engineering: Elective Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engine Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engine Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engine Elective Compulsory General Engineering Science (German program, 7 semester): Specialisation Advanced Materials General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering Sciences: Compulsory	Engineering, eering, Focus Ti ngineering, Fo eering, Focus N ngineering, Foo s: Compulsory I Engineering,	Focus Biomechan heoretical Mechan cus Aircraft Syste Mechatronics: Eleci cus Energy Syste	
	General Engineering Science (German program, 7 semester): Specialisation Mechanical Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engine Engineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engine Engineering: Elective Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engine Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engine Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engine Elective Compulsory General Engineering Science (German program, 7 semester): Specialisation Advanced Materials General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering Sciences: Compulsory Bioprocess Engineering: Specialisation A - General Bioprocess Engineering: Elective Compulsory	Engineering, eering, Focus Ti ngineering, Fo eering, Focus N ngineering, Foo s: Compulsory I Engineering, Y	Focus Biomechan heoretical Mechan cus Aircraft Syste Mechatronics: Eleci cus Energy Syste	
	General Engineering Science (German program, 7 semester): Specialisation Mechanical Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engine Engineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engine Engineering: Elective Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engine Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engine Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engine Elective Compulsory General Engineering Science (German program, 7 semester): Specialisation Advanced Materials General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering Sciences: Compulsory Bioprocess Engineering: Specialisation A - General Bioprocess Engineering: Elective Compulsory Computer Science: Specialisation II. Mathematics and Engineering Science: Elective Compulsory	Engineering, eering, Focus Ti ngineering, Fo eering, Focus N ngineering, Foo s: Compulsory I Engineering, Y	Focus Biomechan heoretical Mechan cus Aircraft Syste Mechatronics: Eleci cus Energy Syste	
	General Engineering Science (German program, 7 semester): Specialisation Mechanical Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engine Engineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engine Engineering: Elective Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engine Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engine Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engine Elective Compulsory General Engineering Science (German program, 7 semester): Specialisation Advanced Materials General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering Sciences: Compulsory Bioprocess Engineering: Specialisation A - General Bioprocess Engineering: Elective Compulsory Computer Science: Specialisation II. Mathematics and Engineering Science: Elective Compulsory Data Science: Core Qualification: Compulsory	Engineering, eering, Focus Ti ngineering, Fo eering, Focus N ngineering, Foo s: Compulsory I Engineering, Y	Focus Biomechan heoretical Mechan cus Aircraft Syste Mechatronics: Eleci cus Energy Syste	
	General Engineering Science (German program, 7 semester): Specialisation Mechanical Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engine Engineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engine Engineering: Elective Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engine Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engine Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engine Elective Compulsory General Engineering Science (German program, 7 semester): Specialisation Advanced Materials General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering Sciences: Compulsory Bioprocess Engineering: Specialisation A - General Bioprocess Engineering: Elective Compulsory Computer Science: Specialisation II. Mathematics and Engineering Science: Elective Compulsory Data Science: Core Qualification: Compulsory Electrical Engineering: Core Qualification: Elective Compulsory	Engineering, eering, Focus Ti ngineering, Fo eering, Focus N ngineering, Foo s: Compulsory I Engineering, Y	Focus Biomechan heoretical Mechan cus Aircraft Syste Mechatronics: Eleci cus Energy Syste	
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	General Engineering Science (German program, 7 semester): Specialisation Mechanical Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engine Engineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engine Engineering: Elective Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engine Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engine Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engine Elective Compulsory General Engineering Science (German program, 7 semester): Specialisation Advanced Materials General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering Sciences: Compulsory Bioprocess Engineering: Specialisation A - General Bioprocess Engineering: Elective Compulsory Computer Science: Specialisation II. Mathematics and Engineering Science: Elective Compulsory Electrical Engineering: Core Qualification: Elective Compulsory Electrical Engineering: Core Qualification: Elective Compulsory Engineering Science: Core Qualification: Compulsory Engineering Science: Core Qualification: Compulsory Engineering Science: Core Qualification: Compulsory	Engineering, eering, Focus Ti ngineering, Fo eering, Focus N ngineering, Foo s: Compulsory I Engineering, Y	Focus Biomechan heoretical Mechan cus Aircraft Syste Mechatronics: Eleci cus Energy Syste	
	General Engineering Science (German program, 7 semester): Specialisation Mechanical Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering: Elective Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engine Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engine Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engine Elective Compulsory General Engineering Science (German program, 7 semester): Specialisation Advanced Materials General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering Sciences: Compulsory Bioprocess Engineering: Specialisation A - General Bioprocess Engineering: Elective Compulsory Data Science: Specialisation II. Mathematics and Engineering Science: Elective Compulsory Electrical Engineering: Core Qualification: Elective Compulsory Engineering Science: Core Qualification: Compulsory Engineering Science: Core Qualification: Compulsory Engineering Science: Core Qualification: Compulsory Computer Science: In Engineering: Core Qualification: Compulsory	Engineering, eering, Focus Ti ngineering, Fo eering, Focus N ngineering, Foo s: Compulsory I Engineering, Y	Focus Biomechan heoretical Mechan cus Aircraft Syste Mechatronics: Eleci cus Energy Syste	
	General Engineering Science (German program, 7 semester): Specialisation Mechanical Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering: Elective Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engine Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engine Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engine Elective Compulsory General Engineering Science (German program, 7 semester): Specialisation Advanced Materials General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering Sciences: Compulsory Bioprocess Engineering: Specialisation A - General Bioprocess Engineering: Elective Compulsory Computer Science: Specialisation II. Mathematics and Engineering Science: Elective Compulsory Data Science: Core Qualification: Compulsory Electrical Engineering: Core Qualification: Elective Compulsory Engineering Science: Core Qualification: Compulsory Engineering Science: Core Qualification: Compulsory Mechanical Engineering: Specialisation Theoretical Mechanical Engineering: Compulsory	Engineering, eering, Focus Ti ngineering, Fo eering, Focus N ngineering, Foo s: Compulsory I Engineering, Y	Focus Biomechan heoretical Mechan cus Aircraft Syste Mechatronics: Eleci cus Energy Syste	
	General Engineering Science (German program, 7 semester): Specialisation Mechanical Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering: Elective Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engine Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engine Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engine Elective Compulsory General Engineering Science (German program, 7 semester): Specialisation Advanced Materials General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering Sciences: Compulsory Bioprocess Engineering: Specialisation A - General Bioprocess Engineering: Elective Compulsory Data Science: Specialisation II. Mathematics and Engineering Science: Elective Compulsory Electrical Engineering: Core Qualification: Elective Compulsory Engineering Science: Core Qualification: Compulsory Engineering Science: Core Qualification: Compulsory Engineering Science: Core Qualification: Compulsory Computer Science: In Engineering: Core Qualification: Compulsory	Engineering, Beering, Focus Ti Ingineering, Fo eering, Focus M Ingineering, Foo s: Compulsory I Engineering, Y Y	Focus Biomechan heoretical Mechan cus Aircraft Syste Mechatronics: Eleci cus Energy Syste	

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

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

Module M0599: Integ	rated Product Dev	elopment and	Lightweigh	t Design		
Courses						
Title				Тур	Hrs/wk	СР
CAE-Team Project (L0271)				Project-/problem-based Learning	2	2
Development of Lightweight Design	Products (L0270)			Lecture	2	2
Integrated Product Development I	L0269)			Lecture	2	2
Module Responsible	Prof. Dieter Krause					
Admission Requirements	None					
Recommended Previous	Advanced Knowledge abo	ut engineering desig	n:			
Knowledge	Fundamentals of Mechani	al Engineering Desi	gn			
	Mechanical Engineering: [	esign				
	Advanced Mechanical Eng	ineering Design				
Educational Objectives	After taking part successf	Illy, students have r	eached the followi	ng learning results		
Professional Competence						
Knowledge	After completing the mode	ile, students are cap	able of:			
	<ul> <li>explaining the func</li> </ul>	ional principle of 30	CAD Systems PD	M and EEM Systems		
				the product development proces		
	- describing the inter		it one systems in	the product development proces	55	
Skills						
	After completing the mod	ile students are abl	e to:			
	riter completing the mod					
	evaluate different	CAD- and PDM-Syste	ems with regards	to the desired requirements su	ıch as classifi	cation schemes and
	product structuring					
	<ul> <li>design an exempla</li> </ul>	y product using CAD	-,PDM- and/or FEM	1-Systems with shared workload		
Personal Competence						
Social Competence	After completing the mode	ile, students are abl	e to:			
	• To develop a project plan and allocate work appropriate work packages in the framework of group discussions					
	<ul> <li>Present project rest</li> </ul>				5	
Autonomy	Students are capable of:					
	<ul> <li>independently adapt to a CAE-Tool and complete a given practical task with it</li> </ul>					
	Independent Study Time 9	6, Study Time in Leo	ture 84			
Credit points	6					
Course achievement	CompulsoryBonusForYes20 %Su		Description	ojekt inkl. Vortrag und Ausarbeitu	ing	
		ctical work	and CAL-reampro	Jekt linki. Vorträg und Ausarbeite	ing	
Examination						
Examination duration and						
scale	50					
Assignment for the	General Engineering Scie	nce (German progr	am, 7 semester)	: Specialisation Mechanical End	ineering, Foc	us Aircraft Systems
Following Curricula	Engineering: Compulsory					,
_		nce (German progra	m, 7 semester): S	pecialisation Mechanical Engine	ering, Focus P	roduct Development
	and Production: Compulso	ry				
	Engineering Science: Spec	-	l Engineering: Ele	ctive Compulsory		
				ecialisation Mechanical Engineeri	ng: Elective C	ompulsory
	Mechanical Engineering: S	pecialisation Produc	t Development an	d Production: Compulsory		
	Mechanical Engineering: S	pecialisation Aircraf	Systems Enginee	ring: Compulsory		
	Product Development, Ma	erials and Productio	n: Technical Com	plementary Course Core Studies:	Elective Com	pulsory

Course L0271: CAE-Team Pro	ject
Тур	Project-/problem-based Learning
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	<ul> <li>Practical Introduction in the used software systems (Creo, Windchill, Hyperworks)</li> <li>Team formation, allocation of tasks and generation of a project plan</li> <li>Collective creation of one product out of CAD models supported by FEM calculations and PDM system</li> <li>Manufacturing of selected parts using 3D printer</li> <li>Presentation of results</li> </ul> <b>Description</b> 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 L0270: Development	of Lightweight Design Products			
Тур	Lecture			
Hrs/wk				
СР	2			
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28			
Lecturer	Prof. Dieter Krause, Prof. Benedikt Kriegesmann			
Language	DE			
Cycle	SoSe			
Content	<ul> <li>Lightweight design materials</li> <li>Product development process for lightweight structures</li> <li>Dimensioning of lightweight structures</li> </ul>			
Literature	<ul> <li>Schürmann, H., "Konstruieren mit Faser-Kunststoff-Verbunden", Springer, Berlin, 2005.</li> <li>Klein, B., "Leichtbau-Konstruktion", Vieweg &amp; Sohn, Braunschweig, 1989.</li> <li>Krause, D., "Leichtbau", In: Handbuch Konstruktion, Hrsg.: Rieg, F., Steinhilper, R., München, Carl Hanser Verlag, 2012.</li> <li>Schulte, K., Fiedler, B., "Structure and Properties of Composite Materials", Hamburg, TUHH - TuTech Innovation GmbH, 2005.</li> <li>Wiedemann, J., "Leichtbau Band 1: Elemente", Springer, Berlin, Heidelberg, 1986.</li> </ul>			

ourse L0269: Integrated Product Development I			
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	<ul> <li>Introduction to Integrated Product Development</li> <li>3D CAD -Systems and CAD interfaces</li> <li>Administration of part lists / PDM systems</li> <li>PDM in different industries</li> <li>Selection of CAD-/PDM Systems</li> <li>Simulation</li> <li>Construction methods</li> <li>Design for X</li> </ul>		
Literature	<ul> <li>Ehrlenspiel, K.: Integrierte Produktentwicklung, München, Carl Hanser Verlag</li> <li>Lee, K.: Principles of CAD / CAM / CAE Systems, Addison Wesles</li> <li>Schichtel, M.: Produktdatenmodellierung in der Praxis, München, Carl Hanser Verlag</li> <li>Anderl, R.: CAD Schnittstellen, München, Carl Hanser Verlag</li> <li>Spur, G., Krause, F.: Das virtuelle Produkt, München, Carl Hanser Verlag</li> </ul>		

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				
<b>Recommended Previous</b>	None				
Knowledge					
Educational Objectives	After taking part successfully, students	have reached the following learning results			
Professional Competence					
Knowledge	Students are able to explain the conten	ts of the lecture of the module.			
Skills	Students are able to apply the methods	and models in the module to industrial problem	1S.		
Personal Competence					
Social Competence	-				
Autonomy	-				
Workload in Hours	Independent Study Time 124, Study Tin	ne 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	inical Engineering, Foc	us Aircraft Syster	
Following Curricula	Engineering: Compulsory				
	General Engineering Science (German	program, 7 semester): Specialisation Mechanica	al Engineering, Focus P	roduct Developme	
	and Production: Compulsory				
	General Engineering Science (German p	rogram, 7 semester): Specialisation Advanced I	Materials: Elective Com	pulsory	
	Engineering Science: Core Qualification	Compulsory			
	Engineering Science: Specialisation Med	hatronics: Elective Compulsory			
	Engineering Science: Specialisation Mechanical Engineering: Elective Compulsory				
	Engineering Science: Specialisation Advanced Materials: Elective Compulsory				
		oduction Management and Processes: Compulso	ory		
	Logistics and Mobility: Specialisation En				
	Mechanical Engineering: Core Qualificat	ion: Elective Compulsory			
	Engineering and Management - Major in	Logistics and Mobility: Specialisation Productio	n Management and Pro	cesses: Compulsor	

ourse L0925: Production Process Organization				
Тур	Lecture			
Hrs/wk				
СР				
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28			
Lecturer	Prof. Hermann Lödding			
Language	EN			
Cycle	SoSe			
Content	(A) Introduction			
	(B) Product planning			
	(C) Process planning			
	Procurement			
	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			
CP	3		
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28		
Lecturer	Prof. Hermann Lödding		
Language	EN		
Cycle	SoSe		
Content	<ul> <li>Definition and Relevance of Quality</li> <li>Continuous Quality Improvement</li> <li>Quality Management in Product Development</li> <li>Quality Management in Production Processes</li> <li>Design of Experiments</li> </ul>		
Literature	<ul> <li>Pfeifer, Tilo: Quality Management. Strategies, Methods, Techniques; Hanser-Verlag, München 2002</li> <li>Pfeifer, Tilo: Qualitätsmanagement. Strategien, Methoden, Techniken; Hanser-Verlag, München, 3. Aufl. 2001</li> <li>Mitra, Amitava: Fundamentals of Quality Control and Improvement; Wiley; Macmillan, 2008</li> <li>Kleppmann, W.: Taschenbuch Versuchsplanung. Produkte und Prozesse optimieren; Hanser-Verlag, München, 6. Aufl. 2009</li> </ul>		

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

Module M0767: Aeror	nautical Systems				
Courses					
Title		Тур	Hrs/wk	СР	
Fundamentals of Aircraft Systems	(L0741)	Lecture	2	2	
Fundamentals of Aircraft Systems	(L0742)	Recitation Section (small)	1	1	
Air Transportation Systems (L0591	)	Lecture	2	2	
Air Transportation Systems (L0816	)	Recitation Section (large)	1	1	
Module Responsible	Prof. Frank Thielecke				
Admission Requirements	None				
<b>Recommended Previous</b>	Basics of mathematics, mechanics and th	nermodynamics			
Knowledge					
Educational Objectives	After taking part successfully, students h	ave reached the following learning results			
Professional Competence					
Knowledge	Students get a basic understanding of t	the structure and design of an aircraft, as well	as an overview of th	he systems inside	
	aircraft. In addition, a basic knowledge of the relationchips, the key parameters, roles and ways of working in different subsystem:				
	in the air transport is acquired.				
Skills	Due to the learned cross-system thinking students can gain a deeper understanding of different system concepts and the				
	technical system implementation. In addition, they can apply the learned methods for the design and assessment of subsystems o				
	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 implementatior	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	cal Engineering, Fo	cus Aircraft Syste	
Following Curricula		•			
-	Logistics and Mobility: Specialisation Log	istics and Mobility: Elective Compulsory			
		ffic Planning and Systems: Elective Compulsory			
	Mechanical Engineering: Specialisation A				
	5 5 1	Logistics and Mobility: Specialisation Traffic Plan	ning and Systems: Fl	ective Compulsory	

Course L0741: Fundamentals of Aircraft Systems		
Тур	Lecture	
Hrs/wk	2	
СР	2	
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28	
Lecturer	Prof. Frank Thielecke	
Language	DE	
Cycle	SoSe	
Content	nt - Development of aircrafts, fundamentals of flight physics, propulsion systems, analysis of ranges and loads, aircraft-structures	
	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		
CP	2	
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28	
Lecturer	Prof. Volker Gollnick	
Language	DE	
Cycle	SoSe	
Content	<ol> <li>Air transport as part of the global transportation system</li> <li>Legal basis of air transportation</li> <li>Safety and security aspects</li> <li>Aircraft basics</li> <li>The role of the aircraft amnufacturer</li> <li>The role of the aircraft operator</li> <li>Airport operation</li> <li>The principles of air traffic management</li> <li>Environmental aspects of air transportation</li> </ol>	
Literature	<ol> <li>V. Gollnick, D. Schmitt: "Air Transport System", Springer-Verlag, ISBN 978-3-7091-1879-5</li> <li>H. Mensen: "Handbuch der Luftfahrt", Springer-Verlag, 2003</li> <li>J.P. Clark: "Buying the Big Jets", ISBN 9781317170341, Taylor &amp; Francis, 2017</li> <li>Mike Hirst: The Air Transport System, AIAA, 2008</li> <li>D.P. Raymer: "Aircraft Design - A Conceptual Approach", AIAA Education Series, 2006, ISBN 1-56347-281-3</li> <li>N. Ashford: "Airport Operations", McGraw-Hill, 1997, ISBN 0-07-003077-4</li> <li>P. Maurer: "Luftverkehrsmanagement", Oldenbourg-Verlag, ISBN 3-486-27422-8</li> <li>H. Mensen: "Moderne Flugsicherung", Springer-Verlag, 2004, ISBN 3-540-20581-0</li> </ol>	

Course L0816: Air Transport	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	

itle		Тур	Hrs/wk	СР
odeling, Simulation and Optimizat	on (EN) (L2446)	Integrated Lecture	4	6
Module Responsible	Prof. Benedikt Kriegesmann			
Admission Requirements	None			
<b>Recommended Previous</b>	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		
<b>Professional Competence</b>				
Knowledge	Students will have an overview of various	s technical problems and the differential equati	ons, which describe	them. Students
	gave an overview of different solution app	roaches and for which kind of problems they can	be used for.	
Skills	Students are able to solve different technic	cal problems with the introduced discretization n	nethods	
SKIIS		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 solution	strategies for complex problems self-consistent a	and critically analyse	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	eoretical Mechar
-	Engineering: Compulsory			
		gram, 7 semester): Specialisation Advanced Mat		
		rogram, 7 semester): Specialisation Mechanic	al Engineering, Foc	us Aircraft Syste
	Engineering: Elective Compulsory			
	Engineering Science: Core Qualification: Co	ompulsory		
	Mechanical Engineering: Specialisation The	eoretical Mechanical Engineering: 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	<ul> <li>Partial Differential Equations in technical problems</li> <li>Overview of modelling approaches</li> <li>Finite Approximation Methods - Finite Differences / Elements / Volumes</li> <li>Introduction to the Discrete Element Method</li> <li>Numerical methods for time dependent problems</li> <li>Gradient-based optimization</li> </ul>	
Literature	Michael Schäfer, Computational Engineering - Introduction to Numerical Methods, Springer.	

## **Focus Materials in Engineering Sciences**

In the specialization "materials in the engineering sciences" the graduates learn how to systematically and methodically analyze and understand fundamental materials-related phenomena. They have broad knowledge of the material science basics of structural and functional materials, including metals, polymers and ceramics. The graduates understand the impact of composition, processing, and service conditions on the material's behavior. Based on this understanding they can assess the suitability of materials for specific technological problems.

Module M0730: Comp	uter Engineering			
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 the follow	ing learning results		
Professional Competence				
Knowledge	-		ne layers from t	he assembly-level
	programming down to gates. The module includes the following	topics:		
	Introduction			
	Combinational logic: Gates, Boolean algebra, Boolean fur	nctions, hardware synthesis, comb	pinational netwo	rks
	<ul> <li>Sequential logic: Flip-flops, automata, systematic hardwa</li> </ul>	are design		
	<ul> <li>Technological foundations</li> </ul>			
	Computer arithmetic: Integer addition, subtraction, multi			
	Basics of computer architecture: Programming models, N     Managing Managing Figure CDAM, DDAM, and base	IIPS single-cycle architecture, pipe	elining	
	<ul> <li>Memories: Memory hierarchies, SRAM, DRAM, caches</li> <li>Input/output: I/O from the perspective of the CPU, princip</li> </ul>	les of passing data point-to-point	connections by	15505
	• Inputoutput. To nom the perspective of the Cro, princip		connections, bu	15565
Skills	The students perceive computer systems from the architect's p	erspective, i.e., they identify the i	internal structur	e and the physical
	composition of computer systems. The students can analyze, h			
	collection of few and simple components. They are able to dis		the different ab	straction layers of
	today's computing systems - from gates and circuits up to comp	olete processors.		
	After successful completion of the module, the students are a	able to judge the interdependence	ies between a p	physical computer
	system and the software executed on it. In particular, they sha	II understand the consequences t	hat the execution	on of software has
	on the hardware-centric abstraction layers from the assembly I			
	the impact that these low abstraction levels have on an entire s	system's performance and to prop	ose feasible opt	ions.
Personal Competence				
Social Competence	Students are able to solve similar problems alone or in a group	and to present the results accordi	ngly.	
Autonomy	Students are able to acquire new knowledge from specific litera	ture and to associate this knowle	dge with other c	lasses.
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56			
Credit points	6			
Course achievement	Compulsory Bonus Form Description			
course demeternene	Yes 10 % Excercises			
Examination	Written exam			
-	90 minutes, contents of course and labs			
scale				
Assignment for the	General Engineering Science (German program, 7 semester): S	pecialisation Computer Science: C	ompulsory	
Following Curricula	General Engineering Science (German program, 7 semeste	er): Specialisation Mechanical E	ngineering, Foo	us Mechatronics:
	Compulsory			
	General Engineering Science (German program, 7 semester	): Specialisation Mechanical Eng	ineering, Focus	Aircraft Systems
	Engineering: Compulsory	a sidiration Maskanias Francisco		
	General Engineering Science (German program, 7 semester): S Engineering: Compulsory	pecialisation Mechanical Engineer	ing, rocus theo	retical Mechanical
	General Engineering Science (German program, 7 semest	er). Specialisation Mechanical	Engineering Fo	ocus Materials in
	Engineering Sciences: Compulsory		,,,,,,	
	General Engineering Science (German program, 7 semester): 9	Specialisation Mechanical Enginee	ering, Focus Prod	duct Development
	and Production: Compulsory			
	General Engineering Science (German program, 7 semester)	: Specialisation Mechanical Eng	ineering, Focus	Energy Systems:
	Compulsory			
	General Engineering Science (German program, 7 semeste	er): Specialisation Mechanical E	ngineering, Foc	us Biomechanics:
	Compulsory	Antipalization Electrical Engineering	a: Compulson	
	General Engineering Science (German program, 7 semester): S General Engineering Science (German program, 7 semester): S			le Enerav: Flective
	Compulsory	sectandation or cent rectinologies,	. seus nenewap	e Energy. Elective
	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: Compulso	ry		

Integrated Building Technology: Core Qualification: Elective Compulsory Technomathematics: Specialisation II. Informatics: Elective Compulsory

Course L0321: Computer Engineering	
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	<ul> <li>Introduction</li> <li>Combinational Logic</li> <li>Sequential Logic</li> <li>Technological Foundations</li> <li>Representations of Numbers, Computer Arithmetics</li> <li>Foundations of Computer Architecture</li> <li>Memories</li> <li>Input/Output</li> </ul>
Literature	<ul> <li>A. Clements. The Principles of Computer Hardware. 3. Auflage, Oxford University Press, 2000.</li> <li>A. Tanenbaum, J. Goodman. Computerarchitektur. Pearson, 2001.</li> <li>D. Patterson, J. Hennessy. Rechnerorganisation und -entwurf. Elsevier, 2005.</li> </ul>

Course L0324: Computer Eng	Course 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
Companion Lecture for Materials Se	cience Laboratory (L1088)	Lecture	2	2
Material Science Laboratory (L123		Practical Course	4	4
Module Responsible	Prof. Kaline Pagnan Furlan			
Admission Requirements	None			
<b>Recommended Previous</b>	none			
Knowledge				
Educational Objectives	After taking part successfully, students ha	ve reached the following learning results		
Professional Competence				
Knowledge	Students are able to give a summary of	the technical details of experiments in the	e area of materials so	iences and illustr
	respective relationships. They are capable	e of describing and communicating relevant	problems and question	ns using appropri
	technical language. They can explain the t	ypical process of solving practical problems a	nd present related res	ults.
Chille	The students can transfer their fundament	the longuiled an instantial asian as the the	recess of column area	tical problems. T
SKIIIS		ntal knowledge on material sciences to the p uring the realization of experiments in the con	÷ .	
	identity and overcome typical problems do	and the realization of experiments in the con		
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 a			
	to effectively present and explain their res	ults alone or in groups in front of a qualified a	udience.	
Autonomy	Students are capable of solving problems	in the context of materials sciences using pr	ovided literature. The	v are able to fill o
Autonomy		the literature and other sources provided by t		y are able to fill g
Workload in Hours	Independent Study Time 96, Study Time ir			
Credit points				
Course achievement				
Examination	Subject theoretical and practical work			
Examination duration and	Test reports on the respective tests and or	nline learning modules with integrated succes	s control	
scale		5		
Assignment for the	General Engineering Science (German pro	ogram, 7 semester): Specialisation Mechanica	I Engineering, Focus I	Product Developm
Following Curricula	and Production: Elective Compulsory			
	General Engineering Science (German pro	gram, 7 semester): Specialisation Advanced M	laterials: Compulsory	
	General Engineering Science (German	program, 7 semester): Specialisation Med	hanical Engineering,	Focus Materials
	Engineering Sciences: Compulsory			
	Engineering Science: Specialisation Advan	ced Materials: Compulsory		
	Mechanical Engineering: Specialisation Pro	oduct Development and Production: Compulso	ry	
	Mechanical Engineering: Specialisation Ma	terials in Engineering Sciences: Compulsory		
	Product Development, Materials and Produ	iction: Technical Complementary Course Core	Studios: Elective Com	nulcony

Course L1088: Companion Lecture for Materials Science Laboratory		
Тур	Lecture	
Hrs/wk	2	
CP		
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	
	in mysical measurements, za zaron, omverský science books, 1997 https://katalog.tub.talm.ta/Accolu/024511070	
	1	

ourse L1235: Material Science Laboratory		
	Practical Course	
Hrs/wk		
CP		
	Independent Study Time 64, Study Time in Lecture 56	
	Prof. Kaline Pagnan Furlan, Prof. Bodo Fiedler, Prof. Gerold Schneider, Prof. Jörg Weißmüller, Prof. Patrick Huber, Prof. Stefan Fritz Müller	
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')	

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		
<b>Recommended Previous</b>			
Knowledge	<ul> <li>Mathematik I + II for Engineering Students (german or english) or Analysis &amp; Linear Algel</li> <li>basic MATLAB/Python knowledge</li> </ul>	bra I + II for Te	echnomathematici
Educational Objectives	After taking part successfully, students have reached the following learning results		
Professional Competence			
Knowledge	Students are able to		
	<ul> <li>name numerical methods for interpolation, integration, least squares problems, eigenval problems and to explain their core ideas,</li> <li>repeat convergence statements for the numerical methods,</li> <li>explain aspects for the practical execution of numerical methods with respect to compute</li> </ul>		
Skills	Students are able to		
	<ul> <li>implement, apply and compare numerical methods using MATLAB/Python,</li> <li>justify the convergence behaviour of numerical methods with respect to the problem and</li> <li>select and execute a suitable solution approach for a given problem.</li> </ul>	solution algor	ithm,
Personal Competence			
Social Competence	Students are able to		
	<ul> <li>work together in heterogeneously composed teams (i.e., teams from different study progexplain theoretical foundations and support each other with practical aspects regarding to</li> </ul>		
Autonomy	Students are capable		
	<ul> <li>to assess whether the supporting theoretical and practical excercises are better solved in</li> <li>to assess their individual progess and, if necessary, to ask questions and seek help.</li> </ul>	ndividually or in	n a 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:	Compulsory	
	General Engineering Science (German program, 7 semester): Specialisation Biomedical Enginee		ory
, , , , , , , , , , , , , , , , , , ,	General Engineering Science (German program, 7 semester): Specialisation Mechanical I Compulsory	÷ .	-
	General Engineering Science (German program, 7 semester): Specialisation Mechanical Enginee Engineering: Compulsory	ering, Focus Tł	neoretical Mechani
	General Engineering Science (German program, 7 semester): Specialisation Mechanical En	ngineering, Foo	cus Aircraft Syste
	Engineering, Elective Compulson		
	Engineering: Elective Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engine	ering, Focus M	lechatronics: Elect
	General Engineering Science (German program, 7 semester): Specialisation Mechanical Engine Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical En		
	General Engineering Science (German program, 7 semester): Specialisation Mechanical Engine Compulsory		
	General Engineering Science (German program, 7 semester): Specialisation Mechanical Engine Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical En Elective Compulsory General Engineering Science (German program, 7 semester): Specialisation Advanced Materials	igineering, Foo s: Compulsory	us Energy Syster
	General Engineering Science (German program, 7 semester): Specialisation Mechanical Engine Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical En Elective Compulsory General Engineering Science (German program, 7 semester): Specialisation Advanced Materials General Engineering Science (German program, 7 semester): Specialisation Mechanical	igineering, Foo s: Compulsory	us Energy Syster
	General Engineering Science (German program, 7 semester): Specialisation Mechanical Engine Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical En Elective Compulsory General Engineering Science (German program, 7 semester): Specialisation Advanced Materials General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering Sciences: Compulsory	igineering, Foo : Compulsory Engineering,	us Energy Syster
	General Engineering Science (German program, 7 semester): Specialisation Mechanical Engine Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical En- Elective Compulsory General Engineering Science (German program, 7 semester): Specialisation Advanced Materials General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering Sciences: Compulsory Bioprocess Engineering: Specialisation A - General Bioprocess Engineering: Elective Compulsory	ngineering, Foo s: Compulsory Engineering,	us Energy Syster
	General Engineering Science (German program, 7 semester): Specialisation Mechanical Engine Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical En Elective Compulsory General Engineering Science (German program, 7 semester): Specialisation Advanced Materials General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering Sciences: Compulsory Bioprocess Engineering: Specialisation A - General Bioprocess Engineering: Elective Compulsory Computer Science: Specialisation II. Mathematics and Engineering Science: Elective Compulsory	ngineering, Foo s: Compulsory Engineering,	us Energy Syster
	General Engineering Science (German program, 7 semester): Specialisation Mechanical Engine Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical En- Elective Compulsory General Engineering Science (German program, 7 semester): Specialisation Advanced Materials General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering Sciences: Compulsory Bioprocess Engineering: Specialisation A - General Bioprocess Engineering: Elective Compulsory Computer Science: Specialisation II. Mathematics and Engineering Science: Elective Compulsory Data Science: Core Qualification: Compulsory	ngineering, Foo s: Compulsory Engineering,	us Energy Syster
	General Engineering Science (German program, 7 semester): Specialisation Mechanical Engine Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical En- Elective Compulsory General Engineering Science (German program, 7 semester): Specialisation Advanced Materials General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering Sciences: Compulsory Bioprocess Engineering: Specialisation A - General Bioprocess Engineering: Elective Compulsory Computer Science: Specialisation II. Mathematics and Engineering Science: Elective Compulsory Data Science: Core Qualification: Compulsory Electrical Engineering: Core Qualification: Elective Compulsory	ngineering, Foo s: Compulsory Engineering,	us Energy Syster
	General Engineering Science (German program, 7 semester): Specialisation Mechanical Engine Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical En- Elective Compulsory General Engineering Science (German program, 7 semester): Specialisation Advanced Materials General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering Sciences: Compulsory Bioprocess Engineering: Specialisation A - General Bioprocess Engineering: Elective Compulsory Computer Science: Specialisation II. Mathematics and Engineering Science: Elective Compulsory Data Science: Core Qualification: Compulsory Electrical Engineering: Core Qualification: Elective Compulsory Engineering Science: Core Qualification: Compulsory	ngineering, Foo s: Compulsory Engineering,	us Energy Syster
	General Engineering Science (German program, 7 semester): Specialisation Mechanical Engine Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical En- Elective Compulsory General Engineering Science (German program, 7 semester): Specialisation Advanced Materials General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering Sciences: Compulsory Bioprocess Engineering: Specialisation A - General Bioprocess Engineering: Elective Compulsory Computer Science: Specialisation II. Mathematics and Engineering Science: Elective Compulsory Data Science: Core Qualification: Compulsory Electrical Engineering: Core Qualification: Elective Compulsory Engineering Science: Core Qualification: Compulsory Engineering Science: Core Qualification: Compulsory Engineering Science: Core Qualification: Compulsory	ngineering, Foo s: Compulsory Engineering,	us Energy System
	General Engineering Science (German program, 7 semester): Specialisation Mechanical Engine Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical En- Elective Compulsory General Engineering Science (German program, 7 semester): Specialisation Advanced Materials General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering Sciences: Compulsory Bioprocess Engineering: Specialisation A - General Bioprocess Engineering: Elective Compulsory Computer Science: Specialisation II. Mathematics and Engineering Science: Elective Compulsory Data Science: Core Qualification: Compulsory Electrical Engineering: Core Qualification: Elective Compulsory Engineering Science: Core Qualification: Compulsory	ngineering, Foo s: Compulsory Engineering,	us Energy System
	General Engineering Science (German program, 7 semester): Specialisation Mechanical Engine Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical En Elective Compulsory General Engineering Science (German program, 7 semester): Specialisation Advanced Materials General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering Sciences: Compulsory Bioprocess Engineering: Specialisation A - General Bioprocess Engineering: Elective Compulsory Computer Science: Specialisation II. Mathematics and Engineering Science: Elective Compulsory Data Science: Core Qualification: Compulsory Electrical Engineering: Core Qualification: Elective Compulsory Engineering Science: Core Qualification: Compulsory Computer Science: Core Qualification: Compulsory Engineering Science: Core Qualification: Compulsory Computer Science in Engineering: Core Qualification: Compulsory	ngineering, Foo s: Compulsory Engineering,	us Energy System
	General Engineering Science (German program, 7 semester): Specialisation Mechanical Engine Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical En Elective Compulsory General Engineering Science (German program, 7 semester): Specialisation Advanced Materials General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering Sciences: Compulsory Bioprocess Engineering: Specialisation A - General Bioprocess Engineering: Elective Compulsory Computer Science: Specialisation II. Mathematics and Engineering Science: Elective Compulsory Data Science: Core Qualification: Compulsory Electrical Engineering: Core Qualification: Elective Compulsory Engineering Science: Core Qualification: Compulsory Computer Science: Core Qualification: Compulsory Engineering Science in Engineering: Core Qualification: Compulsory Mechanical Engineering: Specialisation Theoretical Mechanical Engineering: Compulsory	ngineering, Foo s: Compulsory Engineering,	us Energy Syster

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	<ol> <li>Finite precision arithmetic, error analysis, conditioning and stability</li> <li>Linear systems of equations: LU and Cholesky factorization, condition</li> <li>Interpolation: polynomial, spline and trigonometric interpolation</li> <li>Nonlinear equations: fixed point iteration, root finding algorithms, Newton's method</li> <li>Linear and nonlinear least squares problems: normal equations, Gram Schmidt and Householder orthogonalization, singular value decomposition, regularizatio, Gauss-Newton and Levenberg-Marquardt methods</li> <li>Eigenvalue problems: power iteration, inverse iteration, QR algorithm</li> <li>Numerical differentiation</li> <li>Numerical integration: Newton-Cotes rules, error estimates, Gauss guadrature, adaptive guadrature</li> </ol>
Literature	<ul> <li>Gander/Gander/Kwok: Scientific Computing: An introduction using Maple and MATLAB, Springer (2014)</li> <li>Stoer/Bulirsch: Numerische Mathematik 1, Springer</li> <li>Dahmen, Reusken: Numerik f ür Ingenieure und Naturwissenschaftler, Springer</li> </ul>

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
Materials and Process Modeling (L2	862)	Lecture	3	3
Materials Selection and Processing		Lecture	3	3
Module Responsible	Prof. Norbert Huber			
Admission Requirements	None			
<b>Recommended Previous</b>	Fundamentals of mathematics (differential	equations, integration), materials scienc	e (classes of materials, s	structure, propertie
Knowledge	tensile test) and engineering mechanics (st	ress, strain, elasticity, deformation).		
Educational Objectives	After taking part successfully, students hav	e reached the following learning results		
Professional Competence				
Knowledge	The module deals with the production and	properties of engineering materials. Part	ticular attention is paid t	o material selectio
-	material processing, the associated micros			
	are decisive for the applicability and econo			
	covered in the sense of a broad range of av			
	In parallel to the material-technological con			
	laws for plasticity under monotonic and cyc			
	also plays a major role in manufacturing			
	simulation methods for selected manufactu	ring processes, such as rolling or forming,	, are presented for this top	pic area.
Skills	Students are able to			
	•	tallic materials for general load histories		
		t material behavior and describe it with co		5
		the underlying microstructural mechanis		
		s affect the chain microstructure - process		
		perties of metallic materials can be tailo	red by the processing du	le to microstructur
	design			
Personal Competence				
Social Competence	Students are able to			
	actively enrich and shape the course			hada ƙallan akada ak
	<ul> <li>develop solutions to given problems</li> </ul>	and explain them in English in the plenum	h and discuss them with th	heir fellow students
Autonomy	Students are able to,			
	assess their own strengths and weaknesses			
		arning status and define further work step		
	<ul> <li>abstract given tasks and then apply</li> </ul>	them to new problems by transferring the	taught material.	
Workload in Hours	Independent Study Time 96, Study Time in	Lecture 84		
Credit points	6			
Course achievement	Compulsory Bonus Form	Description		
	Yes 20 % Excercises	Wir stellen Übungsaufgaben (ÜA)	, die während des Semes	sters erbracht und
		den wöchentlichen Übungen vorg	jestellt werden. Diese kör	nnen im Umfang v
		bis zu 20% bei der Prüfung berück	ksichtigt werden.	
Examination	Written exam			
Examination duration and	120 min			
scale				
Assignment for the	General Engineering Science (German	program, 7 semester): Specialisation M	Mechanical Engineering,	Focus Materials
Following Curricula	Engineering Sciences: Compulsory			
	General Engineering Science (German prog	ram, 7 semester): Specialisation Advance	d Materials: Compulsory	
	Engineering Science: Specialisation Mechar	nical Engineering: Elective Compulsory		
	Engineering Science: Specialisation Advance	ed Materials: Compulsory		
	Engineering Science: Specialisation Advance	ed Materials: Compulsory		
	Mechanical Engineering: Specialisation Mat	erials in Engineering Sciences: Compulsor	V	

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	<ol> <li>Relevance of plasticity in materials processing and operation</li> <li>Fundamentals of plasticity in metals and alloys</li> <li>Modellierung von Materialverhalten</li> <li>Plasticity in cyclic loading</li> <li>Rate dependency, recristallization</li> <li>Rolling, forming, and solid state joining processes</li> <li>Residual stress design</li> </ol>
Literature	<ul> <li>Hull and Bacon: Introduction to Dislocations (1984)</li> <li>G. Gottstein: Physik. Grundlagen der Materialk. (2001)</li> <li>P. Haupt: Cont. Mechanics and Theory of Materials (2002)</li> <li>N. Huber: Vorlesungsskript "Grundlagen der mechanischen Eigenschaften von Werkstoffen", TUHH</li> </ul>

Course L2861: Materials Sele	ection and Processing
Тур	Lecture
Hrs/wk	3
CP	3
Workload in Hours	Independent Study Time 48, Study Time in Lecture 42
Lecturer	Prof. Kaline Pagnan Furlan
Language	EN
Cycle	SoSe
Content	<ol> <li>Introduction</li> <li>Overview of fabrication processes</li> <li>Shape considerations: macrostructural aspects</li> <li>Material properties: microstructural aspects</li> <li>Materials engineering: microstructure, shape and processing relation</li> <li>Materials engineering: function and costs relation</li> </ol>
Literature	<ul> <li>M.F. Ashby, Materials Selection in Mechanical Design, 4thedition, Butterworth-Heinemann(2011)</li> <li>W.F. Gale and T.C. Totemeier, Smithells Metals Reference Book, 8thedition, Butterworth-Heinemann(2004)</li> <li>J. Beddoes and M. Bibby, Principles of Metal Manufacturing Processes, Butterworth-Heinemann(1999)</li> </ul>

Module M0934: Adva	nced Materials for Sustainabili	ty			
Courses					
Title		T	ур	Hrs/wk	СР
Advanced Materials Characterization	n (I 1087)		ecture	2	2
Advanced Materials for Sustainabili			ecture	2	2
Advanced Materials for Sustainabili	ty (L1092)	R	ecitation Section (large)	2	2
Module Responsible	Prof. Patrick Huber				
Admission Requirements	None				
Recommended Previous	Fundamentals of Materials Science (I and II)				
Knowledge					
Educational Objectives	After taking part successfully, students have	reached the following	learning results		
Professional Competence					
Knowledge	The students will be able to explain the prop metallic, ceramic, polymeric, semiconductor,				nology, in particula
Skills	The students will be able to select material configurations according to the technical needs and, if necessary, to design new materials considering architectural principles from the micro- to the macroscale. The students will also gain an overview on modern materials science, which enables them to select optimum materials combinations depending on the technical applications.				
Personal Competence					
Social Competence	The students are able to present solutions to specialists and to develop ideas further.				
Autonomy	<ul><li>The students are able to</li><li>assess their own strengths and weakn</li><li>define tasks independently.</li></ul>	esses.			
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	90 min				
scale					
Assignment for the	General Engineering Science (German pro	ogram, 7 semester):	Specialisation Mechanica	l Engineering, F	ocus Biomechanics
Following Curricula	Compulsory				
	General Engineering Science (German progra	am, 7 semester): Spec	ialisation Advanced Materi	als: Compulsory	
	General Engineering Science (German pr	ogram, 7 semester)	Specialisation Mechanic	cal Engineering,	Focus Materials in
	Engineering Sciences: Compulsory				
	Engineering Science: Specialisation Mechanic	al Engineering: Electi	ve Compulsory		
	Engineering Science: Specialisation Advance				
	Mechanical Engineering: Core Qualification: E				

Course L1087: Advanced Materials 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	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. Gerold Schneider, Prof. Jörg Weißmüller, Prof. Patrick Huber, Prof. Stefan Fritz Müller	
Language	DE/EN	
Cycle	SoSe	
Content		
Literature	Vorlesungsunterlagen	

Course L1092: Advanced Mat	ourse 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				
<b>Fitle</b>		Тур	Hrs/wk	СР
Aaterials for Energy Storage and C	onversion (DE) (L1086)	Lecture	2	3
Enhanced Fundamentals: Ceramics	and Polymers (L1233)	Lecture	2	2
Inhanced Fundamentals: Ceramics	and Polymers (L1234)	Recitation Section (large)	1	1
Module Responsible	Prof. Gerold Schneider			
Admission Requirements	None			
<b>Recommended Previous</b>	Module "Fundamentals of Materials Science	2"		
Knowledge	Module "Materials Science Laboratory"			
	Module "Advanced Materials"			
Educational Objectives	After taking part successfully, students hav	e reached the following learning results		
Professional Competence				
Noncege	The students are able to give an enhanced overview over the following topics in metals, polymers and ceramics: Atomic bonds, crystal and amorphous structures, defects , electrical and mass tran microstructure and phase diagrams. They are capable to explain the corresponding technical terms.			and mass transpo
Skills	The students are able to apply the appropri	iate physical and chemical methods for the al	oove mentioned subje	ects.
Personal Competence				
Social Competence				
Autonomy	The students are capable to understand inc be able to critally evaluate the profoundnes	dependently the structure and propeties of ce as of their knowledge.	ramics, metals and p	olymers. They sho
Workload in Hours	Independent Study Time 110, Study Time in	n 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 Mecl	nanical Engineering,	Focus Materials
	Engineering Sciences: Compulsory		5 5,	
<b>2</b>	Data Science: Core Qualification: Elective C	Compulsory		
	Mechanical Engineering: Specialisation Mat			

ourse L1086: Materials for Energy Storage and Conversion (DE)		
Тур	Lecture	
Hrs/wk	2	
CP	3	
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28	
Lecturer	Prof. Jörg Weißmüller, DrIng. Nadiia Mameka	
Language	DE	
Cycle	SoSe	
Content	Advanced understanding of metals:	
	Physical materials properties	
	o Materials behaviour - elastic, thermal, electrical	
	o Superelasticity and shape memory effect	
	<ul> <li>Fundamentals of electrical conductivity in metals and semiconductors</li> </ul>	
	o Superconductivity	
	Chemical (or "dry") corrosion	
	o Driving forces and mechanisms	
	o Passivation	
	o Growth laws	
	Introduction to electrochemistry	
	o Electrolytes	
	o lons	
	o Solvatation	
	o Dissolution and deposition of metals	
	Galvanic cells and cell voltage     Galvanic series	
	o Nernst equation     o Polarizable electrodes	
	o Polarizable electrodes     o Electrochemical double layer	
	Capacitive and pseudocapacitive processes	
	Capacitive currents and Faraday currents	
	Electrochemical (or "wet") corrosion and corrosion protection	
	Election find (or wet ) control on and control on protection	

	o Basic observations
	o Galvanic corrosion
	o Protection against galvanic corrosion
	o Stainless steel
	o sacrificial anodes
	o Passivation and Pourbaix diagrams
	o Corrosion through gas reduction
	o Crevice corrosion
	o Stress corrosion cracking
	o Alloy corrosion and nanoporous metals
	Electrochemical energy storage
	o How a battery works
	o Lead accumulators
	o Alkaline batteries
	Nickel-metal hydride accumulators     Elive batterion
	o Flux batteries
	o Lithium-ion accumulators
	o Electrolytic and super capacitors
	o Fuel cells
	Materials for hydrogen storage
	o Storage strategies
	o Requirements for storage materials
	o State of the art
	Magnetism and magnetic materials
	<ul> <li>Phenomenology: magnetic field and magnetization</li> </ul>
	o Para-, ferro-, antiferromagnets; Curie transition
	<ul> <li>Magnetism at the atomic scale; exchange coupling</li> </ul>
	o Magnetization isotherms, domains
	o Measurement methods
	o Magnetocrystalline anisotropy and domain walls
	o Hard magnetic materials and their applications
	o Soft magnetic materials and their applications
Literature	- Vorlesungsskript
	- W.D. Callister, "Materialwissenschaften und Werkstofftechnik ", Wiley-VCH 2012
	- Carl H. Hamann, Wolf Vielstich, "Elektrochemie", Wiley-VCH; 4. Auflage 2005
	- Kurzweil, Dietlmeier, "Elektrochemische Speicher" Springer Vieweg (2015)
	(eBook: https://link.springer.com/book/10.1007/978-3-658-10900-4 )
	- B. D. Cullity, C.D. Graham, "Introduction to magnetic materials", John Wiley & Sons, 2011
	- D. Jiles, "Introduction to magnetism and magnetic materials", CRC press, 2015
	s jies, indication to magnetism and magnetic matchais, one press, 2015

Course L1233: Enhanced Fun	idamentals: Ceramics and Polymers	
Typ Hrs/wk	2	
CP	2	
	Independent Study Time 32, Study Time in Lecture 28	
	Prof. Gerold Schneider, Prof. Robert Meißner	
Language		
Cycle		
	1. Einführung	
content		
	Natürliche "Keramiken" - Steine	
	"Künstliche" Keramik - vom Porzellan bis zur Hochleistungskeramik Anwendungen von Hochleistungskeramik	
	2. Pulverherstellung	
	Finkeitung der Dutuereunklage unfeksen	
	Einteilung der Pulversyntheseverfahren Der Bayer-Prozess zur Al2O3-Herstellung	
	Der Acheson-Prozess zur SiC-Herstellung	
	Chemical Vapour Deposition	
	Pulveraufbereitung	
	Mahltechnik	
	Sprühtrockner	
	3. Formgebung	
	Arten der Formgebung	
	Pressen (0 - 15 % Feuchte)	
	Gießen (> 25 % Feuchte)	
	Plastische Formgebung (15 - 25 % Feuchte)	
	4. Sintern	
	Triebkraft des Sinterns	
	Effekt von gekrümmten Oberflächen und Diffusionswegen	
	Sinterstadien des isothermen Festphasensinterns	
	Herring scaling laws Heißisostatisches Pressen	
	5. Mechanische Eigenschaften von Keramiken	
	Elastisches und plastisches Materialverhalten	
	Bruchzähigkeit - Linear-elastische Bruchmechanik	
	Festigkeit - Festigkeitsstreuung	
	C. Elektrische Einenschaften von Kovensilven	
	6. Elektrische Eigenschaften von Keramiken	
	Ferroelektische Keramiken	
	Piezo-, ferroelektrische Materialeigenschaften	
	Anwendungen	
	Keramische Ionenleiter	
	Keramische Ionenleiter	
	lonische Leitfähigkeit	
	Dotiertes Zirkonoxid in der Brennstoffzelle und Lambdasonde	
Literature	D R H Jones, Michael F. Ashby, Engineering Materials 1, An Introduction to Properties, Applications and Design, Elesevier	
	D.W. Richerson, Modern Ceramic Engineering, Marcel Decker, New York, 1992	
	W.D. Kingery, Introduction to Ceramics, John Wiley & Sons, New York, 1975	
	D.J. Green, An introduction to the mechanical properties of ceramics", Cambridge University Press, 1998	
	D. Munz, T. Fett, Ceramics, Springer, 2001	
	Polymerwerkstoffe	
	Struktur und mechanische Eigenschaften G.W.Ehrenstein;	
	Hanser Verlag; ISBN 3-446-12478-0; ca. 20 €	
	Kunststoffphysik	
	W.Retting, H.M.Laun; Hanser Verlag; ISBN 3446162356; ca. 25 €	
	Werkstoffkunde Kunststoffe	
	G.Menges; Hanser Verlag; ISBN 3-446-15612-7; ca. 25 €	
	Kunststoff-Kompendium	
	A.Frank, K. Biederbick; Vogel Buchverlag; ISBN 3-8023-0135-8; ca.30 €	

Course L1234: Enhanced Fun	ourse L1234: Enhanced Fundamentals: Ceramics and Polymers	
Тур	Recitation Section (large)	
Hrs/wk	1	
CP	1	
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14	
Lecturer	Prof. Gerold Schneider, Prof. Robert Meißner	
Language	DE/EN	
Cycle	SoSe	
Content	See interlocking course	
Literature	See interlocking course	

## 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.

Courses				
Title		Тур	Hrs/wk	СР
Circuit Theory (L0566)		Lecture	3	4
Circuit Theory (L0567)		Recitation Section (small)	2	2
	Prof. Alexander Kölpin			
Admission Requirements	None			
Recommended Previous	Electrical Engineering I and II, Mathematics I and II			
Knowledge				
Educational Objectives	After taking part successfully, students have reached the follow	wing learning results		
Professional Competence				
Knowledge	Students are able to explain the basic methods for calculating	ig electrical circuits. They know	v the Fourier ser	es analysis of linea
	networks driven by periodic signals. They know the methods	s for transient analysis of linea	ir networks in tir	ne and in frequend
	domain, and they are able to explain the frequency behaviour	and the synthesis of passive tw	o-terminal-circui	IS.
Skills	The students are able to calculate currents and voltages in	linear networks by means of	basic methods, a	also when driven b
	periodic signals. They are able to calculate transients in electric	ical circuits in time and frequen	cy domain and a	e able to explain t
	respective transient behaviour. They are able to analyse ar	nd to synthesize the frequency	v behaviour of p	assive two-termina
	circuits.			
Personal Competence				
Social Competence	Students work on exercise tasks in small guided groups. Th	ey are encouraged to present	and discuss the	ir results within th
	group.			
Autonomy	The students are able to find out the required methods for sol	lving the given practice probler	ns. Possibilities a	re given to test the
	knowledge during the lectures continuously by means of	short-time tests. This allows	them to control	independently the
	educational objectives. They can link their gained knowledge t	o other courses like Electrical E	ngineering I and	Mathematics I.
Workload in Hours	Independent Study Time 110, Study Time in Lecture 70			
Credit points	6			
Course achievement				
Examination	Written exam			
Examination duration and	150 min			
scale				
Assignment for the	General Engineering Science (German program, 7 semes	ter): Specialisation Mechanica	I Engineering. I	ocus Mechatronic
Following Curricula			5	
	General Engineering Science (German program, 7 semester): 9	Specialisation Electrical Enginee	ering: Compulsory	,
	Electrical Engineering: Core Qualification: Compulsory			
	Engineering Science: Specialisation Electrical Engineering: Cor	npulsory		
	Computer Science in Engineering: Specialisation II. Mathemati		ive Compulsorv	
	Mechatronics: Core Qualification: Compulsory	5 5		
	Technomathematics: Specialisation III. Engineering Science: El			

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

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	urse 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	
	see interlocking course	

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
Simulation and Design of Mechatro	nic Systems (L1824)	Practical Course	1	2
Module Responsible	NN			
Admission Requirements	None			
<b>Recommended Previous</b>	Fundatmentals of mechanics, control theo	ry and electrical engineering		
Knowledge				
Educational Objectives	After taking part successfully, students ha	ve reached the following learning results		
Professional Competence				
Knowledge	Students are able to describe methods and	d calculations for design, modeling, simulation and	d optimization of n	nechatronic syster
Skills		hms for modeling of mechatronic systems. They c	an identify, simula	ate and design sim
	systems and implement those in laborator	y conditions.		
Personal Competence				
•	Students are able to work goal-oriented in small mixed groups and present results to target groups.			
boelar competence	Stadents are able to work gouronented in smail mixed groups and present results to target groups.			
Autonomy	Students are able to recognize and improv	ve knowledge deficits independently.		
	With instructor assistance, students are able to evaluate their own knowledge level and define a further course of study.			e of study
Workload in Hours				
Credit points	Independent Study Time 124, Study Time in Lecture 56			
Course achievement				
Examination				
Examination duration and				
scale	90 11111			
	Constal Engineering Colones (Corners are	avera 7 conceter). Creciplication Mechanical Fra	incoring Focus N	lachatranica, Elact
-	General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Mechatronics: Electiv			
Following Curricula	Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Aircraft Syste			
		fogram, 7 semester): specialisation Mechanical	Engineering, Fo	cus Aircrait Syste
	Engineering: Elective Compulsory	ification: Compulsory		
	Digital Mechanical Engineering: Core Qual Mechanical Engineering: Specialisation Air			
	Mechanical Engineering: Specialisation Air Mechanical Engineering: Specialisation Me			
	meenamear Engineering, Specialisation Me	charomes, compuisory		

Course L1822: Simulation and Design of Mechatronic Systems	
Тур	Lecture
Hrs/wk	2
СР	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	NN
Language	DE
Cycle	WiSe
Content	Mechatronic Design
	Modeling
	Model Identifikation
	Numerical Methods in simulation
	Applications and examples in Matlab $^{\textcircled{m}}$ and Simulink $^{\textcircled{m}}$
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	NN
Language	DE
Cycle	WiSe
Content	See interlocking course
Literature	See interlocking course

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	NN
Language	DE
Cycle	WiSe
Content	See interlocking course
Literature	See interlocking course

Courcos				
Courses				
F <b>itle</b> Computer Engineering (L0321)		<b>Typ</b> Lecture	Hrs/wk 3	<b>CP</b> 4
Computer Engineering (L0321)		Recitation Section (small)		2
Module Responsible	Prof. Heiko Falk		-	-
-				
Admission Requirements	None			
Recommended Previous	Basic knowledge in electrical engineering	g		
Knowledge				
Educational Objectives	After taking part successfully, students h	nave reached the following learning results		
Professional Competence				
Knowledge	This module deals with the foundations programming down to gates. The module	s of the functionality of computing systems. It c e includes the following topics:	overs the layers fro	m the assembly-le
	Introduction			
	Combinational logic: Gates, Boole	an algebra, Boolean functions, hardware synthes	is, combinational ne	tworks
	<ul> <li>Sequential logic: Flip-flops, autom</li> </ul>			
	Technological foundations			
	-	ition, subtraction, multiplication and division		
		Programming models, MIPS single-cycle architect	ure, pipelining	
	Memories: Memory hierarchies, SF			
		ctive of the CPU, principles of passing data, point-	-to-point connections	s, busses
Skills	The students perceive computer system	s from the architect's perspective, i.e., they iden	tify the internal strue	cture and the physi
		students can analyze, how highly specific and ind		
		ts. They are able to distinguish between and to		
	today's computing systems - from gates			,,,,,,,,,,
	After successful completion of the mod	ule, the students are able to judge the interdep	pendencies between	a physical compu
	system and the software executed on it.	. In particular, they shall understand the consequ	uences that the exec	cution of software
	on the hardware-centric abstraction laye	ers from the assembly language down to gates. $\exists$	This way, they will b	e enabled to evalu
	the impact that these low abstraction lev	vels have on an entire system's performance and	I to propose feasible	options.
B				
Personal Competence				
Social Competence	Students are able to solve similar proble	ms alone or in a group and to present the results	accordingly.	
Autonomy	Students are able to acquire new knowle	edge from specific literature and to associate this	knowledge with oth	er classes.
Workload in Hours	Independent Study Time 124, Study Tim	e in Lecture 56		
Credit points	6			
Course achievement	Compulsory Bonus Form	Description		
course achievement	Yes 10 % Excercises	·		
Examination	Written exam			
	90 minutes, contents of course and labs			
	so minutes, contents of course and labs			
scale				
Assignment for the		rogram, 7 semester): Specialisation Computer Sc		
Following Curricula	5 5	n program, 7 semester): Specialisation Mecha	anical Engineering,	Focus Mechatron
	Compulsory			
		program, 7 semester): Specialisation Mechani	ical Engineering, Fo	cus Aircraft Syste
	Engineering: Compulsory			
	General Engineering Science (German n	rogram, 7 semester): Specialisation Mechanical E	Engineering, Focus T	
		rogram, / semester). specialisation meenamear		heoretical Mechan
	Engineering: Compulsory	rogram, / Semestery. Specialisation mechanical r		heoretical Mechani
	Engineering: Compulsory	n program, 7 semester): Specialisation Mech	nanical Engineering	
	Engineering: Compulsory		nanical Engineering	
	Engineering: Compulsory General Engineering Science (German Engineering Sciences: Compulsory			, Focus Materials
	Engineering: Compulsory General Engineering Science (German Engineering Sciences: Compulsory	n program, 7 semester): Specialisation Mech		, Focus Materials
	Engineering: Compulsory General Engineering Science (Germar Engineering Sciences: Compulsory General Engineering Science (German p and Production: Compulsory	n program, 7 semester): Specialisation Mech	Engineering, Focus	, Focus Materials Product Developm
	Engineering: Compulsory General Engineering Science (Germar Engineering Sciences: Compulsory General Engineering Science (German p and Production: Compulsory	n program, 7 semester): Specialisation Mech program, 7 semester): Specialisation Mechanical	Engineering, Focus	, Focus Materials Product Developm
	Engineering: Compulsory General Engineering Science (Germar Engineering Sciences: Compulsory General Engineering Science (German p and Production: Compulsory General Engineering Science (German Compulsory	n program, 7 semester): Specialisation Mech program, 7 semester): Specialisation Mechanical	Engineering, Focus	, Focus Materials Product Developm cus Energy Syster
	Engineering: Compulsory General Engineering Science (Germar Engineering Sciences: Compulsory General Engineering Science (German p and Production: Compulsory General Engineering Science (German Compulsory	n program, 7 semester): Specialisation Mech program, 7 semester): Specialisation Mechanical program, 7 semester): Specialisation Mechani	Engineering, Focus	, Focus Materials Product Developm cus Energy Syster
	Engineering: Compulsory General Engineering Science (German Engineering Sciences: Compulsory General Engineering Science (German p and Production: Compulsory General Engineering Science (German Compulsory General Engineering Science (German Compulsory	n program, 7 semester): Specialisation Mech program, 7 semester): Specialisation Mechanical program, 7 semester): Specialisation Mechani	Engineering, Focus ical Engineering, Fo anical Engineering,	, Focus Materials Product Developm cus Energy Syster Focus Biomechani
	Engineering: Compulsory General Engineering Science (German Engineering Sciences: Compulsory General Engineering Science (German p and Production: Compulsory General Engineering Science (German Compulsory General Engineering Science (German Compulsory General Engineering Science (German p	n program, 7 semester): Specialisation Mech program, 7 semester): Specialisation Mechanical program, 7 semester): Specialisation Mechani n program, 7 semester): Specialisation Mecha	Engineering, Focus ical Engineering, Fo anical Engineering, gineering: Compulso	, Focus Materials Product Developm cus Energy Syster Focus Biomechani ry
	Engineering: Compulsory General Engineering Science (German Engineering Sciences: Compulsory General Engineering Science (German p and Production: Compulsory General Engineering Science (German Compulsory General Engineering Science (German Compulsory General Engineering Science (German p	n program, 7 semester): Specialisation Mech program, 7 semester): Specialisation Mechanical program, 7 semester): Specialisation Mechani n program, 7 semester): Specialisation Mecha rogram, 7 semester): Specialisation Electrical Eng	Engineering, Focus ical Engineering, Fo anical Engineering, gineering: Compulso	, Focus Materials Product Developm cus Energy Syster Focus Biomechan ry
	Engineering: Compulsory General Engineering Science (German Engineering Sciences: Compulsory General Engineering Science (German p and Production: Compulsory General Engineering Science (German Compulsory General Engineering Science (German Compulsory General Engineering Science (German p General Engineering Science (German p General Engineering Science (German p General Engineering Science (German p Compulsory	n program, 7 semester): Specialisation Mech program, 7 semester): Specialisation Mechanical program, 7 semester): Specialisation Mechani n program, 7 semester): Specialisation Mechan rogram, 7 semester): Specialisation Electrical Eng rogram, 7 semester): Specialisation Green Techn	Engineering, Focus ical Engineering, Fo anical Engineering, gineering: Compulso	, Focus Materials Product Developm cus Energy Syster Focus Biomechan ry
	Engineering: Compulsory General Engineering Science (German Engineering Sciences: Compulsory General Engineering Science (German p and Production: Compulsory General Engineering Science (German Compulsory General Engineering Science (German Compulsory General Engineering Science (German p General Engineering Science (German p General Engineering Science (German p Compulsory Compulsory Computer Science: Core Qualification: Co	n program, 7 semester): Specialisation Mech program, 7 semester): Specialisation Mechanical program, 7 semester): Specialisation Mechani n program, 7 semester): Specialisation Mechan rogram, 7 semester): Specialisation Electrical Eng rogram, 7 semester): Specialisation Green Techno ompulsory	Engineering, Focus ical Engineering, Fo anical Engineering, gineering: Compulso	, Focus Materials Product Developm cus Energy Syster Focus Biomechan ry
	Engineering: Compulsory General Engineering Science (German Engineering Sciences: Compulsory General Engineering Science (German p and Production: Compulsory General Engineering Science (German Compulsory General Engineering Science (German Compulsory General Engineering Science (German p General Engineering Science (German p General Engineering Science (German p Compulsory Computer Science: Core Qualification: Co Data Science: Core Qualification: Elective	n program, 7 semester): Specialisation Mech program, 7 semester): Specialisation Mechanical program, 7 semester): Specialisation Mechani n program, 7 semester): Specialisation Mechan rogram, 7 semester): Specialisation Electrical Eng rogram, 7 semester): Specialisation Green Techno ompulsory e Compulsory	Engineering, Focus ical Engineering, Fo anical Engineering, gineering: Compulso	, Focus Materials Product Developm cus Energy Syster Focus Biomechan ry
	Engineering: Compulsory General Engineering Science (German Engineering Sciences: Compulsory General Engineering Science (German p and Production: Compulsory General Engineering Science (German Compulsory General Engineering Science (German Compulsory General Engineering Science (German p General Engineering Science (German p General Engineering Science (German p Compulsory Computer Science: Core Qualification: Co Data Science: Core Qualification: Elective Data Science: Specialisation I. Mathemat	n program, 7 semester): Specialisation Mech program, 7 semester): Specialisation Mechanical program, 7 semester): Specialisation Mechani n program, 7 semester): Specialisation Mechan rogram, 7 semester): Specialisation Electrical Eng rogram, 7 semester): Specialisation Green Techn ompulsory e Compulsory tics/Computer Science: Elective Compulsory	Engineering, Focus ical Engineering, Fo anical Engineering, gineering: Compulso	, Focus Materials Product Developm cus Energy Syster Focus Biomechan ry
	Engineering: Compulsory General Engineering Science (German Engineering Sciences: Compulsory General Engineering Science (German p and Production: Compulsory General Engineering Science (German Compulsory General Engineering Science (German Compulsory General Engineering Science (German p General Engineering Science (German p General Engineering Science (German p Compulsory Computer Science: Core Qualification: Co Data Science: Core Qualification: Elective Data Science: Specialisation I. Mathemat Electrical Engineering: Core Qualification	n program, 7 semester): Specialisation Mech program, 7 semester): Specialisation Mechanical program, 7 semester): Specialisation Mechani n program, 7 semester): Specialisation Mechan rogram, 7 semester): Specialisation Electrical Eng rogram, 7 semester): Specialisation Green Techn ompulsory e Compulsory tics/Computer Science: Elective Compulsory n: Compulsory	Engineering, Focus ical Engineering, Fo anical Engineering, gineering: Compulso	, Focus Materials Product Developm cus Energy Syster Focus Biomechan ry
	Engineering: Compulsory General Engineering Science (German Engineering Sciences: Compulsory General Engineering Science (German p and Production: Compulsory General Engineering Science (German Compulsory General Engineering Science (German Compulsory General Engineering Science (German p General Engineering Science (German p General Engineering Science (German p Compulsory Computer Science: Core Qualification: Co Data Science: Core Qualification: Elective Data Science: Specialisation I. Mathemat	n program, 7 semester): Specialisation Mech program, 7 semester): Specialisation Mechanical program, 7 semester): Specialisation Mechani n program, 7 semester): Specialisation Mechan rogram, 7 semester): Specialisation Electrical Eng rogram, 7 semester): Specialisation Green Techn ompulsory e Compulsory tics/Computer Science: Elective Compulsory n: Compulsory Qualification: Compulsory	Engineering, Focus ical Engineering, Fo anical Engineering, gineering: Compulso	, Focus Materials Product Developm cus Energy Syster Focus Biomechan ry

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

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	Typ Hrs/wk CP	
Numerical Mathematics I (L0417)		
Numerical Mathematics I (L0418)	Recitation Section (small) 2 3	
Module Responsible	e Prof. Sabine Le Borne	
Admission Requirements	s None	
<b>Recommended Previous</b>		
Knowledge	<ul> <li>Mathematik I + II for Engineering Students (german or english) or Analysis &amp; Linear Algebra I + II for Technomather</li> <li>basic MATLAB/Python knowledge</li> </ul>	matici
Educational Objectives	s After taking part successfully, students have reached the following learning results	
Professional Competence	e	
Knowledge	e Students are able to	
	<ul> <li>name numerical methods for interpolation, integration, least squares problems, eigenvalue problems, nonlinear roc problems and to explain their core ideas,</li> <li>repeat convergence statements for the numerical methods,</li> <li>explain aspects for the practical execution of numerical methods with respect to computational and storage completed and storage compl</li></ul>	
Skills	/s Students are able to	
	<ul> <li>implement, apply and compare numerical methods using MATLAB/Python,</li> <li>justify the convergence behaviour of numerical methods with respect to the problem and solution algorithm,</li> <li>select and execute a suitable solution approach for a given problem.</li> </ul>	
Personal Competence	e	
Social Competence	e Students are able to	
	<ul> <li>work together in heterogeneously composed teams (i.e., teams from different study programs and background kno explain theoretical foundations and support each other with practical aspects regarding the implementation of algor</li> </ul>	
Autonomy	y Students are capable	
	<ul> <li>to assess whether the supporting theoretical and practical excercises are better solved individually or in a team,</li> <li>to assess their individual progess and, if necessary, to ask questions and seek help.</li> </ul>	
Workload in Hours	s Independent Study Time 124, Study Time in Lecture 56	
Credit points	<b>·s</b> 6	
Course achievement	tt None	
Examination	n Written exam	
Examination duration and	d 90 minutes	
Examination duration and scale	e	
Examination duration and scale Assignment for the	General Engineering Science (German program, 7 semester): Specialisation Computer Science: Compulsory	
Examination duration and scale Assignment for the	<ul> <li>General Engineering Science (German program, 7 semester): Specialisation Computer Science: Compulsory</li> <li>General Engineering Science (German program, 7 semester): Specialisation Biomedical Engineering: Compulsory</li> </ul>	echani
Examination duration and scale Assignment for the	<ul> <li>General Engineering Science (German program, 7 semester): Specialisation Computer Science: Compulsory</li> <li>General Engineering Science (German program, 7 semester): Specialisation Biomedical Engineering: Compulsory</li> <li>General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Biometering</li> </ul>	echani
Examination duration and scale Assignment for the	<ul> <li>General Engineering Science (German program, 7 semester): Specialisation Computer Science: Compulsory</li> <li>General Engineering Science (German program, 7 semester): Specialisation Biomedical Engineering: Compulsory</li> <li>General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Biometer</li> </ul>	
Examination duration and scale Assignment for the	<ul> <li>General Engineering Science (German program, 7 semester): Specialisation Computer Science: Compulsory</li> <li>General Engineering Science (German program, 7 semester): Specialisation Biomedical Engineering: Compulsory</li> <li>General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Biometering</li> </ul>	
Examination duration and scale Assignment for the	<ul> <li>General Engineering Science (German program, 7 semester): Specialisation Computer Science: Compulsory</li> <li>General Engineering Science (German program, 7 semester): Specialisation Biomedical Engineering: Compulsory</li> <li>General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Biometory</li> <li>General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Biometory</li> <li>General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Biometory</li> </ul>	echan
Examination duration and scale Assignment for the	<ul> <li>General Engineering Science (German program, 7 semester): Specialisation Computer Science: Compulsory</li> <li>General Engineering Science (German program, 7 semester): Specialisation Biomedical Engineering: Compulsory</li> <li>General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Biomet</li> <li>Compulsory</li> <li>General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Biomet</li> <li>Compulsory</li> <li>General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Theoretical Meteory</li> <li>General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Theoretical Meteory</li> </ul>	echani
Examination duration and scale Assignment for the	<ul> <li>General Engineering Science (German program, 7 semester): Specialisation Computer Science: Compulsory</li> <li>General Engineering Science (German program, 7 semester): Specialisation Biomedical Engineering: Compulsory</li> <li>General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Biometone</li> <li>Compulsory</li> <li>General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Biometone</li> <li>Compulsory</li> <li>General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Theoretical Metone</li> <li>Engineering: Compulsory</li> <li>General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Aircraft</li> </ul>	echan Syste
Examination duration and scale Assignment for the	<ul> <li>General Engineering Science (German program, 7 semester): Specialisation Computer Science: Compulsory</li> <li>General Engineering Science (German program, 7 semester): Specialisation Biomedical Engineering: Compulsory</li> <li>General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Biomet</li> <li>Compulsory</li> <li>General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Biomet</li> <li>Compulsory</li> <li>General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Theoretical Meters</li> <li>Engineering: Compulsory</li> <li>General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Aircraft</li> <li>Engineering: Elective Compulsory</li> </ul>	echan Syste
Examination duration and scale Assignment for the	<ul> <li>General Engineering Science (German program, 7 semester): Specialisation Computer Science: Compulsory</li> <li>General Engineering Science (German program, 7 semester): Specialisation Biomedical Engineering: Compulsory</li> <li>General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Biomet</li> <li>Compulsory</li> <li>General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Biomet</li> <li>Compulsory</li> <li>General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Theoretical Meters</li> <li>Engineering: Compulsory</li> <li>General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Aircraft</li> <li>Engineering: Elective Compulsory</li> <li>General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Aircraft</li> <li>Engineering: Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Aircraft</li> </ul>	echan Syste : Elect
Examination duration and scale Assignment for the	<ul> <li>General Engineering Science (German program, 7 semester): Specialisation Computer Science: Compulsory</li> <li>General Engineering Science (German program, 7 semester): Specialisation Biomedical Engineering: Compulsory</li> <li>General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Biomet</li> <li>Compulsory</li> <li>General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Biomet</li> <li>Compulsory</li> <li>General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Theoretical Meters</li> <li>Engineering: Compulsory</li> <li>General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Aircraft</li> <li>Engineering: Elective Compulsory</li> <li>General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Aircraft</li> <li>Engineering: Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Aircraft</li> <li>Engineering: Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Mechatronics: Compulsory</li> </ul>	echan Syste : Elect
Examination duration and scale Assignment for the	<ul> <li>General Engineering Science (German program, 7 semester): Specialisation Computer Science: Compulsory</li> <li>General Engineering Science (German program, 7 semester): Specialisation Biomedical Engineering: Compulsory</li> <li>General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Biome</li> <li>Compulsory</li> <li>General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Biome</li> <li>Compulsory</li> <li>General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Theoretical Me</li> <li>Engineering: Compulsory</li> <li>General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Aircraft</li> <li>Engineering: Elective Compulsory</li> <li>General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Mechatronics:</li> <li>Compulsory</li> <li>General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Mechatronics:</li> <li>Compulsory</li> <li>General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Mechatronics:</li> <li>Compulsory</li> <li>General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Mechatronics:</li> <li>Compulsory</li> <li>General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Mechatronics:</li> </ul>	echan Syste : Elect
Examination duration and scale Assignment for the	<ul> <li>General Engineering Science (German program, 7 semester): Specialisation Computer Science: Compulsory</li> <li>General Engineering Science (German program, 7 semester): Specialisation Biomedical Engineering: Compulsory</li> <li>General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Biome</li> <li>Compulsory</li> <li>General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Biome</li> <li>Compulsory</li> <li>General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Theoretical Me</li> <li>Engineering: Compulsory</li> <li>General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Aircraft</li> <li>Engineering: Elective Compulsory</li> <li>General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Aircraft</li> <li>Engineering: Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Mechatronics:</li> <li>Compulsory</li> <li>General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Mechatronics:</li> <li>Compulsory</li> <li>General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Mechatronics:</li> <li>Compulsory</li> <li>General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Mechatronics:</li> <li>Compulsory</li> <li>General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Mechatronics:</li> <li>Compulsory</li> <li>General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Energy S</li> <li>Elective Compulsory</li> </ul>	echan Syste : Elect Syster
Examination duration and scale Assignment for the	<ul> <li>General Engineering Science (German program, 7 semester): Specialisation Computer Science: Compulsory</li> <li>General Engineering Science (German program, 7 semester): Specialisation Biomedical Engineering: Compulsory</li> <li>General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Biome</li> <li>Compulsory</li> <li>General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Biome</li> <li>Compulsory</li> <li>General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Theoretical Me</li> <li>Engineering: Compulsory</li> <li>General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Aircraft</li> <li>Engineering: Elective Compulsory</li> <li>General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Mechatronics:</li> <li>Compulsory</li> <li>General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Mechatronics:</li> <li>Compulsory</li> <li>General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Energy S</li> <li>Elective Compulsory</li> <li>General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Energy S</li> <li>Elective Compulsory</li> <li>General Engineering Science (German program, 7 semester): Specialisation Advanced Materials: Compulsory</li> <li>General Engineering Science (German program, 7 semester): Specialisation Advanced Materials: Compulsory</li> <li>General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Material Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Material Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Foc</li></ul>	echan Syste : Elect Syster
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Examination duration and scale Assignment for the	<ul> <li>General Engineering Science (German program, 7 semester): Specialisation Computer Science: Compulsory</li> <li>General Engineering Science (German program, 7 semester): Specialisation Biomedical Engineering: Compulsory</li> <li>General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Biome</li> <li>Compulsory</li> <li>General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Theoretical Me</li> <li>Engineering: Compulsory</li> <li>General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Aircraft</li> <li>Engineering: Compulsory</li> <li>General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Aircraft</li> <li>Engineering: Elective Compulsory</li> <li>General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Mechatronics:</li> <li>Compulsory</li> <li>General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Mechatronics:</li> <li>Compulsory</li> <li>General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Energy S</li> <li>Elective Compulsory</li> <li>General Engineering Science (German program, 7 semester): Specialisation Advanced Materials: Compulsory</li> <li>General Engineering Science (German program, 7 semester): Specialisation Advanced Materials: Compulsory</li> <li>General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Material Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Material Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Material Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Material Engineering Science (Germa</li></ul>	echani Syste : Elect Syster
Examination duration and scale Assignment for the	<ul> <li>General Engineering Science (German program, 7 semester): Specialisation Computer Science: Compulsory</li> <li>General Engineering Science (German program, 7 semester): Specialisation Biomedical Engineering: Compulsory</li> <li>General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Biome</li> <li>Compulsory</li> <li>General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Theoretical Me</li> <li>Engineering: Compulsory</li> <li>General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Aircraft</li> <li>Engineering: Compulsory</li> <li>General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Aircraft</li> <li>Engineering: Elective Compulsory</li> <li>General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Mechatronics:</li> <li>Compulsory</li> <li>General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Mechatronics:</li> <li>Compulsory</li> <li>General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Energy S</li> <li>Elective Compulsory</li> <li>General Engineering Science (German program, 7 semester): Specialisation Advanced Materials: Compulsory</li> <li>General Engineering Science (German program, 7 semester): Specialisation Advanced Materials: Compulsory</li> <li>General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Material Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Material Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Material Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Material Engineering Science: Compu</li></ul>	echani Syste : Elect Syster
Examination duration and scale Assignment for the	<ul> <li>General Engineering Science (German program, 7 semester): Specialisation Computer Science: Compulsory</li> <li>General Engineering Science (German program, 7 semester): Specialisation Biomedical Engineering: Compulsory</li> <li>General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Biome</li> <li>Compulsory</li> <li>General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Theoretical Me</li> <li>Engineering: Compulsory</li> <li>General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Aircraft</li> <li>Engineering: Compulsory</li> <li>General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Aircraft</li> <li>Engineering: Elective Compulsory</li> <li>General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Mechatronics:</li> <li>Compulsory</li> <li>General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Mechatronics:</li> <li>Compulsory</li> <li>General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Energy S</li> <li>Elective Compulsory</li> <li>General Engineering Science (German program, 7 semester): Specialisation Advanced Materials: Compulsory</li> <li>General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Materials: Compulsory</li> <li>General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Materials: Compulsory</li> <li>General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Materials: Compulsory</li> <li>General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Materials: Compulsory</li> <li>Bioprocess Engi</li></ul>	echan Syste : Elect Syster
Examination duration and scale Assignment for the	<ul> <li>e</li> <li>General Engineering Science (German program, 7 semester): Specialisation Computer Science: Compulsory</li> <li>General Engineering Science (German program, 7 semester): Specialisation Biomedical Engineering; Compulsory</li> <li>General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Biome</li> <li>Compulsory</li> <li>General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Theoretical Metering: Compulsory</li> <li>General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Aircraft</li> <li>Engineering: Compulsory</li> <li>General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Aircraft</li> <li>Engineering: Elective Compulsory</li> <li>General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Mechatronics:</li> <li>Compulsory</li> <li>General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Mechatronics:</li> <li>Compulsory</li> <li>General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Energy S</li> <li>Elective Compulsory</li> <li>General Engineering Science (German program, 7 semester): Specialisation Advanced Materials: Compulsory</li> <li>General Engineering Science (German program, 7 semester): Specialisation Advanced Materials: Compulsory</li> <li>General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Materials:</li> <li>Compulsory</li> <li>General Engineering Science (German program, 7 semester): Specialisation Advanced Materials: Compulsory</li> <li>General Engineering Science: Compulsory</li> <li>Bioprocess Engineering: Specialisation A - General Bioprocess Engineering: Elective Compulsory</li> <li>Computer Science: Special</li></ul>	echan Syste : Elect Syster
Examination duration and scale Assignment for the	<ul> <li>e General Engineering Science (German program, 7 semester): Specialisation Computer Science: Compulsory</li> <li>General Engineering Science (German program, 7 semester): Specialisation Biomedical Engineering: Compulsory</li> <li>General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Biomet Compulsory</li> <li>General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Theoretical Metengineering: Compulsory</li> <li>General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Aircraft Engineering: Compulsory</li> <li>General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Aircraft Engineering: Elective Compulsory</li> <li>General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Mechatronics: Compulsory</li> <li>General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Mechatronics: Compulsory</li> <li>General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Energy Selective Compulsory</li> <li>General Engineering Science (German program, 7 semester): Specialisation Advanced Materials: Compulsory</li> <li>General Engineering Science (German program, 7 semester): Specialisation Advanced Materials: Compulsory</li> <li>General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Materials: Compulsory</li> <li>General Engineering Science (German program, 7 semester): Specialisation Advanced Materials: Compulsory</li> <li>General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Materials: Compulsory</li> <li>General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Materialse Engineering Science: Secialisati</li></ul>	echan Syste : Elect Syster
Examination duration and scale Assignment for the	<ul> <li>General Engineering Science (German program, 7 semester): Specialisation Computer Science: Compulsory</li> <li>General Engineering Science (German program, 7 semester): Specialisation Biomedical Engineering: Compulsory</li> <li>General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Biome Compulsory</li> <li>General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Theoretical Mechanica: Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Aircraft Engineering: Compulsory</li> <li>General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Aircraft Engineering Elective Compulsory</li> <li>General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Mechatronics: Compulsory</li> <li>General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Mechatronics: Compulsory</li> <li>General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Energy Selective Compulsory</li> <li>General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Mechatronics: Compulsory</li> <li>General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Mate Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Mate Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Mate Engineering Science: Compulsory</li> <li>General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Mate Engineering Science: Compulsory</li> <li>General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Mate Engineering Science: Compulsory</li> <li>General Engine</li></ul>	echan Syste : Elect Syste
Examination duration and scale Assignment for the	<ul> <li>General Engineering Science (German program, 7 semester): Specialisation Computer Science: Compulsory</li> <li>General Engineering Science (German program, 7 semester): Specialisation Biomedical Engineering: Compulsory</li> <li>General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Biome</li> <li>Compulsory</li> <li>General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Theoretical Me</li> <li>Engineering: Compulsory</li> <li>General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Aircraft</li> <li>Engineering: Elective Compulsory</li> <li>General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Aircraft</li> <li>Engineering: Elective Compulsory</li> <li>General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Mechatronics:</li> <li>Compulsory</li> <li>General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Energy S</li> <li>Elective Compulsory</li> <li>General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Energy S</li> <li>Elective Compulsory</li> <li>General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Matterials: Compulsory</li> <li>General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Matterials: Compulsory</li> <li>General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Matterials: Compulsory</li> <li>General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Matterials: Compulsory</li> <li>General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Matterials:</li></ul>	echan Syste : Elect Syste
Examination duration and scale Assignment for the	<ul> <li>General Engineering Science (German program, 7 semester): Specialisation Computer Science: Compulsory</li> <li>General Engineering Science (German program, 7 semester): Specialisation Biomedical Engineering: Compulsory</li> <li>General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Biome Compulsory</li> <li>General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Theoretical Mechanica: Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Aircraft Engineering: Compulsory</li> <li>General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Aircraft Engineering Elective Compulsory</li> <li>General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Mechatronics: Compulsory</li> <li>General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Mechatronics: Compulsory</li> <li>General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Energy Selective Compulsory</li> <li>General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Mechatronics: Compulsory</li> <li>General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Mate Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Mate Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Mate Engineering Science: Compulsory</li> <li>General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Mate Engineering Science: Compulsory</li> <li>General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Mate Engineering Science: Compulsory</li> <li>General Engine</li></ul>	echan Syste : Elect Syste

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	<ol> <li>Finite precision arithmetic, error analysis, conditioning and stability</li> <li>Linear systems of equations: LU and Cholesky factorization, condition</li> <li>Interpolation: polynomial, spline and trigonometric interpolation</li> <li>Nonlinear equations: fixed point iteration, root finding algorithms, Newton's method</li> <li>Linear and nonlinear least squares problems: normal equations, Gram Schmidt and Householder orthogonalization, singular value decomposition, regularizatio, Gauss-Newton and Levenberg-Marquardt methods</li> <li>Eigenvalue problems: power iteration, inverse iteration, QR algorithm</li> <li>Numerical differentiation</li> <li>Numerical integration: Newton-Cotes rules, error estimates, Gauss quadrature, adaptive quadrature</li> </ol>
Literature	<ul> <li>Gander/Gander/Kwok: Scientific Computing: An introduction using Maple and MATLAB, Springer (2014)</li> <li>Stoer/Bulirsch: Numerische Mathematik 1, Springer</li> <li>Dahmen, Reusken: Numerik f ür Ingenieure und Naturwissenschaftler, Springer</li> </ul>

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
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			
<b>Recommended Previous</b>	Basics of mathematics, in particular comp	lexe numbers, integrals, differentials		
Knowledge	Basics of electrical engineering and mech	anical engineering		
Educational Objectives	After taking part successfully, students ha	ve reached the following learning results		
Professional Competence				
Knowledge	Students can to draw and explain the basi	ic principles of electric and magnetic fields.		
	They can describe the function of the	standard types of electric machines and pre-	esent the correspor	nding equations a
	characteristic curves. For typically used d	rives they can explain the major parameters of th	ne energy efficiency	of the whole syst
	from the power grid to the driven engine.			
Skille	Students are able to calculate two dimor	nsional electric and magnetic fields in particular	forromognotic circ	uite with air gap
SKIIIS	this they apply the usual methods of the c		Terromagnetic circi	uits with air gap.
	this they apply the usual methods of the e	lesign dur cleethe machines.		
	They can calulate the operational perform	mance of electric machines from their given cha	aracteristic data an	d selected quantit
	and characteristic curves. They apply the	usual equivalent circuits and graphical methods.		
Personal Competence				
Social Competence				
Autonomy		ate electric and magnatic fields for applications.		
		nachines from the charactersitic data and they	an calculate thered	of selected quantit
	and characteristic curves.			
Workload in Hours	Independent Study Time 110, Study Time	in Lecture 70		
Credit points	6			
Course achievement	None			
Examination	Subject theoretical and practical work			
Examination duration and	Design of four machines and actuators, re	view of design files		
scale				
Assignment for the	General Engineering Science (German pro	gram, 7 semester): Specialisation Electrical Engi	neering: Elective Co	mpulsory
Following Curricula	General Engineering Science (German p	program, 7 semester): Specialisation Mechanica	al Engineering, Foo	us Energy System
	Compulsory			
		program, 7 semester): Specialisation Mechan	ical Engineering,	Focus Mechatron
	Compulsory			
		ogram, 7 semester): Specialisation Mechanical Er	igineering, Focus Tr	neoretical Mechan
	Engineering: Elective Compulsory Digital Mechanical Engineering: Core Qual	Section Commutation		
	Electrical Engineering: Core Qualification:	1 2		
	Engineering Science: Specialisation Electric			
		ate: Specialisation Energy Technology: Elective Co	ompulsory	
	Logistics and Mobility: Specialisation Engin		sinpaisory	
		ic Planning and Systems: Elective Compulsory		
		uction Management and Processes: Elective Com	pulsory	
	Mechanical Engineering: Core Qualification	-		
	Mechatronics: Core Qualification: Compute	sory		
	Technomathematics: Specialisation III. Eng	gineering Science: Elective Compulsory		
	Engineering and Management - Major in L	ogistics and Mobility: Specialisation Traffic Planni	ng and Systems: El	ective Compulsory
	For stars of a star of Management of Martin to			
	Engineering and Management - Major In	Logistics and Mobility: Specialisation Productio	n Management and	d 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
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
Semiconductor Circuit Design (L076	53)	Lecture	3	4
Semiconductor Circuit Design (L086	54)	Recitation Section (small)	1	2
Module Responsible	Prof. Matthias Kuhl			
Admission Requirements	None			
<b>Recommended Previous</b>	Fundamentals of electrical engineering			
Knowledge	Basics of physics, especially semiconducto	r physics		
		, ,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,		
	After taking part successfully, students have	ve reached the following learning results		
Professional Competence				
Knowledge	<ul> <li>Students are able to explain the fun</li> </ul>	ctionality of different MOS devices in electronic circ	cuits.	
		alog circuits functions and where they are applied.		
	Students are able to explain the fun	ctionality of fundamental operational amplifiers an	d their specificati	ons.
	<ul> <li>Students know the fundamental digit</li> </ul>	tal logic circuits and can discuss their advantages	and disadvantage	es.
	<ul> <li>Students have knowledge about me</li> </ul>	mory circuits and can explain their functionality ar	nd specifications.	
	<ul> <li>Students know the appropriate field</li> </ul>	s for the use of bipolar transistors.		
Skills	<ul> <li>Students can calculate the specifical</li> </ul>	tions of different MOS devices and can define the	parameters of elec	ctronic circuits.
		nt logic circuits and can design different types of lo		
		rational amplifiers and bipolar transistors for specif		
Personal Competence				
Social Competence	<ul> <li>Students are able work efficiently in</li> </ul>	hotorogonoous tooms		
	<ul> <li>Students working together in small groups can solve problems and answer professional questions.</li> </ul>			
			questionsi	
Autonomy				
	<ul> <li>Students are able to assess their lev</li> </ul>	el of knowledge.		
Workload in Hours	Independent Study Time 124, Study Time i	in Lecture 56		
Credit points				
Course achievement				
Examination	Written exam			
Examination duration and	120 min			
scale				
Assignment for the	General Engineering Science (German prog	gram, 7 semester): Specialisation Electrical Engine	ering: Compulsory	/
Following Curricula	General Engineering Science (German	program, 7 semester): Specialisation Mechanica	al Engineering, F	ocus Mechatror
	Compulsory			
	Data Science: Core Qualification: Elective (	1 2		
	Electrical Engineering: Core Qualification: C			
	Engineering Science: Specialisation Electric			
	Engineering Science: Specialisation Mechai General Engineering Science (English prog		ring: Compulsor:	
		ram, 7 semester): Specialisation Electrical Enginee		
		ram, 7 semester): Specialisation Mechatronics: Constitution II. Mathematics & Engineering Science: Election		
	Mechanical Engineering: Specialisation Me		ave compulsory	
	Mechatronics: Core Qualification: Compulse			
	Technomathematics: Specialisation III. Eng	•		

L0763: Semiconducto	
	Lecture
Hrs/wk	
СР	4
Workload in Hours	Independent Study Time 78, Study Time in Lecture 42
Lecturer	Prof. Matthias Kuhl
Language	DE
Cycle	SoSe
Content	<ul> <li>Repetition Semiconductorphysics and Diodes</li> <li>Functionality and characteristic curve of bipolar transistors</li> <li>Basic circuits with bipolar transistors</li> <li>Functionality and characteristic curve of MOS transistors</li> <li>Basic circuits with MOS transistors for amplifiers</li> <li>Operational amplifiers and their applications</li> <li>Typical applications for analog and digital circuits</li> <li>Realization of logical functions</li> <li>Basic circuits with MOS transistors for combinational logic</li> <li>Memory circuits</li> <li>Basic circuits with MOS transistors for sequential logic</li> <li>Basic concepts of analog-to-digital and digital-to-analog-converters</li> </ul>
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/jboo

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	<ul> <li>Basic circuits and characteristic curves of bipolar transistors</li> <li>Basic circuits and characteristic curves of MOS transistors for amplifiers</li> <li>Realization and dimensioning of operational amplifiers</li> <li>Realization of logic functions</li> <li>Basic circuits with MOS transistors for combinational and sequential logic</li> <li>Memory circuits</li> <li>Circuits for analog-to-digital and digital-to-analog converters</li> <li>Design of exemplary circuits</li> </ul>
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 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. Anusch Taraz			
	None			
Recommended Previous Knowledge	Mathematics I - III			
-	After taking part successfully, students have reas	had the following learning results		
	After taking part successfully, students have reac	ned the following learning results		
Professional Competence				
Knowledge	. Chudente con nome the basic concents in N	Asthematics IV They are able to evaluin the		ata avamalaa
	• Students can name the basic concepts in M			
	<ul> <li>Students can discuss logical connections b</li> </ul>	between these concepts. They are capable	e of illustrating th	ese connections wi
	the help of examples.			
	<ul> <li>They know proof strategies and can reprod</li> </ul>	luce them.		
CL:U-				
Skills	<ul> <li>Students can model problems in Mathema</li> </ul>	atics IV with the help of the concepts stud	ied in this course	. Moreover, they a
	capable of solving them by applying establ			,, .
			who obvious in the	
	Students are able to discover and verify fur			
	<ul> <li>For a given problem, the students can de</li> </ul>	evelop and execute a suitable approach,	and are able to c	ritically evaluate the
	results.			
Personal Competence				
Social Competence	<ul> <li>Students are able to work together in team</li> </ul>	as. They are capable to use mathematics as	a common langu	age
	-			
	<ul> <li>In doing so, they can communicate new co</li> </ul>		peracing partners	. Moreover, they ca
	design examples to check and deepen the	understanding of their peers.		
Autonomy				
	<ul> <li>Students are capable of checking their und</li> </ul>	derstanding of complex concepts on their	own. They can sp	ecify open questio
	precisely and know where to get help in so	lving them.		
	<ul> <li>Students have developed sufficient persis</li> </ul>	tence to be able to work for longer perio	ds in a goal-orien	ted manner on ha
	problems.			
	problems.			
	Independent Study Time 68, Study Time in Lectur	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
5	General Engineering Science (German program		5 1	·
. Showing curricula		., . semester, specialisation methanic	a. Engineering,	. seus meenderonne
	Compulsory		_ ·	
	General Engineering Science (German program, 7			
	General Engineering Science (German program, 7	7 semester): Specialisation Mechanical Eng	neering, Focus Th	neoretical Mechanic
	Engineering: Elective Compulsory			
	Electrical Engineering: Core Qualification: Comput	lsorv		
		•	ring, Commission	
	General Engineering Science (English program, 7			, ,
	Computer Science in Engineering: Specialisation I	I. Mathematics & Engineering Science: Elec	tive Compulsory	
	Mechanical Engineering: Specialisation Mechatron	nics: Compulsory		
	Mechanical Engineering: Specialisation Theoretica	al Mechanical Engineering: Elective Comput	sory	
			,	
	Mechatronics: Core Qualification: Compulsory			
	Mechatronics: Core Qualification: Compulsory			
	Mechatronics: Core Qualification: Compulsory Naval Architecture: Core Qualification: Compulsor Theoretical Mechanical Engineering: Technical Co			

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	<ul> <li>Examples of partial differential equations</li> <li>First order quasilinear differential equations</li> <li>Normal forms of second order differential equations</li> <li>Harmonic functions and maximum principle</li> <li>Maximum principle for the heat equation</li> <li>Wave equation</li> <li>Liouville's formula</li> <li>Special functions</li> <li>Difference methods</li> <li>Finite elements</li> <li>http://www.math.uni-hamburg.de/teaching/export/tuhh/index.html</li> </ul>

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	
Literature	<ul> <li>Functions of one complex variable</li> <li>Complex differentiation</li> <li>Conformal mappings</li> <li>Complex integration</li> <li>Cauchy's integral theorem</li> <li>Cauchy's integral formula</li> <li>Taylor and Laurent series expansion</li> <li>Singularities and residuals</li> <li>Integral transformations: Fourier and Laplace transformation</li> </ul>	
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

## **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	
<b>Title</b> 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	<ul> <li>Mechanical Engineering: Design</li> <li>Advanced Mechanical Engineering Design</li> </ul>
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,
	<ul> <li>explain guidelines for designing for function and manufacturing,</li> </ul>
	<ul> <li>explain advanced use-oriented knowledge of machine elements.</li> </ul>
Skills	After passing the module, students are able to:
	<ul> <li>analyze complex tasks and develop principle solutions using sketches,</li> </ul>
	<ul> <li>convert principle solutions into a detailed design,</li> </ul>
	<ul> <li>use methods to design and solve engineering design tasks systematically and solution-oriented,</li> </ul>
	<ul> <li>create a technical documentation including all necessary technical drawings to understand the functions of the system,</li> </ul>
	document calculations of selected machine elements clearly and in detail.
Personal Competence	
Social Competence	After passing the module, students are able to:
	<ul> <li>present and discuss solutions and technical drawings within groups,</li> </ul>
	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
Examination	Written exam
Examination duration and	180
scale	
Assignment for the	General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Aircraft System
Following Curricula	Engineering: Compulsory
	General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Product Development
	and Production: Compulsory
	Mechanical Engineering: Core Qualification: Compulsory

Course L0266: Advanced Med	hanical 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
	<ul> <li>Methodische Erarbeitung von prinzipiellen Lösungskonzepten</li> </ul>
	• Erstellen einer Dokumentation
Literature	<ul> <li>Dubbel, Taschenbuch für den Maschinenbau; Grote, KH., Feldhusen, J.(Hrsg.); Springer-Verlag, aktuelle Auflage.</li> <li>Maschinenelemente, Band I-III; Niemann, G., Springer-Verlag, aktuelle Auflage.</li> <li>Maschinen- und Konstruktionselemente; Steinhilper, W., Röper, R., Springer Verlag, aktuelle Auflage.</li> <li>Einführung in die DIN-Normen; Klein, M., Teubner-Verlag.</li> <li>Konstruktionslehre, Pahl, G.; Beitz, W., Springer-Verlag, aktuelle Auflage.</li> <li>Maschinenelemente 1-2; Schlecht, B., Pearson Verlag, aktuelle Auflage.</li> <li>Maschinenelemente - Gestaltung, Berechnung, Anwendung; Haberhauer, H., Bodenstein, F., Springer-Verlag, aktuelle Auflage.</li> <li>Roloff/Matek Maschinenelemente; Wittel, H., Muhs, D., Jannasch, D., Voßiek, J., Springer Vieweg, aktuelle Auflage.</li> <li>Sowie weitere Bücher zu speziellen Themen</li> </ul>

Courses				
Title		Тур	Hrs/wk	СР
Fundamentals of Machine Tools (LC		Lecture	2	2
Fundamentals of Machine Tools (L1992) Forming and Cutting Technology (L0613)		Recitation Section (larg Lecture	e) 1 2	2
Forming and Cutting Technology (L		Recitation Section (larg		1
Module Responsible	Prof. Wolfgang Hintze			
Admission Requirements	None			
Recommended Previous	without major course assessment			
Knowledge				
	internship recommended			
	Previous knowledge in mathematics, mechan	ics and electrical engineering		
Educational Objectives	After taking part successfully, students have	reached the following learning results		
Professional Competence				
Knowledge	Students are able to			
	· ovalain the basics of ship formation of	d mochanisms and medals of most inter-		
		nd mechanisms and models of machining.	ining processes and t	
		lesign and analysis of metal forming, macl tool building and give an overview on tre		
		ions of CNC-machines and give an overvie		-
	<ul> <li>explain cypes, constructions and rance</li> <li>explain equipment components.</li> </ul>	ions of encentaenines and give an overvie	w on mate-machine 3	ysterns.
	e componentes.			
Skills	Students are able to			
	<ul> <li>select tool geometry, cutting materia</li> </ul>	ls, process parameters and appropriate n	neasuring technique i	n accordance with t
	requirements.		5 1	
	<ul> <li>estimate occurring forces and temper</li> </ul>	atures during chip formation.		
	<ul> <li>select appropriate machine tools for machining and create NC programs for turning and milling.</li> </ul>			
	assess the quality of a machine tools			
Personal Competence	Chudente ere eble te			
Social Competence	Students are able to			
	<ul> <li>develop solutions in a production environmental</li> </ul>	ronment with qualified personnel at techn	ical level and represer	nt decisions.
Autonomy	Students are able to			
Autonomy				
	interpret independently cutting process	ises.		
	create independently NC programs.			
	<ul> <li>select independently machine tools by</li> </ul>			
	<ul> <li>assess own strengths and weaknesses</li> </ul>			
	assess their learning progress and det			
	<ul> <li>assess possible consequences of their</li> </ul>	actions.		
Workload in Hours	Independent Study Time 96, Study Time in L	ecture 84		
Credit points				
Course achievement				
Examination				
Examination duration and	180 min			
scale				
	General Engineering Science (German progr	am, 7 semester): Specialisation Mechanic	al Engineering, Focus	Product Developme
Following Curricula	and Production: Compulsory			
	Mechanical Engineering: Specialisation Produ		,	
	Product Development, Materials and Product	ion: Technical Complementary Course Cor	e Studies: Elective Co	mpulsory

Course 10680; Fundamental	a of Machina Taola
Course L0689: Fundamentals	
Тур Hrs/wk	2
CP	
	Independent Study Time 32, Study Time in Lecture 28
	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, KJ
	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
	Wask Manfrad Brachas Christian
	Weck, Manfred; Brecher, Christian
	Werkzeugmaschinen 5 - Messtechnische Untersuchung und Beurteilung, dynamische Stabilität
	ISBN: 3540225056
	Berlin [u.a.]: Springer, 2006

Course L1992: Fundamentals	Course L1992: Fundamentals of Machine Tools	
Тур	Recitation Section (large)	
Hrs/wk	1	
CP	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			
CP	2		
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28		
Lecturer	Prof. Wolfgang Hintze		
Language	DE		
Cycle	WiSe		
Content	<ul> <li>Thermomechanical Principles and Models of Machining</li> <li>Chip Formation, Forces, Temperature and Tribology process</li> <li>Wear mechanisms and wear patterns</li> <li>Machinability by Cutting and Forming, Specific Problems of Light Weight Structures</li> <li>Cutting Material and Coatings</li> <li>Methods and Parameters for Analysis and Configuration of Forming and Cutting Processes and Tools</li> </ul>		
Literature	Lange, K.; Umformtechnik Grundlagen, 2. Auflage, Springer (2002) Tönshoff, H.; Spanen Grundlagen, 2. Auflage, Springer Verlag (2004) König, W., Klocke, F.; Fertigungsverfahren Bd. 4 <i>Massivumformung</i> , 4. Auflage, VDI-Verlag (1996) König, W., Klocke, F.; Fertigungsverfahren Bd. 5 <i>Blechbearbeitung</i> , 3. Auflage, VDI-Verlag (1995) Klocke, F., König, W.; Fertigungsverfahren <i>Schleifen, Honen, Läppen</i> , 4. Auflage, Springer Verlag (2005) König, W., Klocke, F.: Fertigungsverfahren <i>Drehen, Fräsen, Bohren</i> , 7. Auflage, Springer Verlag (2002)		

Course L0614: Forming and	Course 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. Wolfgang Hintze		
Language	DE		
Cycle	WiSe		
Content	See interlocking course		
Literature	See interlocking course		

Courses					
itle		Тур	Hrs/wk	СР	
roduction 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. Wolfgang Hintze				
Admission Requirements	None				
<b>Recommended Previous</b>	no course assessments required				
Knowledge					
	internship recommended				
Educational Objectives	After taking part successfully, students have	e reached the following learning results			
Professional Competence	, and the part succession, statements have				
	Students are able to				
Knowledge	Students are able to				
	<ul> <li>name basic criteria for the selection of</li> </ul>	of manufacturing processes.			
	<ul> <li>name the main groups of Manufactur</li> </ul>	ing Technology.			
	<ul> <li>name the application areas of differe</li> </ul>	nt manufacturing processes.			
		sadvantages of the different manufacturing proc	ess.		
		ties and kinematic variables and requirements for		and process.	
	<ul> <li>explain the essential models of manual</li> </ul>				
	• explain the essential models of mana	ructuring technology.			
Chille	Chudente ere eble te				
Skills	Students are able to				
	<ul> <li>select manufacturing processes in ac</li> </ul>	cordance with the requirements.			
		imple tasks to meet the required tolerances of th	ne component to b	be produced.	
	<ul> <li>assess components in terms of their</li> </ul>				
Demonstration of the second second					
Personal Competence					
Social Competence	e Students are able to				
	<ul> <li>develop solutions in a production environment</li> </ul>	ironment with qualified personnel at technical le	vel and represent	decisions.	
		· · · · · · · · · · · · · · · · · · ·			
Autonomy	Students are able to				
Autonomy	Statents are able to				
	<ul> <li>interpret independently the manufact</li> </ul>	curing process.			
	<ul> <li>assess own strengths and weaknesse</li> </ul>	s in general.			
	<ul> <li>assess their learning progress and dependence</li> </ul>	efine gaps to be improved.			
	• assess possible consequences of thei	r actions.			
Workload in Hours	Independent Study Time 96, Study Time in	_ecture 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 Mechanical En	gineering, Focus F	Product Developr	
Following Curricula	and Production: Compulsory				
-		ram, 7 semester): Specialisation Mechanical Eng	ineerina. Focus Tł	heoretical Mecha	
	Engineering: Elective Compulsory				
	Digital Mechanical Engineering: Core Qualifi	cation: Compulsory			
	Engineering Science: Specialisation Mechan				
			ooring Commut-		
		am, 7 semester): Specialisation Mechanical Engir		лу	
		e: Specialisation Energy Technology: Elective Cor	npulsory		
		tion Management and Processes: Compulsory			
	Logistics and Mobility: Specialisation Engine				
	Mechanical Engineering: Core Qualification:	Compulsory			
	Mechatronics: Core Qualification: Compulso	ry .			
	Engineering and Management - Major in Loc	istics and Mobility: Specialisation Production Ma	nagement and Pro	cesses: Compuls	

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. Wolfgang Hintze
Language	DE
Cycle	WiSe
Content	<ul> <li>Manufacturing Accuracy</li> <li>Manufacturing Metrology</li> <li>Measurement Errors and Uncertainties</li> <li>Introduction to Forming</li> <li>Massiv forming and Sheet Metal Forming</li> <li>Introduction to Machining Technology</li> <li>Geometrically defined machining (Turning, milling, drilling, broaching, planning)</li> </ul>
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. Wolfgang Hintze		
Language	DE		
Cycle	WiSe		
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. Wolfgang Hintze, Prof. Claus Emmelmann
Language	DE
Cycle	SoSe
Content	<ul> <li>Geometrically undefined machining (grinding, lapping, honing)</li> <li>Introduction into erosion technology</li> <li>Introduction into blastig processes</li> <li>Introduction to the manufacturing process forming (Casting, Powder Metallurgy, Composites)</li> <li>Fundamentals of Laser Technology</li> <li>Process versions and Fundamentals of Laser Joining Technology</li> </ul>
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	urse 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. Wolfgang Hintze, Prof. Claus Emmelmann		
Language	DE		
Cycle	SoSe		
Content	See interlocking course		
Literature	See interlocking course		

Courses				
Courses				
<b>Fitle</b> Computer Engineering (L0321)		<b>Typ</b> Lecture	Hrs/wk 3	<b>CP</b> 4
Computer Engineering (L0321)		Recitation Section (small)	1	2
	Prof. Heiko Falk	ricciation beetion (onion)	-	-
Module Responsible				
Admission Requirements	None			
Recommended Previous	Basic knowledge in electrical engineering			
Knowledge				
Educational Objectives	After taking part successfully, students have rea	ched the following learning results		
Professional Competence				
Knowledge	This module deals with the foundations of the programming down to gates. The module include		vers the layers from	m the assembly-le
	Introduction			
	Combinational logic: Gates, Boolean algeb	ora, Boolean functions, hardware synthesis	s, combinational net	tworks
	<ul> <li>Sequential logic: Flip-flops, automata, system</li> </ul>	tematic hardware design		
	<ul> <li>Technological foundations</li> </ul>			
	Computer arithmetic: Integer addition, sul	btraction, multiplication and division		
	Basics of computer architecture: Program	ming models, MIPS single-cycle architectu	re, pipelining	
	Memories: Memory hierarchies, SRAM, DR	AM, caches		
	<ul> <li>Input/output: I/O from the perspective of t</li> </ul>	he CPU, principles of passing data, point-t	o-point connections	, busses
Skills	The students perceive computer systems from the	he architect's perspective, i.e., they identi	fy the internal struc	ture and the phys
	composition of computer systems. The students	can analyze, how highly specific and indiv	vidual computers ca	an be built based o
	collection of few and simple components. They	are able to distinguish between and to e	xplain the different	abstraction layer
	today's computing systems - from gates and circ	uits up to complete processors.		
	After successful completion of the module, the	students are able to judge the interden	ondoncios hotwoon	a physical comp
	system and the software executed on it. In parti			
	on the hardware-centric abstraction layers from			
	the impact that these low abstraction levels have			
	the impact that these low abstraction levels have	e on an entire system's performance and	.o propose reasible	options.
Personal Competence				
Social Competence	Students are able to solve similar problems alon	e or in a group and to present the results	accordingly.	
Autonomy	Students are able to acquire new knowledge from	n specific literature and to associate this l	cnowledge with othe	er classes.
Workload in Hours	Independent Study Time 124, Study Time in Lect	ture 56		
	6			
Credit points	Compulsory Bonus Form	Description		
Course achievement	Yes 10 % Excercises	Description		
Examination				
	90 minutes, contents of course and labs			
scale				
Assignment for the	General Engineering Science (German program,			
Following Curricula	General Engineering Science (German progra	am, 7 semester): Specialisation Mecha	nical Engineering,	Focus Mechatron
	Compulsory			
	General Engineering Science (German program	n, 7 semester): Specialisation Mechanic	al Engineering, Fo	cus Aircraft Syste
	Engineering: Compulsory			
	General Engineering Science (German program,	7 semester): Specialisation Mechanical E	ngineering, Focus Tl	heoretical Mechan
	Engineering: Compulsory			
	General Engineering Science (German progra	am, 7 semester): Specialisation Mecha	anical Engineering,	Focus Materials
	Engineering Sciences: Compulsory			
	General Engineering Science (German program,	7 semester): Specialisation Mechanical B	Engineering, Focus I	Product Developm
	and Production: Compulsory			
	General Engineering Science (German program	n, 7 semester): Specialisation Mechanic	al Engineering, Foo	cus Energy Syste
	Compulsory			
	General Engineering Science (German progra	m, 7 semester): Specialisation Mechar	ical Engineering,	Focus Biomechan
	Compulsory			
	General Engineering Science (German program,	7 semester): Specialisation Electrical Engi	neering: Compulsor	У
	General Engineering Science (German program,	7 semester): Specialisation Green Techno	logies, Focus Renew	vable Energy: Elec
	Compulsory			
	Computer Science: Core Qualification: Compulso	ry		
	Data Science: Core Qualification: Elective Compu	llsory		
	Data Science: Specialisation I. Mathematics/Com	puter Science: Elective Compulsory		
	Electrical Engineering: Core Qualification: Compu			
	Computer Science in Engineering: Core Qualifica			
	Integrated Building Technology: Core Qualification			

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

Course L0324: Computer Eng	ourse 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		

Module M0599: Integ	rated Product Dev	velopment and	Lightweigh	t Design			
Courses							
Title				Тур	Hrs/wk	СР	
CAE-Team Project (L0271)				Project-/problem-based Learning	2	2	
Development of Lightweight Design Products (L0270)				Lecture	2	2	
Integrated Product Development I	L0269)		Lecture	2	2		
Module Responsible	Prof. Dieter Krause						
Admission Requirements	None						
Recommended Previous	Advanced Knowledge abo	out engineering desig	n:				
Knowledge	Fundamentals of Mechanical Engineering Design						
	Mechanical Engineering:	Design					
	Advanced Mechanical En	gineering Design					
Educational Objectives	After taking part success	fully, students have r	eached the followi	ng learning results			
Professional Competence							
Knowledge	After completing the mod	dule, students are cap	able of:				
	<ul> <li>explaining the fundamental</li> </ul>	ctional principle of 3D	-CAD-Systems, PD	M- and FEM-Systems			
	<ul> <li>describing the interview</li> </ul>	raction of the differe	nt CAE-Systems in	the product development proces	55		
CL:III-							
Skills							
	After completing the mod	dule, students are abl	e to:				
	product structuring	g		to the desired requirements su A-Systems with shared workload	ıch as classifi	cation schemes and	
Personal Competence							
-	After completing the mor	ule students are abl	e to:				
Social competence	After completing the module, students are able to:						
	<ul><li>To develop a proje</li><li>Present project res</li></ul>			vork packages in the framework action	of group discu	issions	
Autonomy	Students are capable of						
Autonomy	/ Students are capable of:						
	<ul> <li>independently ada</li> </ul>	pt to a CAE-Tool and	complete a given	practical task with it			
Workload in Hours	Independent Study Time	96. Study Time in Le	ture 84				
Credit points	6	er, otaay nine in Lev					
Course achievement		orm	Description				
	Yes 20 % Su	ubject theoretical	andCAE-Teampre	ojekt inkl. Vortrag und Ausarbeitu	ung		
	pr	actical work					
Examination	Written exam						
Examination duration and scale	90						
Assignment for the	General Engineering Sci	ence (German prog	am, 7 semester)	: Specialisation Mechanical End	ineering, Foc	us Aircraft Systems	
-	Engineering: Compulsory			-	-	-	
_			m, 7 semester): S	pecialisation Mechanical Engine	ering, Focus P	roduct Development	
	and Production: Compuls	ory					
	Engineering Science: Spe	cialisation Mechanica	I Engineering: Ele	ctive Compulsory			
	General Engineering Scie	nce (English program	, 7 semester): Spe	ecialisation Mechanical Engineeri	ng: Elective Co	ompulsory	
	Mechanical Engineering:	Specialisation Produc	t Development an	d Production: Compulsory			
	Mechanical Engineering:	•					
	Product Development, Ma	aterials and Productio	n: Technical Com	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	<ul> <li>Practical Introduction in the used software systems (Creo, Windchill, Hyperworks)</li> <li>Team formation, allocation of tasks and generation of a project plan</li> <li>Collective creation of one product out of CAD models supported by FEM calculations and PDM system</li> <li>Manufacturing of selected parts using 3D printer</li> <li>Presentation of results</li> </ul> <b>Description</b> 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 L0270: Development	of Lightweight Design Products
Тур	Lecture
Hrs/wk	2
СР	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Prof. Dieter Krause, Prof. Benedikt Kriegesmann
Language	DE
Cycle	SoSe
Content	<ul> <li>Lightweight design materials</li> <li>Product development process for lightweight structures</li> <li>Dimensioning of lightweight structures</li> </ul>
Literature	<ul> <li>Schürmann, H., "Konstruieren mit Faser-Kunststoff-Verbunden", Springer, Berlin, 2005.</li> <li>Klein, B., "Leichtbau-Konstruktion", Vieweg &amp; Sohn, Braunschweig, 1989.</li> <li>Krause, D., "Leichtbau", In: Handbuch Konstruktion, Hrsg.: Rieg, F., Steinhilper, R., München, Carl Hanser Verlag, 2012.</li> <li>Schulte, K., Fiedler, B., "Structure and Properties of Composite Materials", Hamburg, TUHH - TuTech Innovation GmbH, 2005.</li> <li>Wiedemann, J., "Leichtbau Band 1: Elemente", Springer, Berlin, Heidelberg, 1986.</li> </ul>

Course L0269: Integrated Pr	oduct Development l
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	<ul> <li>Introduction to Integrated Product Development</li> <li>3D CAD -Systems and CAD interfaces</li> <li>Administration of part lists / PDM systems</li> <li>PDM in different industries</li> <li>Selection of CAD-/PDM Systems</li> <li>Simulation</li> <li>Construction methods</li> <li>Design for X</li> </ul>
Literature	<ul> <li>Ehrlenspiel, K.: Integrierte Produktentwicklung, München, Carl Hanser Verlag</li> <li>Lee, K.: Principles of CAD / CAM / CAE Systems, Addison Wesles</li> <li>Schichtel, M.: Produktdatenmodellierung in der Praxis, München, Carl Hanser Verlag</li> <li>Anderl, R.: CAD Schnittstellen, München, Carl Hanser Verlag</li> <li>Spur, G., Krause, F.: Das virtuelle Produkt, München, Carl Hanser Verlag</li> </ul>

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			
<b>Recommended Previous</b>	None			
Knowledge				
Educational Objectives	After taking part successfully, students	have reached the following learning results		
Professional Competence				
Knowledge	Students are able to explain the conten	ts of the lecture of the module.		
Skills	Students are able to apply the methods	and models in the module to industrial problem	1S.	
Personal Competence				
Social Competence	-			
Autonomy	-			
Workload in Hours	Independent Study Time 124, Study Tin	ne 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	inical Engineering, Foc	us Aircraft Syster
Following Curricula	Engineering: Compulsory			
	General Engineering Science (German	program, 7 semester): Specialisation Mechanica	al Engineering, Focus P	roduct Developme
	and Production: Compulsory			
	General Engineering Science (German p	rogram, 7 semester): Specialisation Advanced I	Materials: Elective Com	pulsory
	Engineering Science: Core Qualification	Compulsory		
	Engineering Science: Specialisation Med	hatronics: Elective Compulsory		
	Engineering Science: Specialisation Med	hanical Engineering: Elective Compulsory		
	Engineering Science: Specialisation Adv			
		oduction Management and Processes: Compulso	ory	
	Logistics and Mobility: Specialisation En			
	Mechanical Engineering: Core Qualificat	ion: Elective Compulsory		
	Engineering and Management - Major in	Logistics and Mobility: Specialisation Productio	n Management and Pro	cesses: Compulsor

Course L0925: Production Pro	ourse L0925: Production Process Organization		
Тур	Lecture		
Hrs/wk	2		
СР	3		
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28		
Lecturer	Hermann Lödding		
Language	EN		
Cycle	SoSe		
Content	(A) Introduction		
	(B) Product planning		
	(C) Process planning		
	(D) Procurement		
	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	<ul> <li>Definition and Relevance of Quality</li> <li>Continuous Quality Improvement</li> <li>Quality Management in Product Development</li> <li>Quality Management in Production Processes</li> <li>Design of Experiments</li> </ul>
Literature	<ul> <li>Pfeifer, Tilo: Quality Management. Strategies, Methods, Techniques; Hanser-Verlag, München 2002</li> <li>Pfeifer, Tilo: Qualitätsmanagement. Strategien, Methoden, Techniken; Hanser-Verlag, München, 3. Aufl. 2001</li> <li>Mitra, Amitava: Fundamentals of Quality Control and Improvement; Wiley; Macmillan, 2008</li> <li>Kleppmann, W.: Taschenbuch Versuchsplanung. Produkte und Prozesse optimieren; Hanser-Verlag, München, 6. Aufl. 2009</li> </ul>

## **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				
			Line (sule	<b>C</b> D
Title Numerical Mathematics I (L0417)		<b>Typ</b> Lecture	Hrs/wk 2	<b>CP</b> 3
Numerical Mathematics I (L0418)		Recitation Section (small)	2	3
Module Responsible	Prof Sabine Le Borne			-
Admission Requirements				
-	None			
Recommended Previous Knowledge	Mathematik I + II for Engineering Students (	german or english) <b>or</b> Analysis & Linear Alg	gebra I + II for Te	chnomathematici
Knowledge	basic MATLAB/Python knowledge			
	After taking part successfully, students have reach	ed the following learning results		
Professional Competence				
Knowledge	Students are able to			
	<ul> <li>name numerical methods for interpolation,</li> </ul>	integration, least squares problems, eigenv	value problems, r	onlinear root find
	problems and to explain their core ideas,		ande problemb) i	
	<ul> <li>repeat convergence statements for the num</li> </ul>	verical methods		
	<ul> <li>explain aspects for the practical execution of</li> </ul>		itational and stor	rade complexity
	• explain aspects for the practical execution of	indificiencial methods with respect to compt		age complexits.
Skills	Students are able to			
	<ul> <li>implement, apply and compare numerical m</li> </ul>	nethods using MATLAB/Python.		
	<ul> <li>justify the convergence behaviour of numer</li> </ul>		nd solution algori	thm
	<ul> <li>select and execute a suitable solution appro</li> </ul>		a solution algon	
	- Sciece and execute a suitable solution appro			
Personal Competence				
Social Competence	Students are able to			
	<ul> <li>work together in heterogeneously composed</li> </ul>	d teams (i.e., teams from different study pr	ograms and bac	kground knowledg
	explain theoretical foundations and support	each other with practical aspects regarding	g the implementa	tion of algorithms
Autonomy	Students are capable			
Autonomy	Students are capable			
	<ul> <li>to assess whether the supporting theoretica</li> </ul>	and practical excercises are better solved	individually or in	a team,
	<ul> <li>to assess their individual progess and, if nec</li> </ul>	cessary, to ask questions and seek help.		
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	00 minutos			
Examination duration and	90 minutes			
scala				
scale				
Assignment for the	General Engineering Science (German program, 7			
Assignment for the	General Engineering Science (German program, 7	semester): Specialisation Biomedical Engine	eering: Compulso	
Assignment for the		semester): Specialisation Biomedical Engine	eering: Compulso	
Assignment for the	General Engineering Science (German program, 7	semester): Specialisation Biomedical Engine	eering: Compulso	
Assignment for the	General Engineering Science (German program, 7 General Engineering Science (German program	semester): Specialisation Biomedical Engine , 7 semester): Specialisation Mechanical	eering: Compulso I Engineering, F	ocus Biomechan
Assignment for the	General Engineering Science (German program, 7 General Engineering Science (German program Compulsory	semester): Specialisation Biomedical Engine , 7 semester): Specialisation Mechanical	eering: Compulso I Engineering, F	ocus Biomechan
Assignment for the	General Engineering Science (German program, 7 General Engineering Science (German program Compulsory General Engineering Science (German program, 7	semester): Specialisation Biomedical Engine , 7 semester): Specialisation Mechanical semester): Specialisation Mechanical Engin	eering: Compulso I Engineering, F neering, Focus Th	ocus Biomechan
Assignment for the	General Engineering Science (German program, 7 General Engineering Science (German program Compulsory General Engineering Science (German program, 7 Engineering: Compulsory	semester): Specialisation Biomedical Engine , 7 semester): Specialisation Mechanical semester): Specialisation Mechanical Engin	eering: Compulso I Engineering, F neering, Focus Th	ocus Biomechan
Assignment for the	General Engineering Science (German program, 7 General Engineering Science (German program Compulsory General Engineering Science (German program, 7 Engineering: Compulsory General Engineering Science (German program,	semester): Specialisation Biomedical Engine , 7 semester): Specialisation Mechanical semester): Specialisation Mechanical Engin 7 semester): Specialisation Mechanical I	eering: Compulsc I Engineering, F neering, Focus Th Engineering, Foc	ocus Biomechan eoretical Mechan us Aircraft Syste
Assignment for the	General Engineering Science (German program, 7 General Engineering Science (German program Compulsory General Engineering Science (German program, 7 Engineering: Compulsory General Engineering Science (German program, Engineering: Elective Compulsory	semester): Specialisation Biomedical Engine , 7 semester): Specialisation Mechanical semester): Specialisation Mechanical Engin 7 semester): Specialisation Mechanical I	eering: Compulsc I Engineering, F neering, Focus Th Engineering, Foc	ocus Biomechan eoretical Mechan us Aircraft Syste
Assignment for the	General Engineering Science (German program, 7 General Engineering Science (German program Compulsory General Engineering Science (German program, 7 Engineering: Compulsory General Engineering Science (German program, Engineering: Elective Compulsory General Engineering Science (German program, 7	semester): Specialisation Biomedical Engine 7 semester): Specialisation Mechanical semester): Specialisation Mechanical Engin 7 semester): Specialisation Mechanical Engin semester): Specialisation Mechanical Engin	eering: Compulso I Engineering, F neering, Focus Th Engineering, Foo neering, Focus M	ocus Biomechan eoretical Mechan us Aircraft Syste echatronics: Elect
Assignment for the	General Engineering Science (German program, 7 General Engineering Science (German program Compulsory General Engineering Science (German program, 7 Engineering: Compulsory General Engineering Science (German program, Engineering: Elective Compulsory General Engineering Science (German program, 7 Compulsory	semester): Specialisation Biomedical Engine 7 semester): Specialisation Mechanical semester): Specialisation Mechanical Engin 7 semester): Specialisation Mechanical Engin semester): Specialisation Mechanical Engin	eering: Compulso I Engineering, F neering, Focus Th Engineering, Foo neering, Focus M	ocus Biomechan eoretical Mechan us Aircraft Syste echatronics: Elect
Assignment for the	General Engineering Science (German program, 7 General Engineering Science (German program Compulsory General Engineering Science (German program, 7 Engineering: Compulsory General Engineering Science (German program, Engineering: Elective Compulsory General Engineering Science (German program, 7 Compulsory General Engineering Science (German program,	semester): Specialisation Biomedical Engine 7 semester): Specialisation Mechanical semester): Specialisation Mechanical Engin 7 semester): Specialisation Mechanical Engin 8 semester): Specialisation Mechanical Engin 7 semester): Specialisation Mechanical Engin 8 semester): Specialisation Mechanical E	eering: Compulso I Engineering, F neering, Focus Th Engineering, Foc neering, Focus M Engineering, Foc	ocus Biomechan eoretical Mechan us Aircraft Syste echatronics: Elect
Assignment for the	General Engineering Science (German program, 7 General Engineering Science (German program Compulsory General Engineering Science (German program, 7 Engineering: Compulsory General Engineering Science (German program, Engineering: Elective Compulsory General Engineering Science (German program, 7 Compulsory General Engineering Science (German program, Elective Compulsory General Engineering Science (German program, 7	semester): Specialisation Biomedical Engine 7 semester): Specialisation Mechanical semester): Specialisation Mechanical Engin 7 semester): Specialisation Mechanical I semester): Specialisation Mechanical Engir 7 semester): Specialisation Mechanical E semester): Specialisation Advanced Materia	eering: Compulso I Engineering, F eeering, Focus Th Engineering, Foc neering, Focus M Engineering, Foc	ocus Biomechan leoretical Mechan us Aircraft Syste echatronics: Elect us Energy System
Assignment for the	General Engineering Science (German program, 7 General Engineering Science (German program Compulsory General Engineering Science (German program, 7 Engineering: Compulsory General Engineering Science (German program, Engineering: Elective Compulsory General Engineering Science (German program, 7 Compulsory General Engineering Science (German program, 7 Elective Compulsory General Engineering Science (German program, 7 General Engineering Science (German program, 7 General Engineering Science (German program, 7	semester): Specialisation Biomedical Engine 7 semester): Specialisation Mechanical semester): Specialisation Mechanical Engin 7 semester): Specialisation Mechanical I semester): Specialisation Mechanical Engir 7 semester): Specialisation Mechanical E semester): Specialisation Advanced Materia	eering: Compulso I Engineering, F neering, Focus Th Engineering, Foc neering, Focus M Engineering, Foc als: Compulsory	ocus Biomechan leoretical Mechan us Aircraft Syste echatronics: Elect us Energy System
Assignment for the	General Engineering Science (German program, 7 General Engineering Science (German program Compulsory General Engineering Science (German program, 7 Engineering: Compulsory General Engineering Science (German program, Engineering: Elective Compulsory General Engineering Science (German program, 7 Compulsory General Engineering Science (German program, Elective Compulsory General Engineering Science (German program, 7 General Engineering Science (German program, 7	semester): Specialisation Biomedical Engine 7 semester): Specialisation Mechanical semester): Specialisation Mechanical Engin 7 semester): Specialisation Mechanical Engin 7 semester): Specialisation Mechanical Engin 7 semester): Specialisation Mechanical E semester): Specialisation Mechanical E semester): Specialisation Mechanical E semester): Specialisation Mechanical E	eering: Compulso I Engineering, F eeering, Focus Th Engineering, Foc neering, Focus M Engineering, Foc als: Compulsory al Engineering,	ocus Biomechan leoretical Mechan us Aircraft Syste echatronics: Elect us Energy System
Assignment for the	General Engineering Science (German program, 7 General Engineering Science (German program Compulsory General Engineering Science (German program, 7 Engineering: Compulsory General Engineering Science (German program, Engineering: Elective Compulsory General Engineering Science (German program, 7 Compulsory General Engineering Science (German program, Elective Compulsory General Engineering Science (German program, 7 General Engineering Science (German program Engineering Sciences: Compulsory Bioprocess Engineering: Specialisation A - General	semester): Specialisation Biomedical Engine , 7 semester): Specialisation Mechanical semester): Specialisation Mechanical Engin 7 semester): Specialisation Mechanical Engin 7 semester): Specialisation Mechanical Engin 7 semester): Specialisation Mechanical Engin 8 semester): Specialisation Mechanical Engin 9 semester): Specialisation Mechanical Engine 9 semester): Specialisation Mechanical Engin	eering: Compulso I Engineering, F eeering, Focus Th Engineering, Focus M Engineering, Focus M Engineering, Focus als: Compulsory al Engineering, rry	ocus Biomechan leoretical Mechan us Aircraft Syste echatronics: Elect us Energy System
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Assignment for the	General Engineering Science (German program, 7 General Engineering Science (German program Compulsory General Engineering Science (German program, 7 Engineering: Compulsory General Engineering Science (German program, Engineering: Elective Compulsory General Engineering Science (German program, 7 Compulsory General Engineering Science (German program, 7 Compulsory General Engineering Science (German program, 7 General Engineering Science (German program Engineering Science (German program Engineering Science (German program Engineering Science: Compulsory Bioprocess Engineering: Specialisation A - General Computer Science: Specialisation II. Mathematics a Data Science: Core Qualification: Compulsory	semester): Specialisation Biomedical Engine , 7 semester): Specialisation Mechanical semester): Specialisation Mechanical Engin 7 semester): Specialisation Mechanical Engin 7 semester): Specialisation Mechanical Engin 7 semester): Specialisation Mechanical Engin 7 semester): Specialisation Mechanical Engin 8 semester): Specialisation Mechanical Engin 9 semester): Specialisation M	eering: Compulso I Engineering, F eeering, Focus Th Engineering, Focus M Engineering, Focus M Engineering, Focus als: Compulsory al Engineering, rry	ocus Biomechan leoretical Mechan us Aircraft Syste echatronics: Elect us Energy System
Assignment for the	General Engineering Science (German program, 7 General Engineering Science (German program Compulsory General Engineering Science (German program, 7 Engineering: Compulsory General Engineering Science (German program, Engineering: Elective Compulsory General Engineering Science (German program, 7 Compulsory General Engineering Science (German program, 7 Compulsory General Engineering Science (German program, 7 General Engineering Science (German program Engineering Science: Compulsory Bioprocess Engineering: Specialisation A - General Computer Science: Specialisation II. Mathematics a Data Science: Core Qualification: Compulsory Electrical Engineering: Core Qualification: Elective	semester): Specialisation Biomedical Engine , 7 semester): Specialisation Mechanical semester): Specialisation Mechanical Engin 7 semester): Specialisation Mechanical Engin 7 semester): Specialisation Mechanical Engin 7 semester): Specialisation Mechanical Engin 7 semester): Specialisation Mechanical Engin 8 semester): Specialisation Mechanical Engin 9 semester): Specialisation M	eering: Compulso I Engineering, F eeering, Focus Th Engineering, Focus M Engineering, Focus M Engineering, Focus als: Compulsory al Engineering, rry	ocus Biomechan leoretical Mechan us Aircraft Syste echatronics: Elect us Energy System
Assignment for the	General Engineering Science (German program, 7 General Engineering Science (German program Compulsory General Engineering Science (German program, 7 Engineering: Compulsory General Engineering Science (German program, Engineering: Elective Compulsory General Engineering Science (German program, 7 Compulsory General Engineering Science (German program, 7 Compulsory General Engineering Science (German program, 7 General Engineering Science (German program Engineering Science: Compulsory Bioprocess Engineering: Specialisation A - General Computer Science: Specialisation II. Mathematics a Data Science: Core Qualification: Compulsory Electrical Engineering: Core Qualification: Elective Engineering Science: Core Qualification: Compulso	semester): Specialisation Biomedical Engine , 7 semester): Specialisation Mechanical semester): Specialisation Mechanical Engin 7 semester): Specialisation Mechanical Engin 7 semester): Specialisation Mechanical Engin 7 semester): Specialisation Mechanical Engin 7 semester): Specialisation Mechanical E semester): Specialisation Mechanical E semester): Specialisation Mechanical E semester): Specialisation Mechanical Bioprocess Engineering: Elective Compulso and Engineering Science: Elective Compulso Compulsory ry	eering: Compulso I Engineering, F eeering, Focus Th Engineering, Focus M Engineering, Focus M Engineering, Focus als: Compulsory al Engineering, rry	ocus Biomechan leoretical Mechan us Aircraft Syste echatronics: Elect us Energy System
Assignment for the	General Engineering Science (German program, 7 General Engineering Science (German program Compulsory General Engineering Science (German program, 7 Engineering: Compulsory General Engineering Science (German program, Engineering: Elective Compulsory General Engineering Science (German program, 7 Compulsory General Engineering Science (German program, Elective Compulsory General Engineering Science (German program, Elective Compulsory General Engineering Science (German program, Elective Compulsory General Engineering Science (German program, Elective Science: Compulsory Bioprocess Engineering: Specialisation A - General Computer Science: Specialisation II. Mathematics a Data Science: Core Qualification: Elective Engineering Science: Core Qualification: Compulso Engineering Science: Core Qualification: Compulso	semester): Specialisation Biomedical Engine , 7 semester): Specialisation Mechanical semester): Specialisation Mechanical Engin 7 semester): Specialisation Mechanical Engin 7 semester): Specialisation Mechanical Engin 7 semester): Specialisation Mechanical Engin 7 semester): Specialisation Mechanical Engin 8 semester): Specialisation Mechanical Engin 9 semester): Specialisation Mechanical Engin 9 semester): Specialisation Mechanical Engin 9 semester): Specialisation Mechanical 9 semester): Specialisation Mecha	eering: Compulso I Engineering, F eeering, Focus Th Engineering, Focus M Engineering, Focus M Engineering, Focus als: Compulsory al Engineering, rry	ocus Biomechan leoretical Mechan us Aircraft Syste echatronics: Elect us Energy System
Assignment for the	General Engineering Science (German program, 7 General Engineering Science (German program Compulsory General Engineering Science (German program, 7 Engineering: Compulsory General Engineering Science (German program, Engineering: Elective Compulsory General Engineering Science (German program, 7 Compulsory General Engineering Science (German program, 7 Compulsory General Engineering Science (German program, 7 General Engineering Science (German program Engineering Science: Compulsory Bioprocess Engineering: Specialisation A - General Computer Science: Specialisation II. Mathematics a Data Science: Core Qualification: Elective Engineering Science: Core Qualification: Compulso Engineering Science: Core Qualification: Compulso Engineering Science: Core Qualification: Compulso	semester): Specialisation Biomedical Engine , 7 semester): Specialisation Mechanical semester): Specialisation Mechanical Engin 7 semester): Specialisation Mechanical Engin 7 semester): Specialisation Mechanical Engin 7 semester): Specialisation Mechanical Engin 7 semester): Specialisation Mechanical Engin 8 semester): Specialisation Mechanical Engin 9 semester): Specialisation Mechanical Engin 9 semester): Specialisation Mechanical Engin 9 semester): Specialisation Mechanical 9 semester): Specialisation Mecha	eering: Compulso I Engineering, F eeering, Focus Th Engineering, Focus M Engineering, Focus M Engineering, Focus als: Compulsory al Engineering, rry	ocus Biomechan leoretical Mechan us Aircraft Syste echatronics: Elec us Energy Syste
Assignment for the	General Engineering Science (German program, 7 General Engineering Science (German program Compulsory General Engineering Science (German program, 7 Engineering: Compulsory General Engineering Science (German program, Engineering: Elective Compulsory General Engineering Science (German program, 7 Compulsory General Engineering Science (German program, 7 Compulsory General Engineering Science (German program, 7 General Engineering Science (German program Engineering Science: Compulsory Bioprocess Engineering: Specialisation A - General Computer Science: Specialisation II. Mathematics a Data Science: Core Qualification: Elective Engineering Science: Core Qualification: Compulso Electrical Engineering: Core Qualification: Compulso Engineering Science: Core Qualification: Compulso Computer Science in Engineering: Core Qualification Mechanical Engineering: Specialisation Theoretical	semester): Specialisation Biomedical Engine , 7 semester): Specialisation Mechanical semester): Specialisation Mechanical Engin 7 semester): Specialisation Mechanical Engin 7 semester): Specialisation Mechanical Engin 7 semester): Specialisation Mechanical Engin 7 semester): Specialisation Mechanical E semester): Specialisation Mechanical E semester): Specialisation Mechanical E semester): Specialisation Mechanical E semester): Specialisation Mechanical Bioprocess Engineering: Elective Compulso and Engineering Science: Elective Compulso Compulsory ry ry on: Compulsory Mechanical Engineering: Compulsory	eering: Compulso I Engineering, F eeering, Focus Th Engineering, Focus M Engineering, Focus M Engineering, Focus als: Compulsory al Engineering, rry	ocus Biomechan leoretical Mechan us Aircraft Syste echatronics: Elec us Energy Syste
Assignment for the	General Engineering Science (German program, 7 General Engineering Science (German program Compulsory General Engineering Science (German program, 7 Engineering: Compulsory General Engineering Science (German program, Engineering: Elective Compulsory General Engineering Science (German program, 7 Compulsory General Engineering Science (German program, 7 Compulsory General Engineering Science (German program, 7 General Engineering Science (German program Engineering Science: Compulsory Bioprocess Engineering: Specialisation A - General Computer Science: Specialisation II. Mathematics a Data Science: Core Qualification: Elective Engineering Science: Core Qualification: Compulso Engineering Science: Core Qualification: Compulso Engineering Science: Core Qualification: Compulso	semester): Specialisation Biomedical Engine , 7 semester): Specialisation Mechanical semester): Specialisation Mechanical Engin 7 semester): Specialisation Mechanical Engin 7 semester): Specialisation Mechanical Engin 7 semester): Specialisation Mechanical Engin 7 semester): Specialisation Mechanical Engin 8 semester): Specialisation Mechanical Engin 9 semester): Specialisation Mechanical Engin 9 semester): Specialisation Mechanical Engin 9 semester): Specialisation Mechanical Engine 9 semester): Specialisation Mechanical 9 semester): Specialisation 9 semester	eering: Compulso I Engineering, F eeering, Focus Th Engineering, Focus M Engineering, Focus M Engineering, Focus als: Compulsory al Engineering, ary ory	ocus Biomechan leoretical Mechan us Aircraft Syste echatronics: Elect us Energy System

Process Engineering: Specialisation Process Engineering: Elective 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	<ol> <li>Finite precision arithmetic, error analysis, conditioning and stability</li> <li>Linear systems of equations: LU and Cholesky factorization, condition</li> <li>Interpolation: polynomial, spline and trigonometric interpolation</li> <li>Nonlinear equations: fixed point iteration, root finding algorithms, Newton's method</li> <li>Linear and nonlinear least squares problems: normal equations, Gram Schmidt and Householder orthogonalization, singular value decomposition, regularizatio, Gauss-Newton and Levenberg-Marquardt methods</li> <li>Eigenvalue problems: power iteration, inverse iteration, QR algorithm</li> <li>Numerical differentiation</li> <li>Numerical integration: Newton-Cotes rules, error estimates, Gauss quadrature, adaptive quadrature</li> </ol>
Literature	<ul> <li>Gander/Gander/Kwok: Scientific Computing: An introduction using Maple and MATLAB, Springer (2014)</li> <li>Stoer/Bulirsch: Numerische Mathematik 1, Springer</li> <li>Dahmen, Reusken: Numerik f ür Ingenieure und Naturwissenschaftler, Springer</li> </ul>

Course L0418: Numerical Ma	thematics 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

Module M0684: Heat	Transfer			
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			
<b>Recommended Previous</b>	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 mee	chanisms,	
	- 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 di manner, develop a solution and present it. Within the exercises, the students can indep work out targeted solutions.			
Autonomy	The students can check their level of knowledge by means of repetition questions at the b discuss answers in exchange with the other students. In the exercises, the students work 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				
Examination	Written exam			
Examination duration and				
scale				
Assignment for the		al Engineering Foo	us Energy Syste	
Following Curricula		a. Engineering, 100	as Energy Syste	
this carrieua	General Engineering Science (German program, 7 semester): Specialisation Biomedical Er	gineering: Compulse	ory	
	General Engineering Science (German program, 7 semester): Specialisation Biomedical Engineering Science (German program, 7 semester): Specialisation Mechanical E	5 5 1	,	
	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 Comp			

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	<ul> <li>Herwig, H.; Moschallski, A.: Wärmeübertragung, 4. Auflage, Springer Vieweg Verlag, Wiesbaden, 2019</li> <li>Herwig, H.: Wärmeübertragung von A-Z, Springer- Verlag, Berlin, Heidelberg, 2000</li> <li>Baehr, H.D.; Stephan, K.: Wärme- und Stoffübertragung, 2. Auflage, Springer Verlag, Berlin, Heidelberg, 1996</li> </ul>

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

Module M0725: Produ	ction 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. Wolfgang Hintze			
	None			
-				
	no course assessments required			
Knowledge	internship recommended			
Educational Objectives	After taking part successfully, students have r	eached the following learning results		
Professional Competence				
Knowledge	Students are able to			
	<ul> <li>name basic criteria for the selection of</li> </ul>			
	<ul> <li>name the main groups of Manufacturing</li> </ul>			
	<ul> <li>name the application areas of different</li> </ul>	manufacturing processes.		
	<ul> <li>name boundaries, advantages and disa</li> </ul>	dvantages of the different manufacturing proc	ess.	
	<ul> <li>describe elements, geometric propertie</li> </ul>	s and kinematic variables and requirements fo	r tools, workpiece	and process.
	<ul> <li>explain the essential models of manufa</li> </ul>	cturing technology.		
Skills	Students are able to			
	<ul> <li>select manufacturing processes in according</li> </ul>	rdance with the requirements.		
	<ul> <li>design manufacturing processes for sin</li> </ul>	ple tasks to meet the required tolerances of the	ne component to b	pe produced.
	<ul> <li>assess components in terms of their pressure</li> </ul>	oduction-oriented construction.		
Personal Competence				
Social Competence	Students are able to			
	<ul> <li>develop solutions in a production environment</li> </ul>	onment with qualified personnel at technical le	vel and represent	decisions.
Autonomy	Students are able to			
	<ul> <li>interpret independently the manufacture</li> </ul>	ing process.		
	<ul> <li>assess own strengths and weaknesses</li> </ul>	n general.		
	<ul> <li>assess their learning progress and defi</li> </ul>	ne gaps to be improved.		
	<ul> <li>assess possible consequences of their</li> </ul>	actions.		
Workload in Hours	Independent Study Time 96, Study Time in Le	cture 84		
Horkioud III Hours	independent study fille so, study fille in Le			
Credit points	6			
Course achievement				
Examination				
Examination duration and	120 min			
scale				
-		m, 7 semester): Specialisation Mechanical Eng	gineering, Focus F	Product Developm
Following Curricula	and Production: Compulsory			
	General Engineering Science (German progra	m, 7 semester): Specialisation Mechanical Eng	ineering, Focus Tł	neoretical Mechar
	Engineering: Elective Compulsory			
	Digital Mechanical Engineering: Core Qualifica	tion: Compulsory		
	Engineering Science: Specialisation Mechanica	al Engineering: Compulsory		
		n, 7 semester): Specialisation Mechanical Engin	eering: Compulso	iry
		Specialisation Energy Technology: Elective Con	÷ .	-
	Logistics and Mobility: Specialisation Production		,	
	Logistics and Mobility: Specialisation Production			
	Mechanical Engineering: Core Qualification: Co	Jiiipuisui y		
	Mechatronics: Core Qualification: Compulsory			- ·
	Engineering and Management - Major in Logis	tics and Mobility: Specialisation Production Mar	nagement and Pro	cesses: Compuls

Course L0608: Production En	gineering I
Тур	Lecture
Hrs/wk	2
СР	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Prof. Wolfgang Hintze
Language	DE
Cycle	WiSe
Content	<ul> <li>Manufacturing Accuracy</li> <li>Manufacturing Metrology</li> <li>Measurement Errors and Uncertainties</li> <li>Introduction to Forming</li> <li>Massiv forming and Sheet Metal Forming</li> <li>Introduction to Machining Technology</li> <li>Geometrically defined machining (Turning, milling, drilling, broaching, planning)</li> </ul>
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. Wolfgang Hintze	
Language	DE	
Cycle	WiSe	
Content	See interlocking course	
Literature	See interlocking course	

Course L0610: Production En	gineering II
Тур	Lecture
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Prof. Wolfgang Hintze, Prof. Claus Emmelmann
Language	DE
Cycle	SoSe
Content	<ul> <li>Geometrically undefined machining (grinding, lapping, honing)</li> <li>Introduction into erosion technology</li> <li>Introduction into blastig processes</li> <li>Introduction to the manufacturing process forming (Casting, Powder Metallurgy, Composites)</li> <li>Fundamentals of Laser Technology</li> <li>Process versions and Fundamentals of Laser Joining Technology</li> </ul>
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

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. Wolfgang Hintze, Prof. Claus Emmelmann	
Language	DE	
Cycle	SoSe	
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	he following learning results		
Professional Competence				
Knowledge	This module deals with the foundations of the functi		's the layers from	n the assembly-le
	programming down to gates. The module includes the	Tonowing topics.		
	Introduction			
	Combinational logic: Gates, Boolean algebra, Bo	oolean functions, hardware synthesis, c	ombinational net	works
	<ul> <li>Sequential logic: Flip-flops, automata, systemat</li> </ul>	ic hardware design		
	Technological foundations			
	Computer arithmetic: Integer addition, subtract		a la sila la s	
	Basics of computer architecture: Programming     Momories: Momory biorarchies: SRAM, DRAM, c		pipelining	
	<ul> <li>Memories: Memory hierarchies, SRAM, DRAM, c</li> <li>Input/output: I/O from the perspective of the CP</li> </ul>		oint connections	hussos
	• Input/output. No nom the perspective of the Cr	o, principles of passing data, point-to-p	onic connections,	, busses
Skills	The students perceive computer systems from the arc	hitect's perspective, i.e., they identify	the internal struct	ture and the physi
	composition of computer systems. The students can a	nalyze, how highly specific and individ	ual computers ca	n be built based o
	collection of few and simple components. They are a		ain the different	abstraction layers
	today's computing systems - from gates and circuits u	p to complete processors.		
	After successful completion of the module, the stude	ents are able to judge the interdepend	lencies between	a physical compu
	system and the software executed on it. In particular,	they shall understand the consequence	es that the exec	ution of software I
	on the hardware-centric abstraction layers from the a	ssembly language down to gates. This	way, they will be	enabled to evalu
	the impact that these low abstraction levels have on a	n entire system's performance and to p	propose feasible o	options.
Personal Competence				
	Students are able to solve similar problems alone or ir	a group and to present the results acc	ordinaly	
Social competence	stadents are able to solve similar problems alone of it	a group and to present the results ace	ordingly.	
Autonomy	Students are able to acquire new knowledge from spe	cific literature and to associate this kno	wledge with othe	er classes.
Workload in Hours	Independent Study Time 124, Study Time in Lecture 5	6		
Credit points	6	<u> </u>		
Course achievement		cription		
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 Mechatroni
	Compulsory			
	General Engineering Science (German program, 7	semester): Specialisation Mechanical	Engineering, For	cus Aircraft Syste
	Engineering: Compulsory		. –	
	General Engineering Science (German program, 7 sen	nester): Specialisation Mechanical Engi	neering, Focus Th	neoretical Mechani
	Engineering: Compulsory	Competer), Consideration Martin		Focus Material
	General Engineering Science (German program, Engineering Sciences: Compulsory	semester): Specialisation Mechanic	.ai Engineering,	rocus Materials
	General Engineering Science (German program, 7 set	nester): Specialisation Mechanical Eng	ineering Focus (	Product Developm
	and Production: Compulsory	nester). Specialisation mechanical Eng	incernig, rocus r	Toddet Developin
	General Engineering Science (German program, 7	semester): Specialisation Mechanical	Engineering, Foc	us Energy Syster
	Compulsory			3, -,
	General Engineering Science (German program, 7	semester): Specialisation Mechanica	I Engineering, F	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	S		
	Computer Science in Engineering: Core Qualification: (	Lompulsory		
	Internated Duilding Technology C C C IC C T	ative Commulation		
	Integrated Building Technology: Core Qualification: Ele Technomathematics: Specialisation II. Informatics: Ele			

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

ourse 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	
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				
<b>Recommended Previous</b>	Basics of mathematics, in particular comp	plexe numbers, integrals, differentials			
Knowledge	Basics of electrical engineering and mech				
	basics of electrical engineering and meet				
Educational Objectives	After taking part successfully, students ha	ave reached the following learning results			
Professional Competence					
Knowledge	Students can to draw and explain the bas	sic principles of electric and magnetic fields.			
	They can describe the function of the	e standard types of electric machines and pr	esent the correspor	nding equations a	
	characteristic curves. For typically used o	drives they can explain the major parameters of t	the energy efficiency	y of the whole syste	
	from the power grid to the driven engine.				
Skille	Students are able to calculate two-dime	nsional electric and magnetic fields in particula	r ferromagnetic circ	uits with air gap I	
JKIIIS	this they apply the usual methods of the		r lenomagnetic circ	uits with all gap. I	
		rmance of electric machines from their given ch		d selected quantit	
	and characteristic curves. They apply the	e usual equivalent circuits and graphical methods			
Barran I Carrantena					
Personal Competence					
Social Competence					
Autonomy	y Students are able independently to calculate electric and magnatic fields for applications. They are able to analyse independently the operational performance of electric machines from the charactersitic data and theycan calculate thereof selected quantitie				
	and characteristic curves.	machines from the characteristic data and they		or selected quartit	
Workload in Hours	Independent Study Time 110, Study Time	e in Lecture 70			
Credit points	6				
Course achievement	None				
Examination	Subject theoretical and practical work				
Examination duration and	Design of four machines and actuators, re	eview of design files			
scale					
Assignment for the	General Engineering Science (German pr	ogram, 7 semester): Specialisation Electrical Eng	ineering: Elective Co	ompulsory	
Following Curricula	General Engineering Science (German	program, 7 semester): Specialisation Mechanic	al Engineering, Foc	cus Energy Syster	
	Compulsory				
		program, 7 semester): Specialisation Mecha	nical Engineering,	Focus Mechatroni	
	Compulsory	agram 7 competer), Specialization Machanical E	nginooring Focus T	hooratical Machani	
	Engineering: Elective Compulsory	ogram, 7 semester): Specialisation Mechanical E	figineering, rocus fi		
	Digital Mechanical Engineering: Core Qua	alification: Compulsory			
	Electrical Engineering: Core Qualification:				
	Engineering Science: Specialisation Elect				
	Green Technologies: Energy, Water, Clim	ate: Specialisation Energy Technology: Elective C	Compulsory		
	Logistics and Mobility: Specialisation Eng	ineering Science: Elective Compulsory			
	Logistics and Mobility: Specialisation Traf	fic Planning and Systems: Elective Compulsory			
		duction Management and Processes: Elective Con	npulsory		
	Mechanical Engineering: Core Qualification	on: Elective Compulsory			
	Mechatronics: Core Qualification: Comput				
	Technomathematics: Specialisation III. Er	ngineering Science: Elective Compulsory	ing and Customer El	lactivo Computera	
	Technomathematics: Specialisation III. Er Engineering and Management - Major in I				

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

itle		Тур	Hrs/wk	СР
odeling, Simulation and Optimizat	on (EN) (L2446)	Integrated Lecture	4	6
Module Responsible	Prof. Benedikt Kriegesmann			
Admission Requirements	None			
<b>Recommended Previous</b>	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		
<b>Professional Competence</b>				
Knowledge	Students will have an overview of various	s technical problems and the differential equati	ons, which describe	them. Students
	gave an overview of different solution app	roaches and for which kind of problems they can	be used for.	
Skills	Students are able to solve different technic	cal problems with the introduced discretization n	nethods	
SKIIS		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 solution	strategies for complex problems self-consistent a	and critically analyse	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	eoretical Mechar
-	Engineering: Compulsory			
		gram, 7 semester): Specialisation Advanced Mat		
		rogram, 7 semester): Specialisation Mechanic	al Engineering, Foc	us Aircraft Syste
	Engineering: Elective Compulsory			
	Engineering Science: Core Qualification: Co	ompulsory		
	Mechanical Engineering: Specialisation The	eoretical Mechanical Engineering: 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	<ul> <li>Partial Differential Equations in technical problems</li> <li>Overview of modelling approaches</li> <li>Finite Approximation Methods - Finite Differences / Elements / Volumes</li> <li>Introduction to the Discrete Element Method</li> <li>Numerical methods for time dependent problems</li> <li>Gradient-based optimization</li> </ul>
Literature	Michael Schäfer, Computational Engineering - Introduction to Numerical Methods, Springer.

Courses				
Title		Turn	Hrs/wk	СР
Machine Learning I (L2432)		<b>Typ</b> Lecture	2	3
Machine Learning I (L2433)		Recitation Section (small)	2	3
Module Responsible	Prof. Nihat Ay			-
Admission Requirements	None			
Recommended Previous	Linear Algebra, Analysis, Basic Programmi	ng Course		
Knowledge	Linear Algebra, Analysis, basic Programmin	ig course		
Educational Objectives	After taking part successfully, students ha	e reached the following learning results		
Professional Competence	After taking part successivily, stadents ha			
-	The students know			
Knowledge	The students know			
	<ul> <li>general principles of machine left</li> </ul>	arning learning: supervised/unsupervised learr	ning, generative/	descriptive learning
	parametric/non-parametric learning			
	<ul> <li>different learning methods: neural n</li> </ul>	etworks, support vector machines, clustering, dim	ensionality reduc	tion, kernel metho
	<ul> <li>fundamentals of statistical learning</li> </ul>	theory		
	<ul> <li>advanced techniques such as trar</li> </ul>	sfer learning, reinforcement learning, generativ	e adversarial net	works and adapt
	control			
Skills	The students can			
	<ul> <li>apply machine learning methods to</li> </ul>	concrete problems		
	<ul> <li>select and evaluate suitable method</li> </ul>	ls for specific problems		
	<ul> <li>evaluate the quality of a trained date</li> </ul>	a-driven model		
	<ul> <li>work with known software framework</li> </ul>	ks for machine learning		
	<ul> <li>adapt the architecture and cost fund</li> </ul>	tion of neural networks to specific problems		
	<ul> <li>show the limits of machine learning</li> </ul>	methods		
Personal Competence				
	Students can work on complex problems b	oth independently and in teams. They can exchan	ge ideas with eac	h other and use th
,	individual strengths to solve the problem.		5	
Autonomy	Students are able to independently investi	gate a complex problem and assess which competent	tencies are require	ed to solve it.
Workload in Hours	Independent Study Time 124, Study Time	n Lecture 56		
Credit points	6			
Course achievement	Compulsory Bonus Form	Description		
	No 20 % Excercises			
Examination	Written exam			
Examination duration and	90 min			
scale				
Assignment for the	General Engineering Science (German pro	gram, 7 semester): Specialisation Mechanical Eng	ineering, Focus Tł	neoretical Mechani
Following Curricula	Engineering: Elective Compulsory			
	Computer Science: Specialisation I. Compu	ter and Software Engineering: Elective Compulsor	У	
	Data Science: Core Qualification: Compulse	ory		
	Engineering Science: Specialisation Advan-	ced Materials: Elective Compulsory		
	Engineering Science: Specialisation Mecha	nical Engineering: Elective Compulsory		
	Engineering Science: Specialisation Mecha			
	Logistics and Mobility: Specialisation Inform	nation Technology: Elective Compulsory		
	Mechanical Engineering: Specialisation The	eoretical Mechanical Engineering: Elective Compul	sory	
	Technomathematics: Specialisation II. Info	matics: Elective Compulsory		
	Technomathematics: Specialisation II. Info	matics: Elective Compulsory		
	Engineering and Management - Major in Lo	gistics and Mobility: Specialisation Information Te	chnology: Elective	Compulsory

Тур	Lecture
Hrs/wk	
CP	
	Independent Study Time 62, Study Time in Lecture 28
	Prof. Nihat Ay
Language	
Cycle	SoSe
Content	<ul> <li>History of neuroscience and machine learning (in particular, the age of deep learning)</li> <li>McCulloch-Pitts neurons and binary Artificial Neural Networks</li> <li>Boolean and threshold functions</li> <li>Universality of McCulloch-Pitts neural networks</li> <li>Learning and the perceptron convergence theorem</li> <li>Support vector machines</li> <li>Harmonic analysis of Boolean functions</li> <li>Continuous Artificial Neural Networks</li> <li>Kolmogorov's superposition theorem</li> <li>Universal approximation with continuous neural networks</li> <li>Approximation error and the gradient decent method: the general idea</li> <li>The stochastic gradient decent method (Robbins-Monro and Kiefer-Wolfowitz cases)</li> <li>Multilayer networks and the backpropagation algorithm</li> <li>Statistical Learning Theory</li> </ul>
Literature	<ul> <li>Martin Anthony and Peter L. Bartlett. Neural Network Learning: Theoretical Foundations. Cambridge University Press, 1999.</li> <li>Martin Anthony. Discrete Mathematics of Neural Networks: Selected Topics. SIAM Monographs on Discrete Mathematics Applications, 1987.</li> <li>Mehryar Mohri, Afshin Rostamizadeh and Ameet Talwalkar. Foundations of Machine Learning, Second Edition. MIT Pres 2018.</li> <li>Christopher M. Bishop. Pattern Recognition and Machine Learning. Information Science and Statistics. Springer-Verlag, 200</li> <li>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.</li> <li>Luc Devroye, László Györfi, Gábor Lugosi. A Probabilistic Theory of Pattern Recognition. Springer, 1996.</li> <li>Vladimir Vapnik. The Nature of Statistical Learning Theory. Springer-Verlag: New York, Berlin, Heidelberg, 1995.</li> </ul>

Course L2433: Machine Learning I	
Тур	Recitation Section (small)
Hrs/wk	2
CP	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
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	СР
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. Anusch Taraz			
	None			
Recommended Previous	Mathematics I - III			
Knowledge				
	After taking part successfully, students have reached t	he following learning results		
Professional Competence				
Knowledge	. Chudanta ann anns tha baais anns tha bais	weating NV Theory and all the sounds in the		
	<ul> <li>Students can name the basic concepts in Mathe</li> </ul>			
	<ul> <li>Students can discuss logical connections between the students of the students of</li></ul>	en these concepts. They are capable	of illustrating th	ese connections wi
	the help of examples.			
	<ul> <li>They know proof strategies and can reproduce t</li> </ul>	hem.		
Skills	<ul> <li>Students can model problems in Mathematics</li> </ul>	IV with the help of the concepts studi	ed in this course	. Moreover, they a
	capable of solving them by applying established			
	<ul> <li>Students are able to discover and verify further</li> </ul>	-		
	<ul> <li>For a given problem, the students can develo</li> </ul>	o and execute a suitable approach, a	nd are able to c	ritically evaluate the
	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
	<ul> <li>Students are able to work together in teams. The</li> </ul>			
	<ul> <li>In doing so, they can communicate new conception</li> </ul>		perating partners	. Moreover, they ca
	design examples to check and deepen the unde	rstanding of their peers.		
Autonomy				
Autonomy	<ul> <li>Students are capable of checking their underst</li> </ul>	anding of complex concepts on their o	wn. They can sp	ecify open question
	precisely and know where to get help in solving	them.		
	<ul> <li>Students have developed sufficient persistence</li> </ul>		s in a goal-orien	ted manner on ha
	problems.	to be able to work for longer period	is in a goal-orien	
	problems.			
	Independent Study Time 68, Study Time in Lecture 11.	2		
Credit points				
Course achievement				
	Written exam			
Examination duration and	60 min (Complex Functions) + 60 min (Differential Equ	ations 2)		
scale				
Assignment for the	General Engineering Science (German program, 7 sem	ester): Specialisation Electrical Engine	ering: Compulsor	у
5	General Engineering Science (German program, 7		5 1	·
. Showing curricula		constant, operandation meenanice		
	Compulsory			
	General Engineering Science (German program, 7 sem	ester): Specialisation Naval Architectur	e: Compulsory	
	General Engineering Science (German program, 7 sem	ester): Specialisation Mechanical Engin	neering, Focus Th	neoretical Mechanic
	Engineering: Elective Compulsory			
	Electrical Engineering: Core Qualification: Compulsory			
	Lieunical Engineering: Core Qualification: Compulsory			
			ring, Compulsory	
	General Engineering Science (English program, 7 seme	ester): Specialisation Electrical Enginee	ring. Compuisory	
	General Engineering Science (English program, 7 seme Computer Science in Engineering: Specialisation II. Ma	thematics & Engineering Science: Elect		
	General Engineering Science (English program, 7 seme Computer Science in Engineering: Specialisation II. Ma Mechanical Engineering: Specialisation Mechatronics: (	thematics & Engineering Science: Elect Compulsory	ive Compulsory	
	General Engineering Science (English program, 7 seme Computer Science in Engineering: Specialisation II. Ma Mechanical Engineering: Specialisation Mechatronics: 0 Mechanical Engineering: Specialisation Theoretical Me	thematics & Engineering Science: Elect Compulsory	ive Compulsory	
	General Engineering Science (English program, 7 send Computer Science in Engineering: Specialisation II. Ma Mechanical Engineering: Specialisation Mechatronics: Mechanical Engineering: Specialisation Theoretical Me Mechatronics: Core Qualification: Compulsory	thematics & Engineering Science: Elect Compulsory	ive Compulsory	
	General Engineering Science (English program, 7 seme Computer Science in Engineering: Specialisation II. Ma Mechanical Engineering: Specialisation Mechatronics: 0 Mechanical Engineering: Specialisation Theoretical Me	thematics & Engineering Science: Elect Compulsory	ive Compulsory	

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	<ul> <li>Examples of partial differential equations</li> <li>First order quasilinear differential equations</li> <li>Normal forms of second order differential equations</li> <li>Harmonic functions and maximum principle</li> <li>Maximum principle for the heat equation</li> <li>Wave equation</li> <li>Liouville's formula</li> <li>Special functions</li> <li>Difference methods</li> <li>Finite elements</li> <li>http://www.math.uni-hamburg.de/teaching/export/tuhh/index.html</li> </ul>

Course L1044: Differential E	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 E	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	<ul> <li>Functions of one complex variable</li> <li>Complex differentiation</li> <li>Conformal mappings</li> <li>Complex integration</li> <li>Cauchy's integral theorem</li> <li>Cauchy's integral formula</li> <li>Taylor and Laurent series expansion</li> <li>Singularities and residuals</li> <li>Integral transformations: Fourier and Laplace transformation</li> </ul>
Literature	http://www.math.uni-hamburg.de/teaching/export/tuhh/index.html

Course L1041: Complex Fund	ourse 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

## **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.

6					
Courses					
Title	1// 1005	Тур	Hrs/wk	СР	
Fundamentals of Materials Science		Lecture Lecture	2	2 2	
Physical and Chemical Basics of M	<ul> <li>II (Advanced Ceramic Materials, Polymers and Composites) (L0506) aterials Science (L1095)</li> </ul>	Lecture	2	2	
	Prof. Jörg Weißmüller		_	_	
Admission Requirements					
	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 i	metals, ceramics and	polymers and can desc	ribe this knowled	
	comprehensively. Fundamental knowledge here means specific	ally the issues of aton	nic structure, microstruct	ure, phase diagrar	
	phase transformations, corrosion and mechanical properties. T	he students know abo	ut the key aspects of char	acterization meth	
	for materials and can identify relevant approaches for cha	aracterizing specific p	roperties. They are able	e to trace mater	
	phenomena back to the underlying physical and chemical laws	of nature.			
Skills	The students are able to trace materials phenomena back t	the underlying phy	sical and chemical laws	of nature. Mater	
	phenomena here refers to mechanical properties such as stre				
	resistance, and to phase transformations such as solidification, precipitation, or melting. The students can explain the relation				
	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					
Course achievement					
	Written exam				
Examination duration and scale					
	General Engineering Science (German program, 7 semester): S	necialisation Mechanic	al Engineering: Compulse	orv	
Following Curricula				-	
<b>3</b>	General Engineering Science (German program, 7 semester): S				
	Data Science: Specialisation Materials Science: Compulsory				
	Digital Mechanical Engineering: Core Qualification: Compulsory	,			
	Energy and Environmental Engineering: Core Qualification: Compulsory				
	Green Technologies: Energy, Water, Climate: Specialisation Energy	ergy Technology: Elect	ive Compulsory		
	Logistics and Mobility: Specialisation Engineering Science: Elec	tive Compulsory			
	Logistics and Mobility: Specialisation Production Management a	and Processes: Elective	e 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 Mobili	ty: Specialisation Proc	luction Management and	Processes Flor	
	Engineering and Management - Major in Eogistics and Mobili	cy. specialisation riot	action management and	TTOCESSES. 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	s 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 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, Prof. Stefan Fritz Müller
Language	DE
Cycle	WiSe
Content	<ul> <li>Motivation: "Atoms in Mechanical Engineering?"</li> <li>Basics: Force and Energy</li> <li>The electromagnetic Interaction</li> <li>"Detour": Mathematics (complex e-funktion etc.)</li> <li>The atom: Bohr's model of the atom</li> <li>Chemical bounds</li> <li>The multi part problem: Solutions and strategies</li> <li>Descriptions of using statistical thermodynamics</li> <li>Elastic theory of atoms</li> <li>Consequences of atomar properties on makroskopic Properties: Discussion of examples (metals, semiconductors, hybrid systems)</li> </ul>
Literature	<ul> <li>Für den Elektromagnetismus:</li> <li>Bergmann-Schäfer: "Lehrbuch der Experimentalphysik", Band 2: "Elektromagnetismus", de Gruyter</li> <li>Für die Atomphysik:</li> <li>Haken, Wolf: "Atom- und Quantenphysik", Springer</li> <li>Für die Materialphysik und Elastizität:</li> <li>Hornbogen, Warlimont: "Metallkunde", Springer</li> </ul>

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				
<b>Recommended Previous</b>	Basic knowledge in electrical engineering				
Knowledge					
Educational Objectives	After taking part successfully, students have rea	ched the following learning results			
Professional Competence					
Knowledge	This module deals with the foundations of the programming down to gates. The module includ • Introduction		ers the layers from	n the assembly-le	
	<ul> <li>Combinational logic: Gates, Boolean algel</li> <li>Sequential logic: Flip-flops, automata, system</li> <li>Technological foundations</li> <li>Computer arithmetic: Integer addition, suther addition and the system</li> <li>Basics of computer architecture: Program</li> <li>Memories: Memory hierarchies, SRAM, DF</li> <li>Input/output: I/O from the perspective of</li> </ul>	tematic hardware design btraction, multiplication and division ming models, MIPS single-cycle architecture RAM, caches	e, pipelining		
Skills	The students perceive computer systems from the architect's perspective, i.e., they identify the internal structure and the physic composition of computer systems. The students can analyze, how highly specific and individual computers can be built based or collection of few and simple components. They are able to distinguish between and to explain the different abstraction layers today's computing systems - from gates and circuits up to complete processors. After successful completion of the module, the students are able to judge the interdependencies between a physical comput system and the software executed on it. In particular, they shall understand the consequences that the execution of software hor the hardware-centric abstraction layers from the assembly language down to gates. This way, they will be enabled to evalue the impact that these low abstraction levels have on an entire system's performance and to propose feasible options.				
Porsonal Compotonco					
Personal Competence		o or in a group and to precent the results as	cordinaly		
Social Competence	Students are able to solve similar problems alon	e or in a group and to present the results ac	cordingly.		
Autonomy	Students are able to acquire new knowledge fro	m specific literature and to associate this kn	owledge with othe	r classes.	
Werkload in Heure	Independent Study Time 124, Study Time in Lec				
Workload in Hours		ture 56			
Credit points		Description			
Course achievement	Yes 10 % Excercises	Description			
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 Scien	ice: Compulsory		
Following Curricula	General Engineering Science (German program,	7 semester): Specialisation Civil Engineerin	g: Compulsory		
	General Engineering Science (German program,	7 semester): Specialisation Process Engine	ering: Compulsory		
	General Engineering Science (German progra	am, 7 semester): Specialisation Mechani	cal Engineering, F	ocus Mechatroni	
	Compulsory				
		- 7 Constallation Machanial			
	General Engineering Science (German progra	m, / semester): Specialisation Mechanica	l Engineering, Foc	us Aircraft Syste	
	Engineering: Compulsory	m, 7 semester): Specialisation Mechanica	l Engineering, Foc	us Aircraft Syste	
	Engineering: Compulsory General Engineering Science (German program, Engineering: Compulsory	7 semester): Specialisation Mechanical Eng	jineering, Focus Th	eoretical Mechani	
	Engineering: Compulsory General Engineering Science (German program, Engineering: Compulsory General Engineering Science (German progr	7 semester): Specialisation Mechanical Eng	jineering, Focus Th	eoretical Mechani	
	Engineering: Compulsory General Engineering Science (German program, Engineering: Compulsory General Engineering Science (German progr Engineering Sciences: Compulsory	7 semester): Specialisation Mechanical Engram, 7 semester): Specialisation Mechan	jineering, Focus Th	eoretical Mechani Focus Materials	
	Engineering: Compulsory General Engineering Science (German program, Engineering: Compulsory General Engineering Science (German progr Engineering Sciences: Compulsory General Engineering Science (German program	7 semester): Specialisation Mechanical Engram, 7 semester): Specialisation Mechan	jineering, Focus Th	eoretical Mechani Focus Materials	
	Engineering: Compulsory General Engineering Science (German program, Engineering: Compulsory General Engineering Science (German progr Engineering Sciences: Compulsory	7 semester): Specialisation Mechanical Engram, 7 semester): Specialisation Mechan , 7 semester): Specialisation Mechanical En	pineering, Focus Th ical Engineering, gineering, Focus P	eoretical Mechani Focus Materials roduct Developme	
	Engineering: Compulsory General Engineering Science (German program, Engineering: Compulsory General Engineering Science (German progr Engineering Sciences: Compulsory General Engineering Science (German program and Production: Compulsory	7 semester): Specialisation Mechanical Engram, 7 semester): Specialisation Mechan , 7 semester): Specialisation Mechanical En	pineering, Focus Th ical Engineering, gineering, Focus P	eoretical Mechani Focus Materials roduct Developme	
	Engineering: Compulsory General Engineering Science (German program, Engineering: Compulsory General Engineering Science (German progr Engineering Sciences: Compulsory General Engineering Science (German program and Production: Compulsory General Engineering Science (German program	7 semester): Specialisation Mechanical Eng am, 7 semester): Specialisation Mechan , 7 semester): Specialisation Mechanical En m, 7 semester): Specialisation Mechanical	pineering, Focus Th ical Engineering, igineering, Focus P Engineering, Focu	eoretical Mechani Focus Materials roduct Developm us Energy Syster	
	Engineering: Compulsory General Engineering Science (German program, Engineering: Compulsory General Engineering Science (German progr Engineering Sciences: Compulsory General Engineering Science (German program and Production: Compulsory General Engineering Science (German program Compulsory	7 semester): Specialisation Mechanical Eng am, 7 semester): Specialisation Mechan , 7 semester): Specialisation Mechanical En m, 7 semester): Specialisation Mechanical	pineering, Focus Th ical Engineering, igineering, Focus P Engineering, Focu	eoretical Mechani Focus Materials roduct Developm us Energy Syster	
	Engineering: Compulsory General Engineering Science (German program, Engineering: Compulsory General Engineering Science (German progra Engineering Sciences: Compulsory General Engineering Science (German program and Production: Compulsory General Engineering Science (German program Compulsory General Engineering Science (German program	7 semester): Specialisation Mechanical Eng ram, 7 semester): Specialisation Mechanical Eng r, 7 semester): Specialisation Mechanical Eng m, 7 semester): Specialisation Mechanical r, 7 semester): Specialisation Mechanical r, 7 semester): Specialisation Naval Architect r, 8 semester): Specialisation Biomedical Eng r, 8 semester): Specialisation Bioprocess Engl r, 9 semester): Specialisation Bioprocess Engl r, 9 semester): Specialisation Electrical Englin	gineering, Focus Th ical Engineering, igineering, Focus P Engineering, Focu cal Engineering, Focu cal Engineering, F ure: Compulsory ineering: Compulsory eering: Compulsory	eoretical Mechani Focus Materials roduct Developm us Energy Syster ocus Biomechani ry ry	
	Engineering: Compulsory General Engineering Science (German program, Engineering: Compulsory General Engineering Science (German progra Engineering Sciences: Compulsory General Engineering Science (German program and Production: Compulsory General Engineering Science (German program Compulsory General Engineering Science (German program, General Engineering Science (German program,	7 semester): Specialisation Mechanical Eng ram, 7 semester): Specialisation Mechanical Eng r, 7 semester): Specialisation Mechanical Eng m, 7 semester): Specialisation Mechanical r, 7 semester): Specialisation Mechanical r, 7 semester): Specialisation Mechanical r, 8 semester): Specialisation Naval Architector r, 8 semester): Specialisation Biomedical Eng r, 9 semester): Specialisation Biomedical Eng r, 9 semester): Specialisation Bioprocess Engi r, 9 semester): Specialisation Electrical Engin r, 9 semester): Specialisation Green Technolo	gineering, Focus Th ical Engineering, igineering, Focus P Engineering, Focu cal Engineering, Focu cal Engineering, F ure: Compulsory ineering: Compulsory eering: Compulsory	eoretical Mechani Focus Materials roduct Developm us Energy Syster ocus Biomechani ry ry	
	Engineering: Compulsory General Engineering Science (German program, Engineering: Compulsory General Engineering Science (German progra Engineering Sciences: Compulsory General Engineering Science (German program and Production: Compulsory General Engineering Science (German program Compulsory General Engineering Science (German program, General Engineering Science (German program,	7 semester): Specialisation Mechanical Eng am, 7 semester): Specialisation Mechanical Eng , 7 semester): Specialisation Mechanical Eng m, 7 semester): Specialisation Mechanical am, 7 semester): Specialisation Mechanical am, 7 semester): Specialisation Naval Architector 7 semester): Specialisation Biomedical Eng 7 semester): Specialisation Biomedical Eng 7 semester): Specialisation Bioprocess Engi 7 semester): Specialisation Electrical Engin 7 semester): Specialisation Green Technolo	gineering, Focus Th ical Engineering, igineering, Focus P Engineering, Focu cal Engineering, Focu cal Engineering, F ure: Compulsory ineering: Compulsory eering: Compulsory	eoretical Mechani Focus Materials roduct Developm us Energy Syster ocus Biomechani ry ry	
	Engineering: Compulsory General Engineering Science (German program, Engineering: Compulsory General Engineering Science (German progra Engineering Sciences: Compulsory General Engineering Science (German program and Production: Compulsory General Engineering Science (German program Compulsory General Engineering Science (German program, General Engineering Science (German program, Compulsory Computer Science: Core Qualification: Compulsory	7 semester): Specialisation Mechanical Eng am, 7 semester): Specialisation Mechanical Eng , 7 semester): Specialisation Mechanical Eng m, 7 semester): Specialisation Mechanical am, 7 semester): Specialisation Mechanical am, 7 semester): Specialisation Naval Architector 7 semester): Specialisation Biomedical Eng 7 semester): Specialisation Biomedical Eng 7 semester): Specialisation Bioprocess Engi 7 semester): Specialisation Electrical Engin 7 semester): Specialisation Green Technolo pry ulsory	gineering, Focus Th ical Engineering, igineering, Focus P Engineering, Focu cal Engineering, Focu cal Engineering, F ure: Compulsory ineering: Compulsory eering: Compulsory	eoretical Mechani Focus Materials roduct Developm us Energy Syster ocus Biomechani ry ry	
	Engineering: Compulsory General Engineering Science (German program, Engineering: Compulsory General Engineering Science (German progra Engineering Sciences: Compulsory General Engineering Science (German program and Production: Compulsory General Engineering Science (German program Compulsory General Engineering Science (German program, General Engineering Science (German program, Compulsory Computer Science: Core Qualification: Compulsor	7 semester): Specialisation Mechanical Eng am, 7 semester): Specialisation Mechanical Eng , 7 semester): Specialisation Mechanical Eng m, 7 semester): Specialisation Mechanical am, 7 semester): Specialisation Mechanical am, 7 semester): Specialisation Naval Architector 7 semester): Specialisation Biomedical Eng 7 semester): Specialisation Biomedical Eng 7 semester): Specialisation Bioprocess Engi 7 semester): Specialisation Electrical Engin 7 semester): Specialisation Green Technolo pry ulsory ulsory	gineering, Focus Th ical Engineering, igineering, Focus P Engineering, Focus cal Engineering, Focus cal Engineering, Focus ineering: Compulsory ineering: Compulsory igies, Focus Renew	eoretical Mechani Focus Materials roduct Developm us Energy Syster ocus Biomechani ry ry	
	Engineering: Compulsory General Engineering Science (German program, Engineering: Compulsory General Engineering Science (German progra Engineering Sciences: Compulsory General Engineering Science (German program and Production: Compulsory General Engineering Science (German program Compulsory General Engineering Science (German program, General Engineering Science (German program, Compulsory Computer Science: Core Qualification: Compulsor Data Science: Core Qualification: Elective Comp Electrical Engineering: Core Qualification: Compulsor	7 semester): Specialisation Mechanical Eng am, 7 semester): Specialisation Mechanical Eng , 7 semester): Specialisation Mechanical Eng m, 7 semester): Specialisation Mechanical am, 7 semester): Specialisation Mechanical am, 7 semester): Specialisation Mechanical 7 semester): Specialisation Naval Architectu 7 semester): Specialisation Biomedical Eng 7 semester): Specialisation Bioprocess Engi 7 semester): Specialisation Electrical Engin 7 semester): Specialisation Green Technolo 9 ry ulsory 0 semester): Specialisation Civil Engineering m, 7 semester): Specialisation Civil Engineering m, 7 semester): Specialisation Mechanical	gineering, Focus Th ical Engineering, ogineering, Focus P Engineering, Focus cal Engineering, Focus cal Engineering, Focus ineering: Compulsory ineering: Compulsory gies, Focus Renew p: Compulsory cal Engineering, F	eoretical Mechani Focus Materials roduct Developm us Energy System ocus Biomechani ry ry able Energy: Elect	

Engineering: Compulsory
General Engineering Science (English program, 7 semester): Specialisation Mechanical Engineering, Focus Materials in Engineering
Sciences: Compulsory
General Engineering Science (English program, 7 semester): Specialisation Mechanical Engineering, Focus Mechatronics:
Compulsory
General Engineering Science (English program, 7 semester): Specialisation Mechanical Engineering, Focus Product Development
and Production: Compulsory
General Engineering Science (English program, 7 semester): Specialisation Mechanical Engineering, Focus Theoretical Mechanical
Engineering: Compulsory
Computational Science and Engineering: Core Qualification: Compulsory
Mechatronics: Core Qualification: Compulsory
Technomathematics: Specialisation II. Informatics: Elective Compulsory

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

Course L0324: Computer Eng	ourse 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		

Typ       Hrs/wk       CP         iluid Mechanics (L0454)       Lecture       3       4         iluid Mechanics (L0455)       Recitation Section (large)       2       2         Module Responsible       Prof. Thomas Rung       Vertex						
Typ       Hrs/wk       CP         Huld Mechanics (L0454)       Lecture       3       4         Module Responsible       Prof. Thomas Rung       Recitation Section (large)       2       2         Module Responsible       Prof. Thomas Rung       Admission Requirement       None        2       2         Recommended Previous       Sound knowledge of engineering mathematics, engineering mechanics and thermodynamics.         2       2         Educational Objectives       After taking part successfully, students have reached the following learning results         3       4 <th>Module M0680: Fluid</th> <th>Dynamics</th> <th></th> <th></th> <th></th> <th></th>	Module M0680: Fluid	Dynamics				
Typ       Hrs/wk       CP         Huld Mechanics (L0454)       Lecture       3       4         Module Responsible       Prof. Thomas Rung       Recitation Section (large)       2       2         Module Responsible       Prof. Thomas Rung       Admission Requirement       None        2       2         Recommended Previous       Sound knowledge of engineering mathematics, engineering mechanics and thermodynamics.         2       2         Educational Objectives       After taking part successfully, students have reached the following learning results         3       4 <th></th> <th></th> <th></th> <th></th> <th></th> <th></th>						
Lieture         3         4           Nuid Mechanics (L0454)         Recitation Section (large)         2         2           Module Responsibile         Prof. Thomas Rung         2         2           Admission Requirementa         None	Courses					
Becitation Section (large)       2       2         Module Responsible       Porf. Thomas Rung       Image: Complex Comple	Title			Тур	Hrs/wk	СР
Module Responsible       Prof. Thomas Rung         Admission Requirements       None         Recommended Previous       Sound knowledge of engineering mathematics, engineering mechanics and thermodynamics.         Knowledge       After taking part successfully, students have reached the following learning results         Professional Competence       Knowledge         Knowledge       Students will have the required sound knowledge to explain the general principles of fluid engineering and physics of fluid students can scientifically outline the rationale of flow physics using mathematical models and are familiar with methods for th performance analysis and the prediction of fluid engineering devices.         Skills       Students are able to apply fluid-engineering principles and flow-physics models for the analysis of technical systems. The lecture enables the student to carry out all necessary theoretical calculations for the fluid dynamic design of engineering devices on scientific level.         Personal Competence       Social Competence         Social Competence       The students are able to discuss problems and jointly develop solution strategies.         Autonomy       The students are able to discuss problems and jointly develop solution strategies.         Workload in Hours       Independent Study Time 110, Study Time in Lecture 70         Credit points       6         Course achievement       None         Examination duration and scale       180 min         scale       Seleval fl	Fluid Mechanics (L0454)					-
Admission Requirements         None           Recommended Previous Knowledge         Sound knowledge of engineering mathematics, engineering mechanics and thermodynamics.           Educational Objectives         After taking part successfully, students have reached the following learning results           Professional Competence Knowledge         Students will have the required sound knowledge to explain the general principles of fluid engineering and physics of fluids Students can scientifically outline the rationale of flow physics using mathematical models and are familiar with methods for th performance analysis and the prediction of fluid engineering devices.           Skills         Students are able to apply fluid-engineering principles and flow-physics models for the analysis of technical systems. The lectur enables the student to carry out all necessary theoretical calculations for the fluid dynamic design of engineering devices on scientific level.           Personal Competence Social Competence         The students are able to discuss problems and jointly develop solution strategies.           Mutonomy         The students are able to develop solution strategies for complex problems self-consistent and crtically analyse results.           Workload in Hours         Independent Study Time 110, Study Time in Lecture 70           Course achievement         None           Examination         Written exam           Examination duration and scale         180 min           Asignment for the Following Curricula         General Engineering Science (German program, 7 semester): Specialisation Mechanica	Fluid Mechanics (L0455)			Recitation Section (large)	2	2
Recommended Previous         Sound knowledge           Recommended Previous         Sound knowledge           Educational Objectives         After taking part successfully, students have reached the following learning results           Professional Competence         Knowledge           Knowledge         Students will have the required sound knowledge to explain the general principles of fluid engineering and physics of fluid           Students can scientifically outline the rationale of flow physics using mathematical models and are familiar with methods for th performance analysis and the prediciton of fluid engineering devices.           Skills         Students are able to apply fluid-engineering principles and flow-physics models for the analysis of technical systems. The lectur enables the student to carry out all necessary theoretical calculations for the fluid dynamic design of engineering devices on scientific level.           Personal Competence         The students are able to discuss problems and jointly develop solution strategies.           Autonomy         The students are able to discuss problems and jointly develop solution strategies.           Workload in Hours         Independent Study Time 110, Study Time in Lecture 70           Credit points         6           Course achievement         None           Examination         Written exam           Examination and scale         IBO min           Scale         General Engineering Science (German program, 7 semester): Specialisation Mechanical	Module Responsible	Prof. Thomas Rung				
Knowledge       Adventext         Educational Objectives       Art taking part successfully, students have reached the following learning results         Professional Competence       Students will have the required sound knowledge to explain the general principles of fluid engineering and physics of fluid         Students can scientifically outline the rationale of flow physics using mathematical models and are familiar with methods for the performance analysis and the prediciton of fluid engineering devices.         Skills       Students are able to apply fluid-engineering principles and flow-physics models for the analysis of technical systems. The lectur enables the student to carry out all necessary theoretical calculations for the fluid dynamic design of engineering devices on scientific level.         Personal Competence       The students are able to discuss problems and jointly develop solution strategies.         Social Competence       The students are able to develop solution strategies for complex problems self-consistent and critically analyse results.         Workload in Houra       Independent Study Time 110, Study Time in Lecture 70         Gcourse achievement       None         Examination       Written exam         State       Secial Competence         Assignment for th       General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Naval Architecture: Compulsory Mechanical Engineering: Compulsory General Engineering Science (German program, 7 semester): Specialis	Admission Requirements	None				
Educational Objective         After taking part successfully, students have reached the following learning results           Professional Competence         Knowledge         Students will have the required sound knowledge to explain the general principles of fluid engineering and physics of fluids Students can scientifically outline the rationale of flow physics using mathematical models and are familiar with methods for the performance analysis and the prediction of fluid engineering devices.           Skills         Students are able to apply fluid-engineering principles and flow-physics models for the analysis of technical systems. The lectur enables the student to carry out all necessary theoretical calculations for the fluid dynamic design of engineering devices on scientific level.           Personal Competence         The students are able to discuss problems and jointly develop solution strategies.           Autonomy         The students are able to develop solution strategies for complex problems self-consistent and crtically analyse results.           Workload in Hours         Independent Study Time 110, Study Time in Lecture 70           Credit points         6           Course achievement         None           Examination         Unit exam           Stale         General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Naval Architecture: Compulsory Mechanical Engineering Science (German program, 7 semester): Specialisation Naval Architecture: Compulsory Mechanical Engineering Science (German program, 7 semester): Specialisati	<b>Recommended Previous</b>	Sound knowledge of engineering mathe	ematics, engineering mee	chanics and thermodynamics.		
Professional Competence         Students will have the required sound knowledge to explain the general principles of fluid engineering and physics of fluid           Students can scientifically outline the rationale of flow physics using mathematical models and are familiar with methods for the performance analysis and the prediciton of fluid engineering devices.         Skills           Skills         Students are able to apply fluid-engineering principles and flow-physics models for the analysis of technical systems. The lectur enables the student to carry out all necessary theoretical calculations for the fluid dynamic design of engineering devices on scientific level.           Personal Competence         The students are able to discuss problems and jointly develop solution strategies.           Autonomy         The students are able to discuss problems and jointly develop solution strategies.           Workload in Hours         Independent Study Time 110, Study Time in Lecture 70           Credit points         6           Course achievement         None           Examination duration and         180 min           scale         Scale           Assignment for the         General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Naval Architecture: Compulsory Mechanical Engineering: Com Qualification: Compulsory Naval Architecture: Com Qualification: Compulsory	Knowledge					
Knowledge       Students will have the required sound knowledge to explain the general principles of fluid engineering and physics of fluid         Students can scientifically outline the rationale of flow physics using mathematical models and are familiar with methods for th         performance analysis and the prediction of fluid engineering devices.         Skills       Students are able to apply fluid-engineering principles and flow-physics models for the analysis of technical systems. The lectur         enables the student to carry out all necessary theoretical calculations for the fluid dynamic design of engineering devices on scientific level.         Personal Competence       The students are able to discuss problems and jointly develop solution strategies.         Autonomy       The students are able to develop solution strategies for complex problems self-consistent and critically analyse results.         Workload in Hours       Independent Study Time 110, Study Time in Lecture 70         Gourse achievement       None         Examination       Written exam         Result       180 min         General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering: Compulsory         General Engineering Science (German program, 7 semester): Specialisation Naval Architecture: Compulsory         Mechanical Engineering: Core Qualification: Compulsory         Neurotical Engineering: Core Qualification: Compulsory	Educational Objectives	After taking part successfully, students	have reached the follow	ing learning results		
Students can scientifically outline the rationale of flow physics using mathematical models and are familiar with methods for the performance analysis and the prediciton of fluid engineering devices.         Skills       Students are able to apply fluid-engineering principles and flow-physics models for the analysis of technical systems. The lectur enables the student to carry out all necessary theoretical calculations for the fluid dynamic design of engineering devices on scientific level.         Personal Competence       The students are able to discuss problems and jointly develop solution strategies.         Autonomy       The students are able to develop solution strategies for complex problems self-consistent and crtically analyse results.         Workload in Hours       Independent Study Time 110, Study Time in Lecture 70         Course achievement       None         Examination       Written exam         Examination duration and scale       100 min         General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Biomedical Engineering: Compulsory Mechanical Engineering: Compulsory (Seneral Engineering Science (German program, 7 semester): Specialisation Naval Architecture: Compulsory Naval Architecture: Compulsory Naval Architecture: Compulsory	Professional Competence					
enables the student to carry out all necessary theoretical calculations for the fluid dynamic design of engineering devices on scientific level.         Personal Competence       The students are able to discuss problems and jointly develop solution strategies.         Autonomy       The students are able to develop solution strategies for complex problems self-consistent and crtically analyse results.         Workload in Hours       Independent Study Time 110, Study Time in Lecture 70         Credit points       6         Course achievement       None         Examination       Written exam         Examination duration and scale       180 min         Following Curricula       General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Biomedical Engineering: Compulsory Mechanical Engineering: Compu	Knowledge	Students can scientifically outline the r	ationale of flow physics	using mathematical models		
Social Competence       The students are able to discuss problems and jointly develop solution strategies.         Autonomy       The students are able to develop solution strategies for complex problems self-consistent and crtically analyse results.         Workload in Hours       Independent Study Time 110, Study Time in Lecture 70         Credit points       6         Course achievement       None         Examination duration and scale       130 min         Assignment for the Following Curricul       General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering: Compulsory         General Engineering Science (German program, 7 semester): Specialisation Naval Architecture: Compulsory       General Engineering: Core Qualification: Compulsory         Mechanical Engineering Science (German program, 7 semester): Specialisation Naval Architecture: Compulsory       Naval Architecture: Core Qualification: Compulsory	Skills	enables the student to carry out all necessary theoretical calculations for the fluid dynamic design of engineering devices on a				
Workload in Hours       Independent Study Time 110, Study Time in Lecture 70         Credit points       6         Course achievement       None         Examination       Written exam         Examination duration and scale       180 min         Assignment for the Following Curricula       General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Biomedical Engineering: Compulsory Mechanical Engineering: Core Qualification: Compulsory Naval Architecture: Core Qualification: Compulsory		The students are able to discuss proble	ms and jointly develop s	olution strategies.		
Credit points       6         Course achievement       None         Examination       Written exam         Examination duration and scale       180 min         Assignment for the Following Curricula       General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering: Compulsory         General Engineering Science (German program, 7 semester): Specialisation Biomedical Engineering: Compulsory         General Engineering Science (German program, 7 semester): Specialisation Naval Architecture: Compulsory         Mechanical Engineering: Core Qualification: Compulsory         Mechanical Engineering: Core Qualification: Compulsory         Naval Architecture: Core Qualification: Compulsory	Autonomy	The students are able to develop solutic	on strategies for complex	c problems self-consistent and	d crtically analyse	e results.
Credit points       6         Course achievement       None         Examination       Written exam         Examination duration and scale       180 min         Assignment for the Following Curricula       General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering: Compulsory         General Engineering Science (German program, 7 semester): Specialisation Biomedical Engineering: Compulsory         General Engineering Science (German program, 7 semester): Specialisation Naval Architecture: Compulsory         Mechanical Engineering: Core Qualification: Compulsory         Mechanical Engineering: Core Qualification: Compulsory         Naval Architecture: Core Qualification: Compulsory	Workload in Hours	Independent Study Time 110. Study Tim	ne in Lecture 70			
Course achievement         None           Examination         Written exam           Examination duration and scale         180 min           Assignment for the Following Curricula         General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Biomedical Engineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Naval Architecture: Compulsory Mechanical Engineering: Core Qualification: Compulsory Naval Architecture: Core Qualification: Compulsory						
Examination       Written exam         Examination duration and scale       180 min         Assignment for the Following Curricula       General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering: Compulsory         General Engineering Science (German program, 7 semester): Specialisation Biomedical Engineering: Compulsory         General Engineering Science (German program, 7 semester): Specialisation Naval Architecture: Compulsory         Mechanical Engineering: Core Qualification: Compulsory         Naval Architecture: Core Qualification: Compulsory						
Examination duration and scale       180 min         Assignment for the Following Curricula       General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering: Compulsory         General Engineering Science (German program, 7 semester): Specialisation Biomedical Engineering: Compulsory         General Engineering Science (German program, 7 semester): Specialisation Biomedical Engineering: Compulsory         General Engineering Science (German program, 7 semester): Specialisation Naval Architecture: Compulsory         Mechanical Engineering: Core Qualification: Compulsory         Naval Architecture: Core Qualification: Compulsory         Naval Architecture: Core Qualification: Compulsory						
scale         Assignment for the Following Curricula       General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering: Compulsory         General Engineering Science (German program, 7 semester): Specialisation Biomedical Engineering: Compulsory         General Engineering Science (German program, 7 semester): Specialisation Naval Architecture: Compulsory         Mechanical Engineering: Core Qualification: Compulsory         Naval Architecture: Core Qualification: Compulsory	Examination duration and	180 min				
Assignment for the       General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering: Compulsory         Following Curricula       General Engineering Science (German program, 7 semester): Specialisation Biomedical Engineering: Compulsory         General Engineering Science (German program, 7 semester): Specialisation Naval Architecture: Compulsory         General Engineering: Core Qualification: Compulsory         Naval Architecture: Core Qualification: Compulsory						
Following Curricula       General Engineering Science (German program, 7 semester): Specialisation Biomedical Engineering: Compulsory         General Engineering Science (German program, 7 semester): Specialisation Naval Architecture: Compulsory         Mechanical Engineering: Core Qualification: Compulsory         Naval Architecture: Core Qualification: Compulsory		General Engineering Science (German n	program, 7 semester). Sr	pecialisation Mechanical Engin	neering: Compulse	orv
General Engineering Science (German program, 7 semester): Specialisation Naval Architecture: Compulsory Mechanical Engineering: Core Qualification: Compulsory Naval Architecture: Core Qualification: Compulsory	-		- ,	-		-
Mechanical Engineering: Core Qualification: Compulsory Naval Architecture: Core Qualification: Compulsory			-	-		,
Naval Architecture: Core Qualification: Compulsory			-			
				ctive Compulsory		

ourse L0454: Fluid Mechan	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	<ul> <li>continuum physics definition of fluids, difference to solids/structures and material properties of fluids</li> <li>dimensional analysis and similitude</li> <li>fluid forces and fluid statics</li> <li>transport and conservation of mass, momentum &amp; energy</li> <li>fluid kinematics</li> <li>technically relevant flow models for incompressible fluids         <ul> <li>control volume &amp; stream tube analysis</li> <li>vortical flow models</li> <li>potential flows</li> <li>boundary layer flows</li> <li>different types of conservation equations and their realm             (Navier-Stokes/Euler/Bernoulli equations)</li> <li>analytical solutions for Navier-Stokes systems</li> </ul> </li> <li>Analysis of internal flows (channels, pipes, open channels) and external flows, fundamentals of wing aerodynamics</li> <li>turbulent flows</li> <li>fundamentals of gas dynamics (1D compressible flows)</li> </ul>
Literature	<ul> <li>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 &amp; Sons.</li> <li>Spurk, J.; Aksel, N.: Strömungslehre, Springer.</li> <li>Schade, H.; Kunz, E., Kameier, F.; Paschereit, C.O.: Strömungslehere, De Gruyter.</li> <li>Herwig, H.: Strömungsmechanik, Springer.</li> <li>Herwig, H.: Strömungsmechanik von A-Z, Vieweg.</li> </ul>

Course L0455: Fluid Mechani	ics
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

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Courses					
Title		Тур	Hrs/wk	СР	
	al Mechanics, Numerical Mechanics) (L1137) al Mechanics, Numerical Mechanics) (L1138)	Lecture Recitation Section (small)	3 2	3 2	
-	al Mechanics, Numerical Mechanics) (L1136) al Mechanics, Numerical Mechanics) (L1139)	Recitation Section (Small) Recitation Section (large)	2	1	
Module Responsible		Reclation Section (large)	-	1	
Admission Requirements	None				
•					
Recommended Previous Knowledge	Mathematics I-III and Mechanics I-III				
	After teling part successfully, students have reach	ed the following locating regults			
	After taking part successfully, students have reach	ed the following learning results			
Professional Competence					
Knowledge	The students can				
	<ul> <li>describe the axiomatic procedure used in m</li> </ul>	echanical contexts;			
	<ul> <li>explain important steps in model design;</li> </ul>				
	<ul> <li>present technical knowledge.</li> </ul>				
Skills	The students can				
	<ul> <li>explain the important elements of mathematical elements of</li></ul>	atical / mechanical analysis and model for	mation, and app	ly it to the context	
	<ul> <li>apply basic methods to engineering problem</li> </ul>	ns;			
	<ul> <li>estimate the reach and boundaries of the methods and extend them to be applicable to wider problem sets.</li> </ul>				
Personal Competence					
Social Competence	The students can work in groups and support each	other to overcome difficulties.			
Autonomy	Students are capable of determining their own stre	engths and weaknesses and to organize the	eir 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 program, 7	semester): Specialisation Mechanical Engir	neering: Compuls	sory	
Following Curricula	General Engineering Science (German program, 7	semester): Specialisation Biomedical Engir	eering: Compuls	ory	
	General Engineering Science (German program, 7	semester): Specialisation Naval Architectu	re: Compulsory		
	Energy Systems: Technical Complementary Course	Core Studies: Elective Compulsory			
	Mechanical Engineering: Core Qualification: Compu	llsory			
	Mechatronics: Core Qualification: Compulsory				
	Naval Architecture: Core Qualification: Compulsory				
	Technomathematics: Specialisation III. Engineering	Science: Elective Compulsory			
	Theoretical Mechanical Engineering: Technical Con				

Course L1137: Mechanics IV	(Oscillations, Analytical Mechanics, Numerical Mechanics)
Тур	Lecture
Hrs/wk	3
СР	3
Workload in Hours	Independent Study Time 48, Study Time in Lecture 42
Lecturer	Prof. Robert Seifried
Language	DE
Cycle	SoSe
Content	
	<ul> <li>Elements of vibration theory</li> <li>Vibration of Multi-degree of freedom systems</li> <li>Analytical Mechanics</li> <li>Multibody Systems</li> <li>Numerical methods for time integration</li> <li>Introduction to Matlab</li> </ul>
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 L1138: Mechanics IV	(Oscillations, Analytical Mechanics, Numerical Mechanics)
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	SoSe
Content	See interlocking course
Literature	See interlocking course
Course L1139: Mechanics IV	(Oscillations, Analytical Mechanics, Numerical Mechanics)
Тур	Recitation Section (large)
Hrs/wk	1
СР	1
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14
Lecturer	Prof. Robert Seifried
Language	DE

Cycle

Content

SoSe

Literature See interlocking course

See interlocking course

Courses				
Title		Тур	Hrs/wk	СР
Introduction to Anatomy (L0384)		Lecture	2	3
Module Responsible	Prof. Udo Schumacher			
Admission Requirements	None			
<b>Recommended Previous</b>	None			
Knowledge				
Educational Objectives	After taking part successfully, students	have reached the following learning results		
Professional Competence				
Knowledge	The students can describe basal structu	res and functions of internal organs and the m	nusculoskeletal system.	
	The students can describe the basic ma	croscopy and microscopy of those systems.		
Skille	The students can recognize the relation	ship between given anatomical facts and the c	development of some cor	nmon diseases: t
JKIIIS	-	and their functions in the context of widesprea		minori disedses, c
	can explain the relevance of structures		a discuses.	
Personal Competence				
Social Competence	The students can participate in current	discussions in biomedical research and medici	ne on a professional leve	el.
Autonomy	The students are able to access anator	nical knowledge by themselves, can participa	te in conversations on t	he tonic and acqu
Autonomy	the relevant knowledge themselves.	mear knowledge by memserves, can participa		
Workload in Hours	Independent Study Time 62, Study Time	e in Lecture 28		
Credit points	3			
Course achievement	None			
Examination	Written exam			
Examination duration and	90 minutes			
scale				
Assignment for the	General Engineering Science (German p	rogram, 7 semester): Specialisation Biomedica	al Engineering: Compulso	ory
Following Curricula	General Engineering Science (German	n program, 7 semester): Specialisation Me	chanical Engineering, F	ocus Biomechan
	Compulsory			
	Data Science: Specialisation Medicine: C	Compulsory		
	Electrical Engineering: Specialisation Me	edical Technology: Elective Compulsory		
	Engineering Science: Specialisation Bior	nedical Engineering: Compulsory		
	General Engineering Science (English pr	ogram, 7 semester): Specialisation Biomedica	l Engineering: Compulsor	ry
	Mechanical Engineering: Specialisation I	Biomechanics: Compulsory		
	Biomedical Engineering: Specialisation	Medical Technology and Control Theory: Elective	ve Compulsory	
	Biomedical Engineering: Specialisation	Management and Business Administration: Elec	ctive Compulsory	
	Biomedical Engineering: Specialisation A	Artificial Organs and Regenerative Medicine: El	lective Compulsory	
	Biomedical Engineering: Specialisation I	mplants and Endoprostheses: Elective Comput	lsory	

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

Courses				
ritle		Tun	Hre hule	CD
ntre ntroduction to Radiology and Radi	ation Therapy (L0383)	<b>Typ</b> Lecture	Hrs/wk 2	<b>CP</b> 3
Module Responsible	Prof. Ulrich Carl			
Admission Requirements	None			
<b>Recommended Previous</b>	None			
Knowledge				
	After taking part successfully, students have	e reached the following learning results		
Professional Competence Knowledge	Therapy			
	The students can distinguish different types	of currently used equipment with respect	to its use in radiation th	erapy.
	The students can explain treatment plans u	sed in radiation therapy in interdisciplinary	, contexts (e.a. 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 ba	ase concepts of projection radiography, ir	ncluding angiography an	d mammography, a
	well as sectional imaging techniques (CT, M	IRT, US).		
	The students can explain the diagnostic as	well as therapeutic use of imaging techni	ques, as well as the tech	nical basis for thos
	techniques.			
	The students can choose the right treatmen	nt method depending on the patient's clinic	cal history and needs.	
	The student can explain the influence of teo	chnical errors on the imaging techniques.		
	The student can draw the right conclusions	based on the images' diagnostic findings of	or the error protocol.	
Skills	Therapy			
	The students can distinguish curative and p	alliative situations and motivate why they	came to that conclusion.	
	The students can develop adequate therapy	y concepts and relate it to the radiation bio	ological aspects.	
	The students can use the therapeutic principle (effects vs adverse effects)			
	The students can distinguish different kinds of radiation, can choose the best one depending on the situation (location of the tumor) and choose the energy needed in that situation (irradiation planning).			
	tumor) and choose the energy needed in th			
	The student can assess what an individua		e.g. follow-up treatment	, sports, social he
	groups, self-help groups, social services, ps	ycho-oncology).		
	Diagnostics			
	The students can suggest solutions for repa	irs of imaging instrumentation after having	g done error analyses.	
	The students can classify results of imagir	ng techniques according to different grou	ps of diseases based or	n their knowledge
	anatomy, pathology and pathophysiology.	J		
Personal Competence				
	The students can assess the special social s	situation of tumor patients and interact wit	h them in a professional	way.
	The students are aware of the special, o	often fear-dominated behavior of sick pe	ople caused by diagnos	stic and therapeut
	measures and can meet them appropriately	1.		
Autonomy	The students can apply their new knowledg	e and skills to a concrete therapy case.		
	The students can introduce younger studen	ts to the clinical daily routine.		
	The students are able to access anatomica	I knowledge by themselves, can participa	te competently in conve	rsations on the top
	and acquire the relevant knowledge themse	elves.		
Workload in Hours	Independent Study Time 62, Study Time in	Lecture 28		
Credit points				
Course achievement	None			
Examination	Written exam			
Examination duration and	90 minutes			
scale Assignment for the	General Engineering Science (German prog	ram 7 semester): Specialization Biomedic	al Engineering: Compulse	
Following Curricula	General Engineering Science (German progr			
2	Compulsory		2 0,	
	Data Science: Specialisation Medicine: Com			
	Electrical Engineering: Specialisation Medica			
	Engineering Science: Specialisation Biomed General Engineering Science (English progra		l Engineering: Compulso	ſy
	Mechanical Engineering: Specialisation Bion		5 5 xp.100.	-
	Biomedical Engineering: Specialisation Med			
	Biomedical Engineering: Specialisation Man			
	Biomedical Engineering: Specialisation Artif Biomedical Engineering: Specialisation Impl			
	apecialisation mp	and Endoprostreses, Elective compu		

Technomathematics: Specialisation III. Engineering Science: Elective Compulsory

Course L0383: Introduction t	o Radiology and Radiation Therapy
Тур	Lecture
Hrs/wk	2
CP	
	Independent Study Time 62, Study Time in Lecture 28 Prof. Ulrich Carl, Prof. Thomas Vestring
Language	
Cycle	
Content	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
	<ul> <li>"Strahlentherapie und Onkologie f ür MTA-R" von R. Sauer –</li> </ul>
	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

Module M0684: Heat				
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			
<b>Recommended Previous</b>				
Knowledge				
Educational Objectives		S		
Professional Competence				
Knowledge	The students can			
	- explain the technical terms,			
	- classify the various physical processes of heat transfer in terms of conduction-ba	sed and radiat	ion-based med	hanisms,
	- 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				
	In lectures and exercises, the students can use many examples and experimen manner, develop a solution and present it. Within the exercises, the students can work out targeted solutions.			
Autonomy	The students can check their level of knowledge by means of repetition questions discuss answers in exchange with the other students. In the exercises, the student 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 M	lechanical Eng	gineering, Focu	us Energy Syster
Following Curricula	Compulsory			
	General Engineering Science (German program, 7 semester): Specialisation Biome	edical Engineer	ring: Compulso	ry
	General Engineering Science (German program, 7 semester): Specialisation Mecha	anical Enginee	ring, Focus Th	eoretical Mechan
	Engineering: Compulsory			
	Energy Systems: Technical Complementary Course Core Studies: Elective Computer	sory		
	Integrated Building Technology: Core Qualification: Compulsory			
	Mechanical Engineering: Specialisation Energy Systems: Compulsory			
	Mechanical Engineering: Specialisation Theoretical Mechanical Engineering: Elective	ve 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	<ul> <li>Herwig, H.; Moschallski, A.: Wärmeübertragung, 4. Auflage, Springer Vieweg Verlag, Wiesbaden, 2019</li> <li>Herwig, H.: Wärmeübertragung von A-Z, Springer- Verlag, Berlin, Heidelberg, 2000</li> <li>Baehr, H.D.; Stephan, K.: Wärme- und Stoffübertragung, 2. Auflage, Springer Verlag, Berlin, Heidelberg, 1996</li> </ul>

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
Practical Course: Measurement and	Control Systems (L1119)	Practical	Course	2	2
Measurement Technology for Mech	anical Engineering (L1116)	Lecture		2	3
Measurement Technology for Mech	anical Engineering (L1118)	Recitatio	n Section (large)	1	1
Module Responsible	Prof. Thorsten Kern				
Admission Requirements	None				
<b>Recommended Previous</b>	Basic knowledge of physics, chemistry and	electrical engineering			
Knowledge					
Educational Objectives	After taking part successfully, students have	e reached the following learning	ng results		
Professional Competence					
Knowledge	Students are able to name the most impo	rtant fundmentals of the Meas	surement Technolog	y (Quantities and	I Units, Uncertain
	Calibration, Static and Dynamic Properties	of Sensors and Systems).			
	They can outline the most important mea	suring methods for different k	inds of quantities to	o be maesured (F	Electrical Quantiti
	Temperature, mechanical quantities, Flow		and of quantities t	o be macsarea (i	
		inne, i requeirey,			
	They can describe important methods of cl	emical Analysis (Gas Sensors,	Spectroscopy, Gas (	Chromatography)	
Skills	Students can select suitable measuring me	thods to given problems and c	an use refering mea	surement devices	s in practice.
	The students are able to orally explain iss	ues in the subiect area of mea	surement technolog	v and solution an	pproaches as well
	place the issues into the right context and			,,	
	·····				
Personal Competence					
Social Competence	Students can arrive at work results in grou	e Students can arrive at work results in groups and document them in a common report.			
			inite in tep of the		
			epore		
Autonomy	Students are able to familiarize themselves	with new measurement techn			
Workload in Hours	Independent Study Time 110, Study Time i				
Workload in Hours Credit points					
Workload in Hours	Independent Study Time 110, Study Time i 6	n Lecture 70 Description			
Workload in Hours Credit points	Independent Study Time 110, Study Time i 6 Compulsory Bonus Form	n Lecture 70 Description			
Workload in Hours Credit points Course achievement	Independent Study Time 110, Study Time i 6 Compulsory Bonus Form Yes None Subject theoretic	n Lecture 70 Description			
Workload in Hours Credit points Course achievement	Independent Study Time 110, Study Time i 6 Compulsory Bonus Form Yes None Subject theoretic practical work Subject theoretical and practical work	n Lecture 70 Description			
Workload in Hours Credit points Course achievement Examination	Independent Study Time 110, Study Time i 6 Compulsory Bonus Form Yes None Subject theoretic practical work Subject theoretical and practical work	n Lecture 70 Description			
Workload in Hours Credit points Course achievement Examination Examination duration and scale	Independent Study Time 110, Study Time i 6 Compulsory Bonus Form Yes None Subject theoretic practical work Subject theoretical and practical work	n Lecture 70 Description al and	ologies.	eering: Compulso	
Workload in Hours Credit points Course achievement Examination Examination duration and scale Assignment for the	Independent Study Time 110, Study Time i 6 Compulsory Bonus Form Yes None Subject theoretic practical work Subject theoretical and practical work 105 minutes	n Lecture 70 Description al and ram, 7 semester): Specialisatio	ologies. on Mechanical Engin		
Workload in Hours Credit points Course achievement Examination Examination duration and scale Assignment for the	Independent Study Time 110, Study Time i 6 Compulsory Bonus Form Yes None Subject theoretic practical work Subject theoretical and practical work 105 minutes General Engineering Science (German proc	n Lecture 70 Description al and ram, 7 semester): Specialisatio ram, 7 semester): Specialisatio	ologies. on Mechanical Engin on Biomedical Engin	eering: Compulso	ry
Workload in Hours Credit points Course achievement Examination Examination duration and scale Assignment for the	Independent Study Time 110, Study Time i 6 Compulsory Bonus Form Yes None Subject theoretic practical work Subject theoretical and practical work 105 minutes General Engineering Science (German prog	n Lecture 70 Description al and ram, 7 semester): Specialisatio ram, 7 semester): Specialisatio ram, 7 semester): Specialisatio	ologies. on Mechanical Engin on Biomedical Engin	eering: Compulso	ry
Workload in Hours Credit points Course achievement Examination Examination duration and scale Assignment for the	Independent Study Time 110, Study Time i 6 Compulsory Bonus Form Yes None Subject theoretic practical work Subject theoretical and practical work 105 minutes General Engineering Science (German prog General Engineering Science (German prog General Engineering Science (German prog	n Lecture 70 Description al and ram, 7 semester): Specialisatio ram, 7 semester): Specialisatio ram, 7 semester): Specialisatio ram, 7 semester): Specialisatio	ologies. on Mechanical Engin on Biomedical Engin	eering: Compulso	ry
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Workload in Hours Credit points Course achievement Examination Examination duration and scale Assignment for the	Independent Study Time 110, Study Time i 6 Compulsory Bonus Form Yes None Subject theoretic practical work Subject theoretical and practical work 105 minutes General Engineering Science (German prog General Engineering Science (German prog General Engineering Science (German prog Digital Mechanical Engineering: Core Quali Energy and Environmental Engineering: Core Engineering Science: Specialisation Mecha Engineering Science: Specialisation Mecha Engineering Science: Specialisation Biomed Engineering Science: Specialisation Advance	Description al and ram, 7 semester): Specialisatio ram, 7 semester): Specialisatio ram, 7 semester): Specialisatio ram, 7 semester): Specialisatio ication: Compulsory re Qualification: Compulsory ronics: Compulsory nical Engineering: Compulsory lical Engineering: Elective Compuls ed Materials: Elective Compuls	ologies. on Mechanical Engin on Biomedical Engin on Advanced Materia pulsory cory	eering: Compulso als: Elective Comp	ry
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Workload in Hours Credit points Course achievement Examination Examination duration and scale Assignment for the	Independent Study Time 110, Study Time i 6 Compulsory Bonus Form Yes None Subject theoretic practical work Subject theoretical and practical work 105 minutes General Engineering Science (German prog General Engineering Science (German prog General Engineering Science (German prog Digital Mechanical Engineering: Core Quali Energy and Environmental Engineering: Core Engineering Science: Specialisation Mecha Engineering Science: Specialisation Mecha Engineering Science: Specialisation Mecha Engineering Science: Specialisation Mecha Engineering Science: Specialisation Advance General Engineering Science (English prog General Engineering Science (English prog General Engineering Science (English prog General Engineering Science (English prog Logistics and Mobility: Specialisation Produ Mechanical Engineering: Core Qualification	Description al and ram, 7 semester): Specialisatio ram, 7 semester): Specialisatio ram, 7 semester): Specialisatio ram, 7 semester): Specialisatio ication: Compulsory re Qualification: Compulsory nical Engineering: Compulsory lical Engineering: Elective Com ed Materials: Elective Compuls am, 7 semester): Specialisatio am, 7 semester): Specialisatio am, 7 semester): Specialisatio am, 7 semester): Specialisatio cam, 7 semester): Specialisatio cam, 7 semester): Specialisatio com, 7 semester): Specialisatio	ologies. on Mechanical Engin on Biomedical Engin on Advanced Materia pulsory :ory n Mechatronics: Cor n Mechanical Engine n Biomedical Engine	eering: Compulso als: Elective Comp npulsory eering: Compulsor eering: Elective Co	ry bulsory Y
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ourse 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	Experiment 1: Emission and immission measurement of gaseous pollutants: different technologies to determine different gaseou pollutants in automotive exhaust are used.
	Experiment 2: Simulation and measurement of asynchrone engine and rotary pump: the dynamic behaviour of e pump engine w be investigated. The starting will be simulated on a PC and compared with measurement.
	Experiment 3: Michelson interferometer and fiber optic: fundamental optical phenonema will be understood and applications wi Michelson interferometer and optical fibers demonstrated.
	Experiment 4:Identification of the parameters of a control system and optimal control parameters
Literature	Versuch 1:
	<ul> <li>Leith, W.: Die Analyse der Luft und ihrer Verunreinigung in der freien Atmosphäre und am Arbeitsplatz. 2. Auf Wissenschaftliche Verlagsgesellschaft, Stuttgart, 1974</li> <li>Birkle, M.: Meßtechnik für den Immissionsschutz, Messen der gas- und partikelförmigen Luftverunreinigungen. R. Oldenbu Verlag, München-Wien, 1979</li> <li>Luftbericht 83/84, Freie und Hansestadt Hamburg, Behörde für Bezirksangelegenheiten, Naturschutz und Umweltgestaltun</li> <li>Gebrauchs- und Bedienungsanweisungen</li> <li>VDI-Handbuch Reinhaltung der Luft, Band 5: VDI-Richtlinien 2450 BI.1, 2451 BI.4, 2453 BI.5, 2455 BI.1</li> </ul>
	<ul> <li>Grundlagen über elektrische Maschinen, speziell: Asynchronmotoren</li> <li>Simulationsmethoden, speziell: Verwendung von Blockschaltbildern</li> <li>Betriebsverhalten von Kreispumpen, speziell: Kennlinien, Ähnlichkeitsgesetze</li> </ul>
	<ul> <li>Versuch 3:</li> <li>Unger, HG.: Optische Nachrichtentechnik, Teil 1: Optische Wellenleiter. Hüthing Verlag, Heidelberg, 1984</li> <li>Dakin, J., Cushaw, B.: Optical Fibre Sensors: Principles and Components. Artech House Boston, 1988</li> <li>Culshaw, B., Dakin, J.: Optical Fibre Sensors: Systems and Application. Artech House Boston, 1989</li> </ul>
	<ul> <li>Versuch 4:</li> <li>Leonhard: Einführung in die Regelungstechnik. Vieweg Verlag, Braunschweig-Wiesbaden</li> <li>Jan Lunze: Systemtheoretische Grundlagen, Analyse und Entwurf einschleifiger Regelungen</li> </ul>

Course L1116: Measurement	Technology for Mechanical Engineering
Тур	Lecture
Hrs/wk	
СР	3
	Independent Study Time 62, 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
	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 Technology for Mechanical Engineering	
Тур	Recitation Section (large)
Hrs/wk	1
CP	1
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14
Lecturer	Prof. Thorsten Kern
Language	EN
Cycle	WiSe
Content	See interlocking course
Literature	See interlocking course

Courses			
Гitle	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		
<b>Recommended Previous</b>			
Knowledge	<ul> <li>Mathematik I + II for Engineering Students (german or english) or Analysis &amp; Linear Algo</li> <li>basic MATLAB/Python knowledge</li> </ul>	ebra I + II for Te	echnomathematici
Educational Objectives	After taking part successfully, students have reached the following learning results		
Professional Competence			
Knowledge	Students are able to		
	<ul> <li>name numerical methods for interpolation, integration, least squares problems, eigenvaproblems and to explain their core ideas,</li> <li>repeat convergence statements for the numerical methods,</li> <li>explain aspects for the practical execution of numerical methods with respect to compute</li> </ul>		
Skills	Students are able to		
5445	<ul> <li>implement, apply and compare numerical methods using MATLAB/Python,</li> <li>justify the convergence behaviour of numerical methods with respect to the problem an</li> <li>select and execute a suitable solution approach for a given problem.</li> </ul>	d solution algor	ithm,
Personal Competence			
Social Competence	Students are able to		
	<ul> <li>work together in heterogeneously composed teams (i.e., teams from different study pro explain theoretical foundations and support each other with practical aspects regarding</li> </ul>		
Autonomy	Students are capable		
	<ul> <li>to assess whether the supporting theoretical and practical excercises are better solved i</li> <li>to assess their individual progess and, if necessary, to ask questions and seek help.</li> </ul>	individually or in	n a 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	: Compulsory	
Following Curricula	General Engineering Science (German program, 7 semester): Specialisation Biomedical Engine		ory
	General Engineering Science (German program, 7 semester): Specialisation Mechanical	Engineering,	Focus Biomechan
	Compulsory	ooring Focus T	hoorotical Mochan
	Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engine Engineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical E	-	
	General Engineering Science (German program, 7 semester): Specialisation Mechanical Engine Engineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical E Engineering: Elective Compulsory	ingineering, Fo	cus Aircraft Syste
	General Engineering Science (German program, 7 semester): Specialisation Mechanical Engine Engineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical E Engineering: Elective Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engin Compulsory	eering, Focus N	cus Aircraft Syste
	General Engineering Science (German program, 7 semester): Specialisation Mechanical Engine Engineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical E Engineering: Elective Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engin Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engin	eering, Focus N	cus Aircraft Syste
	General Engineering Science (German program, 7 semester): Specialisation Mechanical Engine Engineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical E Engineering: Elective Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engin Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engin Elective Compulsory	ngineering, Fo eering, Focus M ngineering, Foc	cus Aircraft Syste
	General Engineering Science (German program, 7 semester): Specialisation Mechanical Engine Engineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical E Engineering: Elective Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engin Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engin Elective Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engine Elective Compulsory General Engineering Science (German program, 7 semester): Specialisation Advanced Material	ngineering, Fou eering, Focus M ngineering, Foc	cus Aircraft Syste Mechatronics: Elect
	General Engineering Science (German program, 7 semester): Specialisation Mechanical Engine Engineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical E Engineering: Elective Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engin Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engin Elective Compulsory	ngineering, Fou eering, Focus M ngineering, Foc	cus Aircraft Syste Mechatronics: Elect
	General Engineering Science (German program, 7 semester): Specialisation Mechanical Engine Engineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical E Engineering: Elective Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engin Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engin Elective Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engin Elective Compulsory General Engineering Science (German program, 7 semester): Specialisation Advanced Material General Engineering Science (German program, 7 semester): Specialisation Mechanical	ingineering, For eering, Focus M ngineering, Foo Is: Compulsory al Engineering,	cus Aircraft Syste Mechatronics: Elect
	General Engineering Science (German program, 7 semester): Specialisation Mechanical Engine Engineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical E Engineering: Elective Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engin Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engine Elective Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering Elective Compulsory General Engineering Science (German program, 7 semester): Specialisation Advanced Material General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering Sciences: Compulsory	ingineering, For eering, Focus M ngineering, Foo Is: Compulsory al Engineering, Ty	cus Aircraft Syste Mechatronics: Elect
	General Engineering Science (German program, 7 semester): Specialisation Mechanical Engine Engineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical E Engineering: Elective Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engin Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engine Elective Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering Elective Compulsory General Engineering Science (German program, 7 semester): Specialisation Advanced Material General Engineering Science (German program, 7 semester): Specialisation Mechanicae Engineering Sciences: Compulsory Bioprocess Engineering: Specialisation A - General Bioprocess Engineering: Elective Compulsor	ingineering, For eering, Focus M ngineering, Foo Is: Compulsory al Engineering, Ty	cus Aircraft Syste Mechatronics: Elect
	General Engineering Science (German program, 7 semester): Specialisation Mechanical Engine Engineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical E Engineering: Elective Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engin Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engine Elective Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering Science (German program, 7 semester): Specialisation Advanced Material General Engineering Science (German program, 7 semester): Specialisation Advanced Material General Engineering Science (German program, 7 semester): Specialisation Mechanica Engineering Sciences: Compulsory Bioprocess Engineering: Specialisation A - General Bioprocess Engineering: Elective Compulsor Computer Science: Specialisation II. Mathematics and Engineering Science: Elective Compulsor	ingineering, For eering, Focus M ngineering, Foo Is: Compulsory al Engineering, Ty	cus Aircraft Syste Mechatronics: Elect
	General Engineering Science (German program, 7 semester): Specialisation Mechanical Engine Engineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical E Engineering: Elective Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engin Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engine Elective Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering Science (German program, 7 semester): Specialisation Advanced Material General Engineering Science (German program, 7 semester): Specialisation Advanced Material General Engineering Science (German program, 7 semester): Specialisation Mechanica Engineering Sciences: Compulsory Bioprocess Engineering: Specialisation A - General Bioprocess Engineering: Elective Compulsor Computer Science: Specialisation II. Mathematics and Engineering Science: Elective Compulsor Data Science: Core Qualification: Compulsory	ingineering, For eering, Focus M ngineering, Foo Is: Compulsory al Engineering, Ty	cus Aircraft Syste Mechatronics: Elect
	General Engineering Science (German program, 7 semester): Specialisation Mechanical Engine Engineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical E Engineering: Elective Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engin Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engine Elective Compulsory General Engineering Science (German program, 7 semester): Specialisation Advanced Material General Engineering Science (German program, 7 semester): Specialisation Advanced Material General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering Sciences: Compulsory Bioprocess Engineering: Specialisation A - General Bioprocess Engineering: Elective Compulsor Computer Science: Specialisation II. Mathematics and Engineering Science: Elective Compulsor Data Science: Core Qualification: Compulsory Electrical Engineering: Core Qualification: Elective Compulsory	ingineering, For eering, Focus M ngineering, Foo Is: Compulsory al Engineering, Ty	cus Aircraft Syste Mechatronics: Elect
	General Engineering Science (German program, 7 semester): Specialisation Mechanical Engine Engineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical E Engineering: Elective Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engin Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engine Elective Compulsory General Engineering Science (German program, 7 semester): Specialisation Advanced Material General Engineering Science (German program, 7 semester): Specialisation Advanced Material General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering Sciences: Compulsory Bioprocess Engineering: Specialisation A - General Bioprocess Engineering: Elective Compulsor Computer Science: Specialisation II. Mathematics and Engineering Science: Elective Compulsor Data Science: Core Qualification: Compulsory Electrical Engineering: Core Qualification: Elective Compulsory Engineering Science: Core Qualification: Compulsory Engineering Science: Core Qualification: Compulsory Computer Science in Engineering: Core Qualification: Compulsory	ingineering, For eering, Focus M ngineering, Foo Is: Compulsory al Engineering, Ty	cus Aircraft Syste Mechatronics: Elect
	General Engineering Science (German program, 7 semester): Specialisation Mechanical Engine Engineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical E Engineering: Elective Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engin Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engin Elective Compulsory General Engineering Science (German program, 7 semester): Specialisation Advanced Material General Engineering Science (German program, 7 semester): Specialisation Advanced Material General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering Sciences: Compulsory Bioprocess Engineering: Specialisation A - General Bioprocess Engineering: Elective Compulsor Computer Science: Specialisation II. Mathematics and Engineering Science: Elective Compulsor Data Science: Core Qualification: Compulsory Electrical Engineering: Core Qualification: Elective Compulsory Engineering Science: Core Qualification: Compulsory Engineering Science: Core Qualification: Compulsory Computer Science in Engineering: Core Qualification: Compulsory Mechanical Engineering: Specialisation Theoretical Mechanical Engineering: Compulsory	ingineering, For eering, Focus M ngineering, Foo Is: Compulsory al Engineering, Ty	cus Aircraft Syste Mechatronics: Elec cus Energy Syste
	General Engineering Science (German program, 7 semester): Specialisation Mechanical Engine Engineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical E Engineering: Elective Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engin Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engine Elective Compulsory General Engineering Science (German program, 7 semester): Specialisation Advanced Material General Engineering Science (German program, 7 semester): Specialisation Advanced Material General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering Sciences: Compulsory Bioprocess Engineering: Specialisation A - General Bioprocess Engineering: Elective Compulsor Computer Science: Specialisation II. Mathematics and Engineering Science: Elective Compulsor Data Science: Core Qualification: Compulsory Electrical Engineering: Core Qualification: Elective Compulsory Engineering Science: Core Qualification: Compulsory Engineering Science: Core Qualification: Compulsory Computer Science in Engineering: Core Qualification: Compulsory	ingineering, For eering, Focus M ngineering, Foc Is: Compulsory al Engineering, ry	cus Aircraft Syste Mechatronics: Elect

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	<ol> <li>Finite precision arithmetic, error analysis, conditioning and stability</li> <li>Linear systems of equations: LU and Cholesky factorization, condition</li> <li>Interpolation: polynomial, spline and trigonometric interpolation</li> <li>Nonlinear equations: fixed point iteration, root finding algorithms, Newton's method</li> <li>Linear and nonlinear least squares problems: normal equations, Gram Schmidt and Householder orthogonalization, singular value decomposition, regularizatio, Gauss-Newton and Levenberg-Marquardt methods</li> <li>Eigenvalue problems: power iteration, inverse iteration, QR algorithm</li> <li>Numerical differentiation</li> <li>Numerical integration: Newton-Cotes rules, error estimates, Gauss quadrature, adaptive quadrature</li> </ol>
Literature	<ul> <li>Gander/Gander/Kwok: Scientific Computing: An introduction using Maple and MATLAB, Springer (2014)</li> <li>Stoer/Bulirsch: Numerische Mathematik 1, Springer</li> <li>Dahmen, Reusken: Numerik f ür Ingenieure und Naturwissenschaftler, Springer</li> </ul>

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
Introduction to Biochemistry and M	olecular Biology (L0386)	Lecture	2	3
Module Responsible	Prof. Hans-Jürgen Kreienkamp			
	None			
	None			
Knowledge				
-	After taking part successfully, students	s have reached the following learning results		
Professional Competence		5 5		
-	The students can			
	<ul> <li>describe basic biomolecules;</li> </ul>			
	<ul> <li>explain how genetic information</li> </ul>			
	<ul> <li>explain the connection between</li> </ul>	n DNA and proteins;		
Skills	The students can			
		lecular parameters for the course of a disease;		
	describe selected molecular-dia			
	<ul> <li>explain the relevance of these p</li> </ul>	sociedates for some diseases		
Personal Competence				
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	rona nandemic)and wil	l he able to evol:
	these issues to others.	istanding of current medical problems (e.g. co	inona panaerine/ana wii	i be able to explic
Autonomy	The students can develop an understa	nding of topics from the course, using technical l	iterature, by themselves	5.
	·····	······		
	Students will be better equipped to red	cognize fake news in the media regarding medica	al research topics.	
	Independent Study Time 62, Study Tin	ne in Lecture 28		
Credit points	3			
Course achievement	None			
	Written exam			
Examination duration and	60 minutes			
scale				
		program, 7 semester): Specialisation Biomedical		
Following Curricula		an program, 7 semester): Specialisation Mec	hanical Engineering, F	ocus Biomechani
	Compulsory	And include the state of the commutation		
		Aedical Technology: Elective Compulsory		
	Engineering Science: Specialisation Big	omedical Engineering: Compulsory program, 7 semester): Specialisation Biomedical	Engineering: Compulser	
	Mechanical Engineering: Specialisation		Engineering: Compulsor	у
		Management and Business Administration: Elect	tive Compulsory	
		Artificial Organs and Regenerative Medicine: Elect		
		Medical Technology and Control Theory: Elective		
		Implants and Endoprostheses: Elective Compuls		
		Engineering Science: Elective Compulsory	-	

Course L0386: Introduction to Biochemistry and Molecular Biology	
Lecture	
2	
3	
Independent Study Time 62, Study Time in Lecture 28	
Prof. Hans-Jürgen Kreienkamp	
DE	
WiSe	
Müller-Esterl, Biochemie, Spektrum Verlag, 2010; 2. Auflage	
Löffler, Basiswissen Biochemie, 7. Auflage, Springer, 2008	

Module M1333: BIO I:	Implants and Fracture Healing	g		
	-	-		
Courses				
Title		Тур	Hrs/wk	СР
Implants and Fracture Healing (L03	76)	Lecture	2	3
Module Responsible	Prof. Michael Morlock			
Admission Requirements	None			
<b>Recommended Previous</b>	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 way	s how bones heal, and the requirements for	their existence.	
	The students can name different treatments	for the spine and hollow bones under giver	n fracture morphologies	
Skills	The students can determine the forces actin	g within the human body under quasi-static	situations under speci	fic assumptions.
Personal Competence				·
•	The students can in groups, solve basis pur	norical modeling tacks for the calculation of	internal forces	
Social Competence	The students can, in groups, solve basic nun	nerical modeling tasks for the calculation of	internal forces.	
Autonomy	The students can, in groups, solve basic num	nerical modeling tasks for the calculation of	internal forces.	
Workload in Hours	Independent Study Time 62, Study Time in L	Lecture 28		
Credit points	3			
Course achievement	None			
Examination	Written exam			
Examination duration and	90 min			
scale				
Assignment for the	General Engineering Science (German pr	ogram, 7 semester): Specialisation Mech	nanical Engineering, F	ocus Biomechanic
Following Curricula	Compulsory			
	General Engineering Science (German progr	am, 7 semester): Specialisation Biomedical	Engineering: Compulso	ry
	Engineering Science: Specialisation Biomedi	cal Engineering: Compulsory		
	General Engineering Science (English progra	am, 7 semester): Specialisation Biomedical B	Engineering: Compulsor	У
	Mechanical Engineering: Specialisation Biom	nechanics: Compulsory		
	Biomedical Engineering: Specialisation Impla	ants and Endoprostheses: Elective Compulse	ory	
	Biomedical Engineering: Specialisation Artifi	cial Organs and Regenerative Medicine: Ele	ctive Compulsory	
	Biomedical Engineering: Specialisation Mana	agement and Business Administration: Elect	ive Compulsory	
	Biomedical Engineering: Specialisation Medi		Compulsory	
	Orientation Studies: Core Qualification: Elect	tive Compulsory		
	Technomathematics: Specialisation III. Engin	neering Science: Elective Compulsory		

Course L0376: Implants and	Fracture Healing
-	Lecture
CP	3
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			Trim		Hrs/wk	СР
Embodiment Design and 3D-CAD (I	0268)		<b>Typ</b> Lecture		2	1
Mechanical Design Project I (L0695			Project-/problem-b	ased Learning	3	2
Mechanical Design Project II (L0592			Project-/problem-b	-	3	2
Team Project Design Methodology			Project-/problem-b		2	1
Module Responsible	Prof. Dieter Krause					
Admission Requirements	None					
Recommended Previous						
Knowledge		s of Mechanical Engineering	g Design			
-	<ul> <li>Mechanics</li> </ul>					
		s of Materials Science				
	<ul> <li>Production Er</li> </ul>	ngineering				
Educational Objectives	After taking part suc	ccessfully, students have re	ached the following learning results	;		
Professional Competence		· · ·				
	After passing the mo	odule, students are able to:				
-						
			parts e.g. considering load situation	ı, materials an	d manufactur	ing requirements
	describe basi					
	<ul> <li>explain basics</li> </ul>	s methods of engineering d	esigning.			
Skills	After passing the mo	odule, students are able to:				
	. In days and a shift					
			l drawings and documentations e.g.	using 3D CAL	),	
		onents based on design gui alculate) used components,				
				d colution-orio	nted	
	<ul> <li>use methods to design and solve engineering design tasks systamtically and solution-oriented,</li> <li>apply creativity techniques in teams.</li> </ul>					
	- apply creative	ty teeninques in teams.				
Personal Competence						
Social Competence	After passing the module, students are able to:					
	<ul> <li>develop and e</li> </ul>	evaluate solutions in group	s including making and documenting	n decisions		
	<ul> <li>develop and evaluate solutions in groups including making and documenting decisions,</li> <li>moderate the use of scientific methods,</li> <li>present and discuss solutions and technical drawings within groups,</li> </ul>					
	<ul> <li>reflect the ow</li> </ul>	n results in the work group	s 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 engi	neering design tasks syster	natically.			
Workload in Hours	Indonendent Chudu	Time 40 Chudu Time in Lee	humo 140			
Credit points		Time 40, Study Time in Lec	lure 140			
Course achievement		Form	Description			
course acmevement	Yes None	Written elaboration	Konstruktionsprojekt 2			
	Yes None	Written elaboration	3D-CAD-Praktikum			
	Yes None	Written elaboration	Teamprojekt Konstruktionsmet	hodik		
	Yes None	Written elaboration	Konstruktionsprojekt 1			
Examination	Written exam					
Examination duration and	180					
scale						
Assignment for the	General Engineering	Science (German program	, 7 semester): Specialisation Mecha	nical Engineer	ring: Compuls	ory
Following Curricula	General Engineering	Science (German program	, 7 semester): Specialisation Biome	dical Engineer	ing: Compuls	ory
	General Engineering	Science (German program	, 7 semester): Specialisation Biome	dical Engineer	ing: Compuls	ory
	Digital Mechanical E	ngineering: Core Qualificat	ion: Compulsory			
	Engineering Science	: Specialisation Mechatron	cs: Compulsory			
	Engineering Science	: Specialisation Mechanica	Engineering: Compulsory			
		: Specialisation Biomedical				
	-		pecialisation Energy Technology: Ele	ective Compul	sory	
	-	ring: Core Qualification: Co	mpulsory			
		Qualification: Compulsory				
	Naval Architecture:	Core Qualification: Compute	sory			

Course L0268: Embodiment E	Design and 3D-CAD
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	<ul> <li>Basics of 3D CAD technology</li> <li>Practical course to apply a 3D CAD system</li> </ul>
	<ul> <li>Introduction to the system</li> <li>Sketching and creation of components</li> <li>Creation of assemblies</li> <li>Deriving technical drawings</li> </ul>
Literature	<ul> <li>CAx für Ingenieure eine praxisbezogene Einführung; Vajna, S., Weber, C., Bley, H., Zeman, K.; Springer-Verlag, aktuelle Auflage.</li> <li>Handbuch Konstruktion; Rieg, F., Steinhilper, R.; Hanser; aktuelle Auflage.</li> <li>Dubbel, Taschenbuch für den Maschinenbau; Grote, KH., Feldhusen, J.(Hrsg.); Springer-Verlag, aktuelle Auflage.</li> <li>Technisches Zeichnen: Grundlagen, Normen, Beispiele, Darstellende Geometrie, Hoischen, H; Hesser, W; Cornelsen, aktuelle Auflage.</li> <li>Maschinenelemente, Band I-III; Niemann, G., Springer-Verlag, aktuelle Auflage.</li> <li>Maschinenelemente, Band I-III; Niemann, G., Springer-Verlag, aktuelle Auflage.</li> <li>Konstruktionslehre, Pahl, G.; Beitz, W., Springer-Verlag, aktuelle Auflage.</li> <li>Maschinenelemente 1-2; Schlecht, B., Pearson Verlag, aktuelle Auflage.</li> <li>Maschinenelemente - Gestaltung, Berechnung, Anwendung; Haberhauer, H., Bodenstein, F., Springer-Verlag, aktuelle Auflage.</li> <li>Roloff/Matek Maschinenelemente; Wittel, H., Muhs, D., Jannasch, D., Voßiek, J., Springer Vieweg, aktuelle Auflage.</li> </ul>

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

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

ourse 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	<ul> <li>Introduction to engineering designing methodology</li> <li>Team Project Design Methodology         <ul> <li>Creating requirement lists</li> <li>Problem formulation</li> <li>Creating functional structures</li> <li>Finding solutions</li> <li>Evaluation of the found concepts</li> <li>Documentation of the taken methodological steps and the concepts using presentation slides</li> </ul> </li> </ul>
Literature	<ul> <li>Dubbel, Taschenbuch für den Maschinenbau; Grote, KH., Feldhusen, J.(Hrsg.); Springer-Verlag, aktuelle Auflage.</li> <li>Maschinenelemente, Band I-III; Niemann, G., Springer-Verlag, aktuelle Auflage.</li> <li>Maschinen- und Konstruktionselemente; Steinhilper, W., Röper, R., Springer Verlag, aktuelle Auflage.</li> <li>Einführung in die DIN-Normen; Klein, M., Teubner-Verlag.</li> <li>Konstruktionslehre, Pahl, G.; Beitz, W., Springer-Verlag, aktuelle Auflage.</li> <li>Maschinenelemente 1-2; Schlecht, B., Pearson Verlag, aktuelle Auflage.</li> <li>Maschinenelemente - Gestaltung, Berechnung, Anwendung; Haberhauer, H., Bodenstein, F., Springer-Verlag, aktuelle Auflage.</li> <li>Roloff/Matek Maschinenelemente; Wittel, H., Muhs, D., Jannasch, D., Voßiek, J., Springer Vieweg, aktuelle Auflage.</li> <li>Sowie weitere Bücher zu speziellen Themen</li> </ul>

Courses							
Fitle			、 、		<b>Typ</b> Lecture	Hrs/wk 2	<b>СР</b> 3
Introduction into Medical Technolo	plogy and Systems (L0342)				Project Seminar	2	2
Introduction into Medical Technolo							
Module Responsible	1						
Admission Requirements							
	principles of math (algebra, analysis/calculus)						
	principles of stochastics						
j-			nming, R/Matlab				
	· ·		5.				
Educational Objectives	After takin	ng part suc	cessfully, stude	nts have reached t	he following learning results		
Professional Competence							
Knowledge					nology, including imaging systems,	-	
	informatio	on systems	. They are able	o give an overview	of regulatory affairs and standards	in medical technolo	ogy.
Skills	The stude	ents are ab <sup>i</sup>	le to evaluate sv	stems and medica	I devices in the context of clinical ap	plications.	
			· · · · · · · · · · · · · · · · · · ·				
Personal Competence							
Social Competence	The stude	ents describ	pe a problem in i	medical technolog	as a project, and define tasks that	are solved in a joint	effort.
	The stude	ents can cri	tically reflect on	the results of othe	r groups and make constructive sug	gestions for improv	vement.
Autonomy	The stude	ents can a	ssess their leve	el of knowledge a	nd document their work results.	They can critically	evaluate the resi
	achieved	and preser	nt them in an ap	propriate manner.			
Mandala a dite di su	la de a cad	ant Church 7	Ener 110 Church	Time a in 1 a atoma 7	<u></u>		
Workload in Hours		ent Study I	Time 110, Study	Time in Lecture 7	)		
Credit points		Bonus	Form	Dec	cription		
Course achievement	Yes	10 %	Presentation	Des			
	Yes	10 %	Written elabo	pration			
Examination			Whiteh clube	adon .			
Examination duration and		-					
scale	90 minute	25					
Assignment for the	Conoral E	naincorina	Science (Corma	n program 7 com	octor), Charielication Riomodical En	aincoring, Compuls	254
-					ester): Specialisation Biomedical Engineering Science, Elective Comp		ЛУ
Following Curricula					Engineering Science: Elective Compu	aisol y	
				cation: Elective Co ctive Compulsory	mpuisory		
			Qualification: Ele	cuve compulsory			
			a: Coro Ouslifier	tion: Elective Com	pulson		
	Electrical	Engineerin	-	ation: Elective Con			
	Electrical Engineeri	Engineerin ing Science	: Specialisation	Biomedical Engine	ering: Compulsory	incoring, Computer	24
	Electrical Engineeri General E	Engineerin ing Science Engineering	Specialisation	Biomedical Engine h program, 7 seme	ering: Compulsory (ster): Specialisation Biomedical Eng		ry
	Electrical Engineerin General E Computer	Engineerin ing Science Engineering r Science in	: Specialisation Science (Englis Engineering: Sp	Biomedical Engine h program, 7 seme pecialisation II. Ma	ering: Compulsory ster): Specialisation Biomedical Eng hematics & Engineering Science: El	ective Compulsory	ry
	Electrical Engineerin General E Computer Biomedica	Engineerin ing Science Engineering r Science in ral Engineer	: Specialisation Science (Englis Engineering: Sp ring: Specialisati	Biomedical Engine h program, 7 seme pecialisation II. Ma on Artificial Organ	ering: Compulsory ster): Specialisation Biomedical Eng thematics & Engineering Science: El and Regenerative Medicine: Electiv	ective Compulsory	ry
	Electrical Engineerin General E Computer Biomedica Biomedica	Engineerin ing Science Engineering r Science in al Engineer al Engineer	: Specialisation Science (Englis Engineering: Sp ring: Specialisati ring: Specialisati	Biomedical Engine h program, 7 seme pecialisation II. Ma on Artificial Organ on Implants and E	ering: Compulsory ster): Specialisation Biomedical Eng thematics & Engineering Science: El and Regenerative Medicine: Electiv doprostheses: Elective Compulsory	ective Compulsory ve Compulsory	ry
	Electrical Engineerin General E Computer Biomedica Biomedica	Engineerin ing Science Engineering r Science in al Engineer al Engineer al Engineer	: Specialisation Science (Englis Engineering: Sp ring: Specialisati ring: Specialisati ring: Specialisati	Biomedical Engine h program, 7 seme becialisation II. Ma on Artificial Organ on Implants and E on Medical Techno	ering: Compulsory ster): Specialisation Biomedical Eng hematics & Engineering Science: El ; and Regenerative Medicine: Electiv doprostheses: Elective Compulsory logy and Control Theory: Elective Co	ective Compulsory ve Compulsory ompulsory	ry
	Electrical Engineerii General E Computer Biomedica Biomedica Biomedica	Engineerin ing Science Engineering r Science in al Engineer al Engineer al Engineer al Engineer	: Specialisation   Science (Englis   Engineering: Sp ring: Specialisati ring: Specialisati ring: Specialisati ring: Specialisati	Biomedical Engine h program, 7 seme becialisation II. Ma on Artificial Organ on Implants and E on Medical Techno on Management a	ering: Compulsory ster): Specialisation Biomedical Eng thematics & Engineering Science: El and Regenerative Medicine: Electiv doprostheses: Elective Compulsory	ective Compulsory ve Compulsory ompulsory	ry

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
<b>Recommended Previous</b>	None
Knowledge	
Educational Objectives	After taking part successfully, students have reached the following learning results
Professional Competence	
Knowledge	The students can
	<ul> <li>describe the basics of the energy metabolism;</li> </ul>
	<ul> <li>describe physiological relations in selected fields of muscle, heart/circulation, neuro- and sensory physiology.</li> </ul>
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.
Werklend in Heure	Independent Chudu Time C2. Chudu Time in Lesture 20
	Independent Study Time 62, Study Time in Lecture 28
Credit points	
Course achievement	
Examination	
Examination duration and scale	60 minutes
	Consul Engineering Colonge (Correspondents Technologia Consultants Consultants
	General Engineering Science (German program, 7 semester): Specialisation Biomedical Engineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Biomechan
Following curricula	Compulsory
	Data Science: Specialisation Medicine: 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
	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	
СР	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	
	It is recommended to participate in "Implantate und Frakturheilung" before attending "Experimentelle Methoden".
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 cha 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	
Assignment for the	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
	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 von Mathworks: https://de.mathworks.com/help/matlab/
	onine nine von Haanvorks, happs/jacanaanworks.com/heip/hadab/

## **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			
<b>Recommended Previous</b>	Good knowledge in Mathemathics I-III and Mechar	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 reac	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 lectur			
	is basic requirement for all following lectures in th	e subjects shipo design and safety of ships.		
Chille	The student is able to cover out budractatic cale	ulations to ensure that the ship has sufficie	ant stability lie i	a abla ta daalaa bu
SKIIIS	s The student is able to carry out hydrostatic calculations to ensure that the ship has sufficient stability. He is able to design he forms that are safe against capsizing or sinking.			
	forms that are sale against capsizing of sinking.			
Personal Competence				
Social Competence	The student gets access to hydrostatical problems	5.		
4				
Autonomy	la de seu de st. Churche Time a O.C., Churche Time a inclue stru	- 04		
	Independent Study Time 96, Study Time in Lectur	e 84		
Credit points				
Course achievement				
	Written exam			
Examination duration and	180 min			
scale				
5	General Engineering Science (German program, 7		e: Compulsory	
Following Curricula	Naval Architecture: Core Qualification: Compulsor	У		

Course L1260: Hydrostatics	
Тур	
Hrs/wk	2
СР	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
	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	
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	<ol> <li>Herner/Rusch: Die Theorie des Schiffes Fachbuchverlag Leipzig</li> <li>Henschke Schiffstechnisches Handbuch, Band 1 VEB Technik Verlag Berlin</li> <li>Das Skript zur Vorlesung, Anwendungsbeispiele und Klausuren sind auf unserer Homepage abrufbar.</li> </ol>

Courses				
Title		Тур	Hrs/wk	СР
Fundamentals of Materials Science	e I (L1085)	Lecture	2	2
	II (Advanced Ceramic Materials, Polymers and Composites) (L0506)	Lecture	2	2
Physical and Chemical Basics of M	aterials Science (L1095)	Lecture	2	2
Module Responsible	Prof. Jörg Weißmüller			
Admission Requirements	None			
	Highschool-level physics, chemistry und mathematics			
Knowledge				
Educational Objectives	After taking part successfully, students have reached the follow	ing learning results		
Professional Competence				
Knowledge	The students have acquired a fundamental knowledge on r	netals, ceramics and	d polymers and can descr	ibe this knowled
	comprehensively. Fundamental knowledge here means specific	ally the issues of ato	mic structure, microstructu	ıre, phase diagran
	phase transformations, corrosion and mechanical properties. The	ne students know abo	out the key aspects of chara	acterization meth
	for materials and can identify relevant approaches for cha		properties. They are able	to trace materi
	phenomena back to the underlying physical and chemical laws	of nature.		
Skille	The students are able to trace materials phonomona back t	a tha undarlying ph	veical and chomical laws	of paturo Matori
SKIIIS	s The students are able to trace materials phenomena back to the underlying physical and chemical laws of nature. Materia phenomena here refers to mechanical properties such as strength, ductility, and stiffness, chemical properties such as corrosic			
	resistance, and to phase transformations such as solidificatio			
	between processing conditions and the materials microstructu			
	material's behavior.	are, and they can de		
Personal Competence				
Social Competence				
Autonomy	-			
,				
Workload in Hours	Independent Study Time 96, Study Time in Lecture 84			
Workload in Hours Credit points	Independent Study Time 96, Study Time in Lecture 84 6			
Workload in Hours Credit points Course achievement	Independent Study Time 96, Study Time in Lecture 84 6 None			
Workload in Hours Credit points Course achievement Examination	Independent Study Time 96, Study Time in Lecture 84 6 None Written exam			
Workload in Hours Credit points Course achievement Examination Examination duration and	Independent Study Time 96, Study Time in Lecture 84 6 None Written exam			
Workload in Hours Credit points Course achievement Examination Examination duration and scale	Independent Study Time 96, Study Time in Lecture 84 6 None Written exam 180 min			
Workload in Hours Credit points Course achievement Examination Examination duration and scale Assignment for the	Independent Study Time 96, Study Time in Lecture 84 6 None Written exam 180 min General Engineering Science (German program, 7 semester): S			
Workload in Hours Credit points Course achievement Examination Examination duration and scale Assignment for the	Independent Study Time 96, Study Time in Lecture 84 6 None Written exam 180 min General Engineering Science (German program, 7 semester): S General Engineering Science (German program, 7 semester): S	pecialisation Biomedi	cal Engineering: Compulso	
Workload in Hours Credit points Course achievement Examination Examination duration and scale Assignment for the	Independent Study Time 96, Study Time in Lecture 84 6 None Written exam 180 min General Engineering Science (German program, 7 semester): S General Engineering Science (German program, 7 semester): S General Engineering Science (German program, 7 semester): S	pecialisation Biomedi	cal Engineering: Compulso	
Workload in Hours Credit points Course achievement Examination Examination duration and scale Assignment for the	Independent Study Time 96, Study Time in Lecture 84 6 None Written exam 180 min 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 Materials Science: Compulsory	pecialisation Biomedi pecialisation Naval Ai	cal Engineering: Compulso	
Workload in Hours Credit points Course achievement Examination Examination duration and scale Assignment for the	Independent Study Time 96, Study Time in Lecture 84 6 None Written exam 180 min 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 Materials Science: Compulsory Digital Mechanical Engineering: Core Qualification: Compulsory	pecialisation Biomedi pecialisation Naval Ai	cal Engineering: Compulso	
Workload in Hours Credit points Course achievement Examination Examination duration and scale Assignment for the	Independent Study Time 96, Study Time in Lecture 84 6 None Written exam 180 min 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 Materials Science: Compulsory Digital Mechanical Engineering: Core Qualification: Compulsory Energy and Environmental Engineering: Core Qualification: Com	pecialisation Biomedi pecialisation Naval Ai npulsory	cal Engineering: Compulsor rchitecture: Compulsory	
Workload in Hours Credit points Course achievement Examination Examination duration and scale Assignment for the	Independent Study Time 96, Study Time in Lecture 84 6 None Written exam 180 min 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 Materials Science: Compulsory Digital Mechanical Engineering: Core Qualification: Compulsory Energy and Environmental Engineering: Core Qualification: Com Green Technologies: Energy, Water, Climate: Specialisation Energy	pecialisation Biomedi pecialisation Naval Ai npulsory ergy Technology: Elec	cal Engineering: Compulsor rchitecture: Compulsory	
Workload in Hours Credit points Course achievement Examination Examination duration and scale Assignment for the	Independent Study Time 96, Study Time in Lecture 84 6 None Written exam 180 min 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 Materials Science: Compulsory Digital Mechanical Engineering: Core Qualification: Compulsory Energy and Environmental Engineering: Core Qualification: Com Green Technologies: Energy, Water, Climate: Specialisation Energication Engineering Science: Elect	pecialisation Biomedi pecialisation Naval An npulsory ergy Technology: Elec tive Compulsory	cal Engineering: Compulsor rchitecture: Compulsory tive Compulsory	
Workload in Hours Credit points Course achievement Examination Examination duration and scale Assignment for the	Independent Study Time 96, Study Time in Lecture 84 6 None Written exam 180 min 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 Materials Science: Compulsory Digital Mechanical Engineering: Core Qualification: Compulsory Energy and Environmental Engineering: Core Qualification: Com Green Technologies: Energy, Water, Climate: Specialisation Ene Logistics and Mobility: Specialisation Production Management a	pecialisation Biomedi pecialisation Naval An npulsory ergy Technology: Elec tive Compulsory	cal Engineering: Compulsor rchitecture: Compulsory tive Compulsory	
Workload in Hours Credit points Course achievement Examination Examination duration and scale Assignment for the	Independent Study Time 96, Study Time in Lecture 84 6 None Written exam 180 min 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 Materials Science: Compulsory Digital Mechanical Engineering: Core Qualification: Compulsory Energy and Environmental Engineering: Core Qualification: Com Green Technologies: Energy, Water, Climate: Specialisation Ene Logistics and Mobility: Specialisation Engineering Science: Elect Logistics and Mobility: Specialisation Production Management a Mechanical Engineering: Core Qualification: Compulsory	pecialisation Biomedi pecialisation Naval An npulsory ergy Technology: Elec tive Compulsory	cal Engineering: Compulsor rchitecture: Compulsory tive Compulsory	
Workload in Hours Credit points Course achievement Examination Examination duration and scale Assignment for the	Independent Study Time 96, Study Time in Lecture 84 6 None Written exam 180 min 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 Materials Science: Compulsory Digital Mechanical Engineering: Core Qualification: Compulsory Energy and Environmental Engineering: Core Qualification: Com Green Technologies: Energy, Water, Climate: Specialisation Ene Logistics and Mobility: Specialisation Engineering Science: Elect Logistics and Mobility: Specialisation Production Management a Mechanical Engineering: Core Qualification: Compulsory Mechatronics: Core Qualification: Compulsory	pecialisation Biomedi pecialisation Naval An npulsory ergy Technology: Elec tive Compulsory	cal Engineering: Compulsor rchitecture: Compulsory tive Compulsory	
Workload in Hours Credit points Course achievement Examination Examination duration and scale Assignment for the	Independent Study Time 96, Study Time in Lecture 84 6 None Written exam 180 min 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 Materials Science: Compulsory Digital Mechanical Engineering: Core Qualification: Compulsory Energy and Environmental Engineering: Core Qualification: Com Green Technologies: Energy, Water, Climate: Specialisation Ene 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 Biomedi pecialisation Naval Ar npulsory ergy Technology: Elec tive Compulsory nd Processes: Electiv	cal Engineering: Compulsor rchitecture: Compulsory tive Compulsory	
Workload in Hours Credit points Course achievement Examination Examination duration and scale Assignment for the	Independent Study Time 96, Study Time in Lecture 84 6 None Written exam 180 min 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 Materials Science: Compulsory Digital Mechanical Engineering: Core Qualification: Compulsory Energy and Environmental Engineering: Core Qualification: Com Green Technologies: Energy, Water, Climate: Specialisation Ene Logistics and Mobility: Specialisation Engineering Science: Elect Logistics and Mobility: Specialisation Production Management a Mechanical Engineering: Core Qualification: Compulsory Mechatronics: Core Qualification: Compulsory	pecialisation Biomedi pecialisation Naval Ar npulsory ergy Technology: Elec tive Compulsory nd Processes: Electiv	cal Engineering: Compulsor rchitecture: Compulsory tive Compulsory e Compulsory	ry

**Course L1085: Fundamentals of Materials Science I** Тур Lecture Hrs/wk СР 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 C	Chemical Basics of Materials Science
Тур	Lecture
Hrs/wk	2
СР	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Gregor Vonbun-Feldbauer, Prof. Stefan Fritz Müller
Language	DE
Cycle	WiSe
Content	<ul> <li>Motivation: "Atoms in Mechanical Engineering?"</li> <li>Basics: Force and Energy</li> <li>The electromagnetic Interaction</li> <li>"Detour": Mathematics (complex e-funktion etc.)</li> <li>The atom: Bohr's model of the atom</li> <li>Chemical bounds</li> <li>The multi part problem: Solutions and strategies</li> <li>Descriptions of using statistical thermodynamics</li> <li>Elastic theory of atoms</li> <li>Consequences of atomar properties on makroskopic Properties: Discussion of examples (metals, semiconductors, hybrid systems)</li> </ul>
Literature	<ul> <li>Für den Elektromagnetismus:</li> <li>Bergmann-Schäfer: "Lehrbuch der Experimentalphysik", Band 2: "Elektromagnetismus", de Gruyter</li> <li>Für die Atomphysik:</li> <li>Haken, Wolf: "Atom- und Quantenphysik", Springer</li> <li>Für die Materialphysik und Elastizität:</li> <li>Hornbogen, Warlimont: "Metallkunde", Springer</li> </ul>

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			
<b>Recommended Previous</b>	Basic knowledge in electrical engineering			
Knowledge				
Educational Objectives	After taking part successfully, students have read	hed the following learning results		
<b>Professional Competence</b>				
Knowledge	This module deals with the foundations of the f programming down to gates. The module include • Introduction		ers the layers fron	n the assembly-le
	<ul> <li>Combinational logic: Gates, Boolean algebtion</li> <li>Sequential logic: Flip-flops, automata, systimation</li> <li>Technological foundations</li> <li>Computer arithmetic: Integer addition, subtion</li> <li>Basics of computer architecture: Programming</li> <li>Memories: Memory hierarchies, SRAM, DR/</li> <li>Input/output: I/O from the perspective of the second s</li></ul>	ematic hardware design traction, multiplication and division ning models, MIPS single-cycle architecture MM, caches	e, pipelining	
Skills	The students perceive computer systems from the composition of computer systems. The students collection of few and simple components. They a today's computing systems - from gates and circu After successful completion of the module, the system and the software executed on it. In partie on the hardware-centric abstraction layers from the impact that these low abstraction levels have	can analyze, how highly specific and indivi are able to distinguish between and to ex- uits up to complete processors. students are able to judge the interdepe cular, they shall understand the conseque the assembly language down to gates. Th	dual computers can plain the different ndencies between nces that the exect is way, they will be	h be built based of abstraction layers a physical compu- ution of software h enabled to evalue
Personal Competence				
-	Students are able to solve similar problems alone	or in a group and to present the results a	cordinaly	
Social Competence	Students are able to solve similar problems alone	or in a group and to present the results a	ccorungiy.	
Autonomy	Students are able to acquire new knowledge from	specific literature and to associate this ki	nowledge with othe	r classes.
Workload in Hours	Independent Study Time 124, Study Time in Lect	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				
-				
Following Curricula				
	General Engineering Science (German program, 7			
	General Engineering Science (German program	m, / semester): Specialisation Mechani	ical Engineering, I	ocus Mechatroni
	Compulsory	7 competer), Specialization Machanica	L Engineering For	us Aircraft Systa
	General Engineering Science (German program Engineering: Compulsory	i, 7 semester): specialisation Mechanica	ii Engineering, Foc	us Aircrait Syste
	General Engineering Science (German program,	7 semester): Specialisation Mechanical En	aineerina. Focus Th	eoretical Mechani
	Serierar Engliseering Serence (Serinari program)		gineering, rocus in	concentration in technologi
	Engineering: Compulsory			
	Engineering: Compulsory General Engineering Science (German progra	m, 7 semester): Specialisation Mechar	nical Engineering,	Focus Materials
		m, 7 semester): Specialisation Mechai	nical Engineering,	Focus Materials
	General Engineering Science (German progra	•		
	General Engineering Science (German progra Engineering Sciences: Compulsory	•		
	General Engineering Science (German progra Engineering Sciences: Compulsory General Engineering Science (German program, and Production: Compulsory General Engineering Science (German program	7 semester): Specialisation Mechanical Er	ngineering, Focus P	roduct Developme
	General Engineering Science (German progra Engineering Sciences: Compulsory General Engineering Science (German program, and Production: Compulsory General Engineering Science (German program Compulsory	7 semester): Specialisation Mechanical Er	ngineering, Focus P I Engineering, Foc	roduct Developme us Energy System
	General Engineering Science (German progra Engineering Sciences: Compulsory General Engineering Science (German program, and Production: Compulsory General Engineering Science (German program Compulsory General Engineering Science (German program	7 semester): Specialisation Mechanical Er	ngineering, Focus P I Engineering, Foc	roduct Developm us Energy Syster
	General Engineering Science (German progra Engineering Sciences: Compulsory General Engineering Science (German program, and Production: Compulsory General Engineering Science (German program Compulsory	7 semester): Specialisation Mechanical Er 7 semester): Specialisation Mechanica m, 7 semester): Specialisation Mechani 7 semester): Specialisation Naval Architect 8 semester): Specialisation Biomedical Eng 9 semester): Specialisation Bioprocess Eng 9 semester): Specialisation Electrical Engin	ngineering, Focus P I Engineering, Foc cal Engineering, F ure: Compulsory ineering: Compulsory ineering: Compulsory	roduct Developm us Energy Syster ocus Biomechani yry ry
	General Engineering Science (German progra Engineering Sciences: Compulsory General Engineering Science (German program, and Production: Compulsory General Engineering Science (German program Compulsory General Engineering Science (German program Compulsory General Engineering Science (German program, General Engineering Science (German program,	7 semester): Specialisation Mechanical Er 7 semester): Specialisation Mechanica 7 semester): Specialisation Mechani 7 semester): Specialisation Naval Architect 7 semester): Specialisation Biomedical Eng 7 semester): Specialisation Bioprocess Eng 7 semester): Specialisation Electrical Engin 7 semester): Specialisation Green Technolog	ngineering, Focus P I Engineering, Foc cal Engineering, F ure: Compulsory ineering: Compulsory ineering: Compulsory	roduct Developm us Energy Syster ocus Biomechani yry ry
	General Engineering Science (German progra Engineering Sciences: Compulsory General Engineering Science (German program, and Production: Compulsory General Engineering Science (German program Compulsory General Engineering Science (German program Compulsory General Engineering Science (German program, General Engineering Science (German program,	7 semester): Specialisation Mechanical Er 7 semester): Specialisation Mechanica m, 7 semester): Specialisation Mechani 7 semester): Specialisation Naval Architect 8 semester): Specialisation Biomedical Eng 9 semester): Specialisation Bioprocess Eng 9 semester): Specialisation Electrical Engin 9 semester): Specialisation Green Technology	ngineering, Focus P I Engineering, Foc cal Engineering, F ure: Compulsory ineering: Compulsory ineering: Compulsory	roduct Developm us Energy Syster ocus Biomechani yry ry
	General Engineering Science (German progra Engineering Sciences: Compulsory General Engineering Science (German program, and Production: Compulsory General Engineering Science (German program Compulsory General Engineering Science (German program Compulsory General Engineering Science (German program, General Engineering Science (German program,	7 semester): Specialisation Mechanical Er 7 semester): Specialisation Mechanica m, 7 semester): Specialisation Mechani 7 semester): Specialisation Naval Architect 8 semester): Specialisation Biomedical Eng 9 semester): Specialisation Bioprocess Eng 9 semester): Specialisation Electrical Engin 9 semester): Specialisation Green Technology 9 9 sory	ngineering, Focus P I Engineering, Foc cal Engineering, F ure: Compulsory ineering: Compulsory ineering: Compulsory	roduct Developm us Energy Syster ocus Biomechani yry ry
	General Engineering Science (German progra Engineering Sciences: Compulsory General Engineering Science (German program, and Production: Compulsory General Engineering Science (German program Compulsory General Engineering Science (German program Compulsory General Engineering Science (German program, General Engineering Science (German program) General Engineering Science (German program) General Engineering Science (German program) General Engineering (German program) General Engineering Science (German progr	7 semester): Specialisation Mechanical Er 7 semester): Specialisation Mechanica m, 7 semester): Specialisation Mechani 7 semester): Specialisation Naval Architect 7 semester): Specialisation Biomedical Eng 7 semester): Specialisation Bioprocess Eng 7 semester): Specialisation Green Technolo 9 9 9 9 9 9 9 9 9 9 9 9 9	ngineering, Focus P I Engineering, Foc cal Engineering, F cure: Compulsory ineering: Compulsory ineering: Compulsory ogies, Focus Renew g: Compulsory	roduct Developm us Energy Syster ocus Biomechani ny ry ry able Energy: Elect

Engineering: Compulsory
General Engineering Science (English program, 7 semester): Specialisation Mechanical Engineering, Focus Materials in Engineering
Sciences: Compulsory
General Engineering Science (English program, 7 semester): Specialisation Mechanical Engineering, Focus Mechatronics:
Compulsory
General Engineering Science (English program, 7 semester): Specialisation Mechanical Engineering, Focus Product Development
and Production: Compulsory
General Engineering Science (English program, 7 semester): Specialisation Mechanical Engineering, Focus Theoretical Mechanical
Engineering: Compulsory
Computational Science and Engineering: Core Qualification: Compulsory
Mechatronics: Core Qualification: Compulsory
Technomathematics: Specialisation II. Informatics: Elective Compulsory

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

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

Module M0854: Math	ematics IV			
Courses				
Title Differential Equations 2 (Partial Dif Differential Equations 2 (Partial Dif	-	<b>Typ</b> Lecture Recitation Section (small)	Hrs/wk 2 1	<b>CP</b> 1 1
Differential Equations 2 (Partial Dif Complex Functions (L1038) Complex Functions (L1041)	ferential Equations) (L1045)	Recitation Section (large) Lecture Recitation Section (small)	1 2 1	1 1 1
Complex Functions (L1042) Module Responsible	Prof. Anusch Taraz	Recitation Section (large)	1	1
Admission Requirements				
Recommended Previous Knowledge				
Educational Objectives	After taking part successfully, students have reached the	e following learning results		
Professional Competence Knowledge Skills	<ul> <li>Students can name the basic concepts in Mathem</li> <li>Students can discuss logical connections between the help of examples.</li> <li>They know proof strategies and can reproduce the</li> </ul>	n these concepts. They are capable	of illustrating th	ese connections wit
	<ul> <li>Students can model problems in Mathematics IV with the help of the concepts studied in this course. Moreover, they are capable of solving them by applying established methods.</li> <li>Students are able to discover and verify further logical connections between the concepts studied in the course.</li> <li>For a given problem, the students can develop and execute a suitable approach, and are able to critically evaluate the results.</li> </ul>			
Personal Competence Social Competence				
Autonomy	<ul> <li>Students are capable of checking their understanding of complex concepts on their own. They can specify open questions precisely and know where to get help in solving them.</li> <li>Students have developed sufficient persistence to be able to work for longer periods in a goal-oriented manner on hard problems.</li> </ul>			
Workload in Hours	Independent Study Time 68, Study Time in Lecture 112			
Credit points				
Course achievement				
	Written exam			
	60 min (Complex Functions) + 60 min (Differential Equa	tions 2)		
scale	(complex reactions) - co fini (Direcential Equa	==/		
Assignment for the	General Engineering Science (German program, 7 seme	ter): Specialisation Electrical Enginee	erina: Compulson	v
-	General Engineering Science (German program, 7 s Compulsory General Engineering Science (German program, 7 seme General Engineering Science (German program, 7 seme	emester): Specialisation Mechanica	e: Compulsory	Focus Mechatronic
	Engineering: Elective Compulsory Computer Science: Specialisation Computational Mathen Electrical Engineering: Core Qualification: Compulsory General Engineering Science (English program, 7 semes		rina: Compulsory	
	General Engineering Science (English program, 7 s Compulsory General Engineering Science (English program, 7 semes	emester): Specialisation Mechanica	l Engineering,	Focus Mechatronic
	Engineering: Compulsory Computational Science and Engineering: Specialisation I Mechanical Engineering: Specialisation Mechatronics: Co Mechanical Engineering: Specialisation Theoretical Mech	mpulsory		ilsory
	Mechatronics: Core Qualification: Compulsory Naval Architecture: Core Qualification: Compulsory Theoretical Mechanical Engineering: Technical Complem			

Course L1043: Differential Equations 2 (Partial Differential Equations)			
Тур	ecture		
Hrs/wk			
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	<ul> <li>Examples of partial differential equations</li> <li>First order quasilinear differential equations</li> <li>Normal forms of second order differential equations</li> <li>Harmonic functions and maximum principle</li> <li>Maximum principle for the heat equation</li> <li>Wave equation</li> <li>Liouville's formula</li> <li>Special functions</li> <li>Difference methods</li> <li>Finite elements</li> <li>http://www.math.uni-hamburg.de/teaching/export/tuhh/index.html</li> </ul>		

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

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

Course L1038: Complex Fund	Course L1038: Complex Functions		
Тур	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	DE		
Cycle	SoSe		
Content	Main features of complex analysis		
	<ul> <li>Functions of one complex variable</li> <li>Complex differentiation</li> <li>Conformal mappings</li> <li>Complex integration</li> <li>Cauchy's integral theorem</li> <li>Cauchy's integral formula</li> <li>Taylor and Laurent series expansion</li> <li>Singularities and residuals</li> <li>Integral transformations: Fourier and Laplace transformation</li> </ul>		
Literature	http://www.math.uni-hamburg.de/teaching/export/tuhh/index.html		

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

Courses					
Title		True	llue (sule	CP.	
	al Mechanics, Numerical Mechanics) (L1137)	<b>Typ</b> Lecture	Hrs/wk 3	<b>СР</b> 3	
-	al Mechanics, Numerical Mechanics) (L1137)	Recitation Section (small)	2	2	
-	al Mechanics, Numerical Mechanics) (L1139)	Recitation Section (large)	1	1	
Module Responsible	Prof. Robert Seifried				
Admission Requirements	None				
Recommended Previous	Mathematics I-III and Mechanics I-III				
Knowledge					
	After taking part successfully, students have reach	ed the following learning results			
Professional Competence	······································				
-	The students can				
nnomedge					
	<ul> <li>describe the axiomatic procedure used in m</li> </ul>	echanical contexts;			
	<ul> <li>explain important steps in model design;</li> </ul>				
	<ul> <li>present technical knowledge.</li> </ul>				
Chille	The students can				
56115	The students can				
	<ul> <li>explain the important elements of mathema</li> </ul>	atical / mechanical analysis and model for	mation, and app	oly it to the context	
	their own problems;				
	<ul> <li>apply basic methods to engineering problems;</li> <li>estimate the reach and boundaries of the methods and extend them to be applicable to wider problem sets.</li> </ul>				
Personal Competence					
Social Competence	The students can work in groups and support each	other to overcome difficulties.			
Autonomy	Students are capable of determining their own stre	ngths and weaknesses and to organize th	eir 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 program, 7	semester): Specialisation Mechanical Engi	neering: Compuls	sory	
Following Curricula	General Engineering Science (German program, 7	semester): Specialisation Biomedical Engi	neering: Compuls	sory	
-	General Engineering Science (German program, 7	semester): Specialisation Naval Architectu	re: Compulsory		
	Energy Systems: Technical Complementary Course	•			
	Mechanical Engineering: Core Qualification: Compu				
	Mechatronics: Core Qualification: Compulsory				
	Naval Architecture: Core Qualification: Compulsory				
	Technomathematics: Specialisation III. Engineering				

Course L1137: Mechanics IV (Oscillations, Analytical Mechanics, Numerical Mechanics)				
Тур	Lecture			
Hrs/wk	3			
CP				
Workload in Hours	Independent Study Time 48, Study Time in Lecture 42			
Lecturer	Prof. Robert Seifried			
Language	DE			
Cycle	SoSe			
Content	<ul> <li>Elements of vibration theory</li> <li>Vibration of Multi-degree of freedom systems</li> <li>Analytical Mechanics</li> <li>Multibody Systems</li> <li>Numerical methods for time integration</li> <li>Introduction to Matlab</li> </ul>			
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 L1138: Mechanics IV	(Oscillations, Analytical Mechanics, Numerical Mechanics)
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	SoSe
Content	See interlocking course
Literature	See interlocking course
Course L1139: Mechanics IV	(Oscillations, Analytical Mechanics, Numerical Mechanics)
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

Content

SoSe

Literature See interlocking course

See interlocking course

Module M0680: Fluid	Dynamics				
Courses					
Title		Тур		Hrs/wk	СР
Fluid Mechanics (L0454)		Lecture		3	4
Fluid Mechanics (L0455)		Recitation Sec	tion (large)	2	2
Module Responsible	Prof. Thomas Rung				
Admission Requirements	None				
<b>Recommended Previous</b>	Sound knowledge of engineering mather	matics, engineering mechanics and the	ermodynamics.		
Knowledge					
Educational Objectives	After taking part successfully, students h	nave reached the following learning re	sults		
Professional Competence					
Knowledge	Students will have the required sound knowledge to explain the general principles of fluid engineering and physics of fluids. Students can scientifically outline the rationale of flow physics using mathematical models and are familiar with methods for the performance analysis and the prediciton of fluid engineering devices.				
Skills	Students are able to apply fluid-engineering principles and flow-physics models for the analysis of technical systems. The lecture 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 problen	ns and jointly develop solution strategi	es.		
Autonomy	The students are able to develop solution strategies for complex problems self-consistent and crtically analyse results.				
Workload in Hours	Independent Study Time 110, Study Tim	e in Lecture 70			
Credit points					
Course achievement					
Examination	Written exam				
Examination duration and	180 min				
scale					
Assignment for the	General Engineering Science (German p	rogram, 7 semester): Specialisation Me	echanical Engineer	ing: Compuls	ory
-	General Engineering Science (German p	-	-		-
-	General Engineering Science (German p	-	-		-
	Mechanical Engineering: Core Qualificati	-			
	Naval Architecture: Core Qualification: C				
	Technomathematics: Specialisation III. E	ngineering Science: Elective Compulso	bry		

Course L0454: Fluid Mechan	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	<ul> <li>continuum physics definition of fluids, difference to solids/structures and material properties of fluids</li> <li>dimensional analysis and similitude</li> <li>fluid forces and fluid statics</li> <li>transport and conservation of mass, momentum &amp; energy</li> <li>fluid kinematics</li> <li>technically relevant flow models for incompressible fluids         <ul> <li>control volume &amp; stream tube analysis</li> <li>vortical flow models</li> <li>potential flows</li> <li>boundary layer flows</li> <li>different types of conservation equations and their realm (Navier-Stokes/Euler/Bernoulli equations)</li> <li>analytical solutions for Navier-Stokes systems</li> </ul> </li> <li>Analysis of internal flows (channels, pipes, open channels) and external flows, fundamentals of wing aerodynamics</li> <li>turbulent flows</li> <li>fundamentals of gas dynamics (1D compressible flows)</li> </ul>
Literature	<ul> <li>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 &amp; Sons.</li> <li>Spurk, J.; Aksel, N.: Strömungslehre, Springer.</li> <li>Schade, H.; Kunz, E., Kameier, F.; Paschereit, C.O.: Strömungslehere, De Gruyter.</li> <li>Herwig, H.: Strömungsmechanik, Springer.</li> <li>Herwig, H.: Strömungsmechanik von A-Z, Vieweg.</li> </ul>

Course L0455: Fluid Mechani	ics
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				
ïtle		Тур	Hrs/wk	СР
hip Dynamics (L0352)		Lecture	2	3
hip Dynamics (L1620)		Recitation Section (small)	1	1
	in Naval Architecure and Ocean Engineering (L0364) Prof. Moustafa Abdel-Maksoud	Lecture	2	3
Admission Requirements	None			
Recommended Previous Knowledge	<ul><li>Technical mechanics</li><li>Linear algebra, analysis, complex numbers</li><li>Fluid mechanics</li></ul>			
Educational Objectives	After taking part successfully, students have reached t	he following learning results		
Professional Competence				
Knowledge	<ul> <li>The students are able to give an overview over vario procedure of the manoeuvres.</li> </ul>	us manoeuvres. They can name applica	ation goals and t	hey can describe t
	- 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 a	are used to determine forces and motic	ons in waves.	
Skills	- The students can come up with the equations of moti			e and linearise the
	- The students are able to determine hydrodynamic co	efficients and they can explain their phy	ysical meaning.	
	- 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 descript	ion of harmoncial motions in waves an	d they can deter	nine them.
Personal Competence				
Social Competence	- The students can arrive at work results in groups and	document them.		
	- The students can discuss in groups and explain their	point of view.		
Autonomy	- The students can assess their own strengthes and we	aknesses and the define further work s	teps on this basi	5.
Workload in Hours	Independent Study Time 140, Study Time in Lecture 70	)		
Credit points	7			
Course achievement	None			
Examination	Written exam			

Тур	Lecture
Hrs/wk	
CP	
	Independent Study Time 62, Study Time in Lecture 28
	Prof. Moustafa Abdel-Maksoud
Language	
Cycle	
	Maneuverability of ships
	<ul> <li>Equations of motion</li> <li>Hydrodynamic forces and moments</li> <li>Linear equations and their solutions</li> <li>Full-scale trials for evaluating the maneuvering performance</li> <li>Regulations for maneuverability</li> <li>Rudder</li> </ul> Seakeeping <ul> <li>Representation of harmonic processes</li> <li>Motions of a rigid ship in regular waves</li> <li>Flow forces on ship cross sections</li> <li>Strip method</li> <li>Consequences induced by ship motion in regular waves</li> <li>Behavior of ships in a stationary sea state</li> <li>Long-term distribution of seaway influences</li> </ul>
Literature	<ul> <li>Abdel-Maksoud, M., Schiffsdynamik, Vorlesungsskript, Institut für Fluiddynamik und Schiffstheorie, Technische Universt Hamburg-Harburg, 2014</li> <li>Abdel-Maksoud, M., Ship Dynamics, Lecture notes, Institute for Fluid Dynamic and Ship Theory, Hamburg University Technology, 2014</li> <li>Bertram, V., Practical Ship Design Hydrodynamics, Butterworth-Heinemann, Linacre House - Jordan Hill, Oxford, Uni Kingdom, 2000</li> <li>Bhattacharyya, R., Dynamics of Marine Vehicles, John Wiley &amp; Sons, Canada,1978</li> <li>Brix, J. (ed.), Manoeuvring Technical Manual, Seehafen-Verlag, Hamburg, 1993</li> <li>Claus, G., Lehmann, E., Östergaard, C). Offshore Structures, I+II, Springer-Verlag. Berlin Heidelberg, Deutschland, 1992</li> <li>Faltinsen, O. M., Sea Loads on Ships and Offshore Structures, Cambridge University Press, United Kingdom, 1990</li> <li>Handbuch der Werften, Deutschland, 1986</li> <li>Jensen, J. J., Load and Global Response of Ships, Elsevier Science, Oxford, United Kingdom, 2001</li> <li>Lewis, Edward V. (ed.), Principles of Naval Architecture - Motion in Waves and Controllability, Society of Naval Architects a Marine Engineers, Jersey City, NJ, 1989</li> <li>Lewandowski, E. M., The Dynamics of Marine Craft: Maneuvering and Seakeeping, World Scientific, USA, 2004</li> <li>Lloyd, A., Ship Behaviour in Rough Weather, Gosport, Chichester, Sussex, United Kingdom, 1998</li> </ul>

Course L1620: Ship Dynamic	S
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

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

Courses				
Title		Тур	Hrs/wk	СР
Ship Structural Design (L0412)		Lecture	2	3
Ship Structural Design (L0415)		Recitation Section (small		3
Welding Technology (L1123)		Lecture	3	3
Module Responsible				
Admission Requirements				
Recommended Previous				
Knowledge				
	Welding Technology I			
	Fundamentals of Mechanical Design I - III			
Educational Objectives	After taking part successfully, students have	e reached the following learning results		
Professional Competence				
Knowledge	Students can reproduce design and sizing	as well as fabrication of the different areas of	f ship structures and	of different ship ty
	(incl. detail design); they can describe calc	ulation models for complex structures.		
Skiils		ements for different ship types and areas o	f the hull, to define o	design criteria for
Skills	Students are capable to specify the requi components, to select suitable calculation		f the hull, to define (	design criteria for
Skills Personal Competence	components, to select suitable calculation		f the hull, to define a	design criteria for
Personal Competence	components, to select suitable calculation			design criteria for
<b>Personal Competence</b> Social Competence	components, to select suitable calculation Students are capable to present their struc	nodels and to assess the chosen structure	ructively in a group.	
<b>Personal Competence</b> Social Competence	components, to select suitable calculation Students are capable to present their struc	nodels and to assess the chosen structure	ructively in a group.	
<b>Personal Competence</b> Social Competence	components, to select suitable calculation Students are capable to present their struc Students are capable to design independent	nodels and to assess the chosen structure	ructively in a group.	
<b>Personal Competence</b> Social Competence Autonomy	components, to select suitable calculation Students are capable to present their struc Students are capable to design independe appropriate fabrication methods.	nodels and to assess the chosen structure tural design and discuss their decisions const ently different structural areas of the ship h	ructively 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 independe appropriate fabrication methods.	nodels and to assess the chosen structure tural design and discuss their decisions const ently different structural areas of the ship h	ructively in a group.	
Personal Competence Social Competence Autonomy Workload in Hours Credit points	components, to select suitable calculation Students are capable to present their struct Students are capable to design independent appropriate fabrication methods.	nodels and to assess the chosen structure tural design and discuss their decisions const ently different structural areas of the ship h	ructively 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 struct Students are capable to design independent appropriate fabrication methods.	nodels and to assess the chosen structure tural design and discuss their decisions const ently different structural areas of the ship h	ructively 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 struct Students are capable to design independent appropriate fabrication methods.	nodels and to assess the chosen structure tural design and discuss their decisions const ently different structural areas of the ship h	ructively 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 struct Students are capable to design independent appropriate fabrication methods. Independent Study Time 172, Study Time i 9 None Written exam 3 hours	nodels and to assess the chosen structure tural design and discuss their decisions const ently different structural areas of the ship h	ructively 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 struct Students are capable to design independent appropriate fabrication methods. Independent Study Time 172, Study Time i 9 None Written exam 3 hours	nodels and to assess the chosen structure tural design and discuss their decisions const ently different structural areas of the ship h	ructively in a group. Null and different ship	

Course L0412: Ship Structura	
	Lecture
Hrs/wk	2
СР	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:
	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:
	<ol> <li>Bulkheads and tanks</li> <li>Structural design of forebodies</li> <li>Structures in engine rooms</li> <li>Aft bodies and rudders</li> <li>Detail structural design</li> <li>Outfitting</li> <li>Bulk carriers</li> <li>Tankers</li> <li>Container ships</li> <li>Production-kind steel structural design</li> <li>Buckling and ultimate strength</li> <li>Safety factors and reliability of structures</li> </ol>
Literature	Vorlesungsskript mit weiteren Literaturangaben wird über das Internet verfügbar gemacht

Course L1123: Welding Tech	nology
Тур	Lecture
Hrs/wk	3
СР	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		Typ	Hrs/wk	СР
Fundamentals of Ship Structural De	sign (10411)	<b>Typ</b> Lecture	2	2
Fundamentals of Ship Structural De	-	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	Prof. Sören Ehlers			
Admission Requirements	None			
<b>Recommended Previous</b>	Mechanics I - III			
Knowledge	Fundamentals of Materials Science I - III			
	Welding Technology I			
	Fundamentals of Mechanical Design I - III			
Educational Objectives	After taking part successfully, students have re	eached the following learning results		
Professional Competence				
Knowledge	Students can reproduce the basic contents of	the structural behaviour of ship structures; the	ey can explain the	theory and metho
	for the calculation of deformations and stresse	es in beam-like structures.		
	Furthermore the second second second second second		and an and a set of the set of	
	Furthermore, they can reproduce the basis co		ned products, join	ing and principles
	structural design of components in the ship str	ructure.		
Skills	Students are capable of applying the metho	ds and tools for the calculation of linear de	formations and s	tresses in the abo
	mentioned structures; they can choose calculation models of typical ship structures.			
	Furthermore, they are conclude to each the m	athede of drawing and sining the chin structu	way thay can cala	et eviteble vectorie
	Furthermore, they are capable to apply the m	iethous of drawing and sizing the ship structu	ire; they can sele	LL SUILADIE MALENA
	semi-finished products and joints.			
Personal Competence				
	The students are able to communicate and c	cooperate in a professional environment in th	e shinbuilding an	d component sup
Social competence	industry.	coperate in a professional environment in a	ie shipbullullig ul	la component sup
	industry.			
Autonomy	The students are capable to independently id	lealize real ship structures and to select suita	ble methods for a	analysis of beam-l
	structures; they are capable to assess the resu	ults of structural analyses.		
	Furthermore the second blacks and	denning of secondary ship should be and he	- destaur skin sk	
	Furthermore, they are capable to assess o	arawings of complex ship structures and to	o design snip st	ructures for vario
	requirements and boundary conditions.			
Weedle ed by Herry	Juden en deut Chada Tines 150, Chada Tines in L			
Workload in Hours Credit points	Independent Study Time 156, Study Time in Le	ELLUIE 64		
Course achievement				
	None Written exam			
Examination duration and	3 hours			
scale				
Anala 14 ii	Concert Frankrankra Culture (C			
Assignment for the Following Curricula	General Engineering Science (German progran Orientation Studies: Core Qualification: Electiv		ire: Compulsory	

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 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 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

ourse 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	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			
<b>Recommended Previous</b>	Mechanics			
Knowledge	<ul> <li>Fluid Dynamics for Naval Architects</li> </ul>			
	Hydrostratics			
	- Hydrositates			
Educational Objectives	After taking part successfully, students have reached the	e following learning results		
Professional Competence				
Knowledge	The hydrodynamic basics that are relevant for res			
	phenomena and their practical applications to hullform	design as well as numerical and emp	irical prediction	methods are subje
	of the course. Furthermore, environmental additional	esistances are dealt with. The course	e includes model	test techniques a
	their application to full scale ships. This hold also for	propulsion and hullefficiency elements	s, mainly thrust o	leduction and wal
	Main Focus is how hull forms can be optimized for mini	num and sustainable fuel consumptior	. The following to	pics are dealt with
	- Stillwater/added resistance, Wave resistance, Minin	ization of wave resistance, numerica	al prediction me	thods, friction law
	laminar/turbulent flow separation, Hull form design f			
	resistance law,form factor method, thrust deduction, w	ake, model scaling laws, resistance to	ests, free running	propeller tests a
	propeller basics, propulsion tests, full scale speed po	ver predictions, additional resistances	(wind, steering,	current, sea state
	EEDI, speed trials, contractual matters concerning spee	d/power, bunker claims		
Skills	The student shall learn to design competitve hull form			-
	evaluate these hulls by several progosis methods.		he student to c	learl determine a
	minimize the required power including environmental in	inuences.		
Personal Competence				
Social Competence	The student learns to prepare technical matters in such	a way that he can compte with his bu	ilding suvervisior	i team.
Autonomy	The student learns to prepare technical matters in such	a way that he can compte with his bu	ilding suvervisior	i team.
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56			
Credit points				
Course achievement	None			
Examination	Written exam			
Examination duration and	180 min			
scale				
Assignment for the	General Engineering Science (German program, 7 seme	ester): Specialisation Naval Architectur	e: Compulsory	
Following Curricula		-		
Course L1265: Resistance an	d Propulsion			
	Lecture			
- 7F	2			

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

Course L1266: Resistance an	urse 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
Ship Design (L1262)	Lecture		2	3
Ship Design (L1264)	Recitation Section	on (large)	2	3
Module Responsible	Prof. Stefan Krüger			
Admission Requirements	None			
Recommended Previous Knowledge	<ul> <li>Eluid Dynamics for Naval Architects Resistance and Propulsion</li> </ul>			
Educational Objectives	After taking part successfully, students have reached the following learning resu	ults		
Professional Competence				
Kiowedge	The lecture starts with an overview about the importance and requirements of Ship Designs are thoroughly discussed. Typical bulding contracts and the related main parameters of a ship are introduced and their influence on the competi influence of alternated main parameters on the total performance of a ship desi lecture, the design changes are dealt with by simple models or formulae. The systems properly so that the relavent technical conclusions can be drawn. The lecture continues with an introduction into the different phases of design contract. Further, methods are introduced to generate bulding specification reled 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 section plant - Design of subdivision - Determination of limiting GMrequ- Curves - Scantlings of most improtant structural members - Longitudinal strength - Outfitting Components - Relevant rules and regulations	d technical risk a itiveness of a de sign and the con The student sha project, from the	re introduced. sign. The lect secutive proce Il further learr e initial design	The most importa ture focusses on t ess elements. In th to model compl phase to a buildi
Skills	The student is made familiar with the basic design principles of seagoing me student shall be able to carry out a concept design based on a vessel of compa the Marine Environment. The lecture deals with the basic design methods to de of a ship design with respect to fulfillment procedures of the contract values. B relevant methods to determine and judge uopn the performance of a ship design	arison fulfilling ty etermine the fun Based on the lect	pical contract damantal tech	requirements with nnical characterist
Personal Competence				
Social Competence	The students learns to prepare technical matters in such a way the he of	can persuade hi	s potantial c	ustomer against l
Autonomy	competitors. The students learns to prepare technical matters in such a way the he c competitors.	can persuade hi	s potantial cu	ustomer against I
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		al Architecture:	Compulsory	
Following Curricula	Naval Architecture: Core Qualification: Compulsory			
Course L1262: Ship Design				
Тур	Lecture			
Hrs/wk				
CP				

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		

## **Specialization Process Engineering**

Process engineering is the engineering discipline that conducts research into, develops, and realizes material change processes. It deals as a crosssectional science with the conversion of materials in their nature, their properties, or their composition by means of physical, chemical, and biological processes with a view to producing usable intermediate or end products such as fuels, sugar, synthetics, proteins, cosmetics, dyestuffs, alcohols, plant protection products, or medications.

To achieve these targets, the process engineering study program aims to enable students to recognize and formulate laws by means of which apparatus, machinery, and entire manufacturing plants can be planned, calculated, designed, built, and operated. The product qualities required are to be achieved by means of safe and environmentally compatible processes and a rational use of energy and raw materials.

Module M0886: Funda	amentals of Process Enginee	ering and Material Engineering		
Courses				
Title		Тур	Hrs/wk	СР
Introduction into Process Engineeri	ng/Bioprocess Engineering (L0829)	Lecture	2	1
Fundamentals of material engineer	ring (L0830)	Lecture	2	2
Module Responsible	Prof. Michael Schlüter			
Admission Requirements	None			
<b>Recommended Previous</b>	none			
Knowledge				
Educational Objectives	After taking part successfully, students h	ave reached the following learning results		
Professional Competence				
Knowledge	After passing this module the students h	ave the ability to:		
	<ul> <li>give an overview of the most important</li> </ul>	ortant fields on process and bioprocess engineer	ing	
		r different fields in process and hoprocess engineering.	ing,	
	- explain some working methods to	and the fields in process engineering.		
Skills	After passing this module the students sl	hould have the ability to:		
	list and outline the most importan	t fields of process engineering,		
		approaches or methods of the different fields o	f process engineering,	
	read and prepare an engineering	drawing,		
	explain the most important techno	ologies for wastewater and exhaust air treatmen	t	
	scheme typical chemical and biote	echnological processes independently with the a	id of pointers.	
Personal Competence				
	The students are able to			
Social competence	The students are able to			
	<ul> <li>work out results in groups and door</li> </ul>	cument them,		
	<ul> <li>provide appropriate feedback and</li> </ul>	handle feedback on their own performance con	structively.	
Autonomv	The students are able to estimate their	progress of learning by themselves and to del	iberate their lack of k	nowledae in Process
	Engineering and Bioprocess Engineering.			
Workload in Hours	Independent Study Time 34, Study Time	in Lecture 56		
Credit points				
Course achievement		Description		
Examination	No 5 % Written elaboration	ווע		
Examination duration and	90 min			
scale	Conoral Engineering Science (Correspondent	agram 7 competer), Specialization Deserve Free	incoring Computer	
Assignment for the		rogram, 7 semester): Specialisation Process Eng		24
Following Curricula		ogram, 7 semester): Specialisation Bioprocess E	ingineering: Compulso	i y
	Bioprocess Engineering: Core Qualificatio Orientation Studies: Core Qualification: E			
	Process Engineering: Core Qualification:			

Course L0829: Introduction into Process Engineering/Bioprocess Engineering	
Тур	Lecture
Hrs/wk	2
CP	1
Workload in Hours	Independent Study Time 2, Study Time in Lecture 28
Lecturer	Dozenten des SD V
Language	DE
Cycle	WiSe
Content	Introduction into the different research fields of the subject Process Engineering and Bioprocess Engineering.
Literature	s. StudIP

Course L0830: Fundamentals	
	Lecture
Hrs/wk	
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Dr. Marko Hoffmann
Language	DE
Cycle	WiSe
Content	<ul> <li>Introduction</li> <li>Atomic structure and bonding</li> <li>Structure of solids</li> <li>Miller indices</li> <li>Imperfections in solids</li> <li>Texture</li> <li>Diffusion</li> <li>Mechanical properties</li> <li>Dislocations and strengthening mechanisms</li> <li>Phase transformations</li> <li>Phase diagrams, iron-carbon phase diagram</li> <li>Metallic materials</li> <li>Corrosion</li> <li>Polymeric materials</li> <li>Ceramic materials</li> </ul>
Literature	<ul> <li>Bargel, HJ.; Schulze, G. (Hrsg.): Werkstoffkunde. Berlin u.a., Springer Vieweg, 2012.</li> <li>Bergmann, W.: Werkstofftechnik 1. München u.a., Hanser, 2009.</li> <li>Bergmann, W.: Werkstofftechnik 2. München u.a., Hanser, 2008.</li> <li>Callister, W. D.; Rethwisch, D. G.: Materialwissenschaften und Werkstofftechnik: eine Einführung, Übersetzungshrsg.: Scheffler, M., 1. Auflage, Weinheim, Wiley-VCH, 2013.</li> <li>Seidel, W. W., Hahn, F.: Werkstofftechnik. München u.a., Hanser, 2012.</li> </ul>

Courses					
Title	Typ Hrs/wk CP				
Computer Engineering (L0321)	Lecture 3 4				
Computer Engineering (L0324)	Recitation Section (small) 1 2				
Module Responsible	Prof. Heiko Falk				
Admission Requirements	None				
<b>Recommended Previous</b>	Basic knowledge in electrical engineering				
Knowledge					
Educational Objectives	After taking part successfully, students have reached the 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-le programming down to gates. The module includes the following topics: • Introduction				
	<ul> <li>Combinational logic: Gates, Boolean algebra, Boolean functions, hardware synthesis, combinational networks</li> <li>Sequential logic: Flip-flops, automata, systematic hardware design</li> <li>Technological foundations</li> <li>Computer arithmetic: Integer addition, subtraction, multiplication and division</li> <li>Basics of computer architecture: Programming models, MIPS single-cycle architecture, pipelining</li> <li>Memories: Memory hierarchies, SRAM, DRAM, caches</li> <li>Input/output: I/O from the perspective of the CPU, principles of passing data, point-to-point connections, busses</li> </ul>				
Skills	The students perceive computer systems from the architect's perspective, i.e., they identify the internal structure and the physic composition of computer systems. The students can analyze, how highly specific and individual computers can be built based on collection of few and simple components. They are able to distinguish between and to explain the different abstraction layers today's computing systems - from gates and circuits up to complete processors. After successful completion of the module, the students are able to judge the interdependencies between a physical computer system and the software executed on it. In particular, they shall understand the consequences that the execution of software he and the hardware-centric abstraction layers from the assembly language down to gates. This way, they will be enabled to evaluat 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 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					
Course achievement					
Eveningtion	Yes 10 % Excercises				
	90 minutes, contents of course and labs				
scale					
Assignment for the					
Following Curricula					
Following curricula	General Engineering Science (German program, 7 semester): Specialisation Civit Engineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Process Engineering: Compulsory				
	General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Mechatron				
	Compulsory				
	General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Aircraft Syste				
	Engineering: Compulsory				
	General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Theoretical Mechan				
	Engineering: Compulsory				
	General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Materials				
	Engineering Sciences: Compulsory				
	General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Product Developm				
	and Production: Compulsory				
	General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Energy Syste Compulsory				
	General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Biomechan				
	Compulsory				
	General Engineering Science (German program, 7 semester): Specialisation Naval Architecture: Compulsory General Engineering Science (German program, 7 semester): Specialisation Biomedical Engineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Bioprocess Engineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Electrical Engineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Green Technologies, Focus Renewable Energy: Elec Compulsory				
	General Engineering Science (German program, 7 semester): Specialisation Biomedical Engineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Bioprocess Engineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Electrical Engineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Electrical Engineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Green Technologies, Focus Renewable Energy: Elec				
	General Engineering Science (German program, 7 semester): Specialisation Biomedical Engineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Bioprocess Engineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Electrical Engineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Green Technologies, Focus Renewable Energy: Elec Compulsory				
	General Engineering Science (German program, 7 semester): Specialisation Biomedical Engineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Bioprocess Engineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Electrical Engineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Green Technologies, Focus Renewable Energy: Elec Compulsory Computer Science: Core Qualification: Compulsory				
	General Engineering Science (German program, 7 semester): Specialisation Biomedical Engineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Bioprocess Engineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Electrical Engineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Green Technologies, Focus Renewable Energy: Elec Compulsory Computer Science: Core Qualification: Compulsory Data Science: Core Qualification: Elective Compulsory Electrical Engineering: Core Qualification: Compulsory General Engineering: Core Qualification: Specialisation Civil Engineering: Compulsory				
	General Engineering Science (German program, 7 semester): Specialisation Biomedical Engineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Bioprocess Engineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Electrical Engineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Green Technologies, Focus Renewable Energy: Elec Compulsory Computer Science: Core Qualification: Compulsory Data Science: Core Qualification: Elective Compulsory Electrical Engineering: Core Qualification: Compulsory				

Engineering: Compulsory
General Engineering Science (English program, 7 semester): Specialisation Mechanical Engineering, Focus Materials in Engineering
Sciences: Compulsory
General Engineering Science (English program, 7 semester): Specialisation Mechanical Engineering, Focus Mechatronics:
Compulsory
General Engineering Science (English program, 7 semester): Specialisation Mechanical Engineering, Focus Product Development
and Production: Compulsory
General Engineering Science (English program, 7 semester): Specialisation Mechanical Engineering, Focus Theoretical Mechanical
Engineering: Compulsory
Computational Science and Engineering: Core Qualification: Compulsory
Mechatronics: Core Qualification: Compulsory
Technomathematics: Specialisation II. Informatics: Elective Compulsory

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

Course L0324: Computer Eng	Course 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
Fundamentals of Fluid Mechanics (L	0091)	Lecture	2	4
Fluid Mechanics for Process Enginee		Recitation Section (large)	2	2
Module Responsible				
Admission Requirements	None			
Recommended Previous Knowledge	Mathematics I+II+III			
Knowledge	Technical Mechanics I+II			
	Technical Thermodynamics I+II			
	Working with force balances			
	Simplification and solving of partial differentia	l equations		
	Integration			
Educational Objectives	After taking part successfully, students have reached	d the following learning results		
Professional Competence				
Knowledge	Students are able to:			
	explain the difference between different types	s of flow		
	<ul> <li>explain the difference between different types of now</li> <li>give an overview for different applications of the Reynolds Transport-Theorem in process engineering</li> </ul>			
	<ul> <li>explain simplifications of the Continuity- and Navier-Stokes-Equation by using physical boundary conditions</li> </ul>			
Skille	The students are able to			
SKIIIS				
	describe and model incompressible flows mathematically			
	reduce the governing equations of fluid mechanics by simplifications to archive quantitative solutions e.g. by inte			
	notice the dependency between theory and te			
	<ul> <li>use the learned basics for fluid dynamical app</li> </ul>	lications in fields of process engineering		
Personal Competence				
Social Competence	The students			
	are capable to gather information from subject	ct related, professional publications and	relate that inform	nation to the cont
	of the lecture and			
	• able to work together on subject related tasks in small groups. They are able to present their results effectively in English			
	(e.g. during small group exercises)			
	<ul> <li>are able to work out solutions for exercises by</li> </ul>	themselves, to discuss the solutions ora	lly and to presen	t the results.
Autonomy	The students are able to			
	<ul> <li>search further literature for each topic and to</li> <li>work on their eversions by their own and to ever</li> </ul>			
	<ul> <li>work on their exercises by their own and to ev</li> </ul>	and the man actual knowledge with the re	Beuback.	
Workload in Hours	Independent Study Time 124, Study Time in Lecture	56		
Credit points				
Course achievement		escription		
Examination				
Examination Examination duration and				
scale	5 110015			
	General Engineering Science (German program, 7 se	mester): Specialisation Process Engineer	ing: Compulsory	
5	General Engineering Science (German program, 7 se		5 1 5	ory
-	General Engineering Science (German program, 7 se			
	Bioprocess Engineering: Core Qualification: Compulse	ory		
	Energy and Environmental Engineering: Core Qualific	cation: Compulsory		
	Green Technologies: Energy, Water, Climate: Core Q			
	Logistics and Mobility: Specialisation Traffic Planning	, , ,		
	Technomathematics: Specialisation III. Engineering S Process Engineering: Core Qualification: Compulsory			

ourse L0091: Fundamentals	of Fluid Mechanics
Тур	Lecture
Hrs/wk	2
CP	4
Workload in Hours	Independent Study Time 92, Study Time in Lecture 28
Lecturer	Prof. Michael Schlüter
Language	DE
Cycle	SoSe
Content	<ul> <li>fluid properties</li> <li>hydrostatic</li> <li>overall balances - theory of streamline</li> <li>overall balances- conservation equations</li> <li>differential balances - Navier Stokes equations</li> <li>irrotational flows - Potenzialströmungen</li> <li>flow around bodies - theory of physical similarity</li> <li>turbulent flows</li> <li>compressible flows</li> </ul>
Literature	<ol> <li>Crowe, C. T.: Engineering fluid mechanics. Wiley, New York, 2009.</li> <li>Durst, F.: Strömungsmechanik: Einführung in die Theorie der Strömungen von Fluiden. Springer-Verlag, Berlin, Heidelberg, 2006.</li> <li>Fox, R.W.; et al.: Introduction to Fluid Mechanics. J. Wiley &amp; Sons, 1994</li> <li>Herwig, H.: Strömungsmechanik: Eine Einführung in die Physik und die mathematische Modellierung von Strömungen. Springer Verlag, Berlin, Heidelberg, New York, 2006</li> <li>Herwig, H.: Strömungsmechanik: Einführung in die Physik von technischen Strömungen: Vieweg+Teubner Verlag / GWV Fachverlage GmbH, Wiesbaden, 2008</li> <li>Kuhlmann, H.C.: Strömungsmechanik: Grundlagen, Grundgleichungen, Lösungsmethoden, Softwarebeispiele. Vieweg+ Teubner Verlag / GWV Fachverlage GmbH, Wiesbaden, 2009</li> <li>Schade, H.; Kunz, E.: Strömungslehre. Verlag de Gruyter, Berlin, New York, 2007</li> <li>Truckenbrodt, E.: Fluidmechanik 1: Grundlagen und elementare Strömungsvorgänge dichtebeständiger Fluide. Springer-Verlag, Berlin, Heidelberg, 2008</li> <li>Schlichting, H.: Grenzschicht-Theorie. Springer-Verlag, Berlin, 2006</li> <li>van Dyke, M.: An Album of Fluid Motion. The Parabolic Press, Stanford California, 1882.</li> <li>White, F.: Fluid Mechanics, Mcgraw-Hill, ISBN-10: 0071311211, ISBN-13: 978-0071311212, 2011</li> </ol>

Course L0092: Fluid Mechani	ics for Process Engineering
Тур	Recitation Section (large)
Hrs/wk	2
СР	2
Workload in Hours	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. 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	<ol> <li>Crowe, C. T.: Engineering fluid mechanics. Wiley, New York, 2009.</li> <li>Durst, F.: Strömungsmechanik: Einführung in die Theorie der Strömungen von Fluiden. Springer-Verlag, Berlin, Heidelberg, 2006.</li> <li>Fox, R.W.; et al.: Introduction to Fluid Mechanics. J. Wiley &amp; Sons, 1994</li> <li>Herwig, H.: Strömungsmechanik: Eine Einführung in die Physik und die mathematische Modellierung von Strömungen. Springer Verlag, Berlin, Heidelberg, New York, 2006</li> <li>Herwig, H.: Strömungsmechanik: Einführung in die Physik von technischen Strömungen: Vieweg+Teubner Verlag / GWV Fachverlage GmbH, Wiesbaden, 2008</li> <li>Kuhlmann, H.C.: Strömungsmechanik: Grundlagen, Grundgleichungen, Lösungsmethoden, Softwarebeispiele. Vieweg+ Teubner Verlag / GWV Fachverlage GmbH, Wiesbaden, 2009</li> <li>Schade, H.; Kunz, E.: Strömungslehre. Verlag de Gruyter, Berlin, New York, 2007</li> <li>Truckenbrodt, E.: Fluidmechanik 1: Grundlagen und elementare Strömungsvorgänge dichtebeständiger Fluide. Springer-Verlag, Berlin, Heidelberg, 2008</li> <li>Schlichting, H.: Grenzschicht-Theorie. Springer-Verlag, Berlin, 2006</li> <li>van Dyke, M.: An Album of Fluid Motion. The Parabolic Press, Stanford California, 1882.</li> <li>White, F.: Fluid Mechanics, Mcgraw-Hill, ISBN-10: 0071311211, ISBN-13: 978-0071311212, 2011</li> </ol>

Courses				
Title		Тур	Hrs/wk	СР
Phase Equilibria Thermodynamics (		Lecture	2	2
Phase Equilibria Thermodynamics (L0140)		Recitation Section (small)	1	2
Phase Equilibria Thermodynamics (L0142)		Recitation Section (large)	1	2
Module Responsible				
Admission Requirements	None			
Recommended Previous Knowledge	Mathematics, Physical Chemistry, Thermodynamics I an	d II		
Educational Objectives	After taking part successfully, students have reached th	e following learning results		
Professional Competence				
Knowledge Skills	<ul> <li>Starting from the very basics of thermodynamic equilibria.</li> <li>They learn how state variables are influenced by these properties.</li> <li>Moreover, the students learn how phase equilibred different phases (vapor, liquid, solid) coexist in exponsion of the student of the stude</li></ul>	y the mixing of compounds and learr ria can be described mathematically quilibrium. Furthermore the fundamen s relevant for different kinds of proc bria are taught.	n concepts to qu and which phen tals of reaction e esses are showr	antitatively descr omena may occu quilibria are taugi n and the necess
	<ul> <li>state and know how to simplify these equations meaningfully.</li> <li>The students know models which can be used to determine the properties of the system in the equilibrium state a are able to solve the resulting mathematical relations.</li> <li>For specific applications, they are able to self-reliantly find necessary physico-chemical properties of compounds at model parameters in literature sources.</li> <li>Beside pure compound properties the students are capable of describing the properties of mixtures.</li> <li>The students know how to visualize phase equilibria graphically and they know how to interpret the occurring phenometric based on their knowledge, the students are able to understand fundamental concepts that are the basis for separation and reaction processes in chemical engineering.</li> </ul>		ompounds as well urring phenomena	
Personal Competence				
	The students are able to work in small groups, to solve other students	e the corresponding problems and to	present them or	aly to the tutors
Autonomy	<ul> <li>The students are able to find necessary information</li> <li>During the semester the students are able to knowledge the students can adept their learning</li> </ul>	check their learning progress contin		
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56			
Credit points				
Course achievement				
Examination				
	120 minutes; theoretical questions and calculations			
scale				
	General Engineering Science (German program, 7 seme	ster): Specialisation Process Engineeri	na: Compulsory	
-	General Engineering Science (German program, 7 serie			ory
g earlied	General Engineering Science (German program, 7 seme		÷ ,	-
	Compulsory		,	
	General Engineering Science (German program, 7 seme	ster): Specialisation Green Technologi	es, Focus Renew	able Energy: Elec
	Compulsory	5		
	Bioprocess Engineering: Core Qualification: Compulsory			
	Green Technologies: Energy, Water, Climate: Specialisa	tion Bioresource Technology: Elective	Compulsory	
	Green Technologies: Energy, Water, Climate: Specialisa	tion Energy Systems: Elective Compuls	sory	
	Process Engineering: Core Qualification: Compulsory			

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	
	<ol> <li>Introduction: Applications of thermodynamics of mixtures</li> <li>Thermodynamic equations in multi-component systems: Fundamental equations, chemical potential, fugacity</li> <li>Phase equilibria of pure substances: thermodynamic equilibrium, vapor pressure, Gibbs' phase rule</li> <li>Equations of state: virial equations, van-der-Waals equation, generalized equations of state</li> <li>Mixing properties: ideal and real mixtures, excess properties, partial molar properties</li> <li>Vapor-liquid-equilibria: binary systems, azeotropes, equilibrium condition</li> <li>Gas-liquid-equilibria: equilibrium condition, Henry-coefficient</li> <li>G<sup>E</sup>-Models: Hildebrand-model, Flory-Huggins-model, Wilson-model, UNIQUAC, UNIFAC</li> <li>Liquid-liquid-equilibria: equilibrium condition, phase equilibria in binary systems</li> <li>Solid-liquid-equilibria: equilibrium condition, binary systems</li> <li>Chemical reactions: reaction coordinate, mass action law, influence of pressure and temperature</li> <li>Osmotic pressure</li> </ol>
Literature	<ul> <li>Jürgen Gmehling, Bärbel Kolbe: Thermodynamik. VCH 1992</li> <li>J.M. Prausnitz, R.N. Lichtenthaler, E.G. de Azevedo: Molecular Thermodynamics of Fluid-Phase Equilibria, 3rd ed. Prentice Hall, 1999.</li> <li>J.W. Tester, M. Modell: Thermodynamics and its Applications. 3<sup>rd</sup> ed. Prentice Hall, 1997.J.P. O'Connell, J.M. Haile: Thermodynamics. Cambridge University Press, 2005.</li> </ul>

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	<ol> <li>Introduction: Applications of thermodynamics of mixtures</li> <li>Thermodynamic equations in multi-component systems: Fundamental equations, chemical potential, fugacity</li> <li>Phase equilibria of pure substances: thermodynamic equilibrium, vapor pressure, Gibbs' phase rule</li> <li>Equations of state: virial equations, van-der-Waals equation, generalized equations of state</li> <li>Mixing properties: ideal and real mixtures, excess properties, partial molar properties</li> <li>Vapor-liquid-equilibria: binary systems, azeotropes, equilibrium condition</li> <li>Gas-liquid-equilibria: equilibrium condition, Henry-coefficient</li> <li>G<sup>E</sup>-Models: Hildebrand-model, Flory-Huggins-model, Wilson-model, UNIQUAC, UNIFAC</li> <li>Liquid-liquid-equilibria: equilibrium condition, phase equilibria in binary and ternary systems</li> <li>Solid-liquid-equilibria: reaction coordinate, mass action law, influence of pressure and temperature</li> <li>Osmotic pressure</li> <li>The students work on tasks in small groups and present their results in front of all students.</li> </ol>
Literature	<ul> <li>Jürgen Gmehling, Bärbel Kolbe: Thermodynamik. VCH 1992</li> <li>J.M. Prausnitz, R.N. Lichtenthaler, E.G. de Azevedo: Molecular Thermodynamics of Fluid-Phase Equilibria, 3rd ed. Prentice Hall, 1999.</li> <li>J.W. Tester, M. Modell: Thermodynamics and its Applications. 3<sup>rd</sup> ed. Prentice Hall, 1997.J.P. O'Connell, J.M. Haile: Thermodynamics. Cambridge University Press, 2005.</li> </ul>

Course L0142: Phase Equilibr	ria Thermodynamics
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	SoSe
Content	<ol> <li>Introduction: Applications of thermodynamics of mixtures</li> <li>Thermodynamic equations in multi-component systems: Fundamental equations, chemical potential, fugacity</li> <li>Phase equilibria of pure substances: thermodynamic equilibrium, vapor pressure, Gibbs' phase rule</li> <li>Equations of state: virial equations, van-der-Waals equation, generalized equations of state</li> <li>Mixing properties: ideal and real mixtures, excess properties, partial molar properties</li> <li>Vapor-liquid-equilibria: binary systems, azeotropes, equilibrium condition</li> <li>Gas-liquid-equilibria: equilibrium condition, Henry-coefficient</li> <li>G<sup>E</sup>-Models: Hildebrand-model, Flory-Huggins-model, Wilson-model, UNIQUAC, UNIFAC</li> <li>Liquid-liquid-equilibria: equilibrium condition, phase equilibria in binary and ternary systems</li> <li>Solid-liquid-equilibria: eaction coordinate, mass action law, influence of pressure and temperature</li> <li>Osmotic pressure</li> </ol>
Literature	<ul> <li>Jürgen Gmehling, Bärbel Kolbe: Thermodynamik. VCH 1992</li> <li>J.M. Prausnitz, R.N. Lichtenthaler, E.G. de Azevedo: Molecular Thermodynamics of Fluid-Phase Equilibria, 3rd ed. Prentice Hall, 1999.</li> <li>J.W. Tester, M. Modell: Thermodynamics and its Applications. 3<sup>rd</sup> ed. Prentice Hall, 1997.J.P. O'Connell, J.M. Haile: Thermodynamics. Cambridge University Press, 2005.</li> </ul>

Courses				
Title		Тур	Hrs/wk	СР
Bioprocess Engineering - Fundamer	tals (L0841)	Lecture	2	3
Bioprocess Engineering- Fundamentals (L0842)		Recitation Section (large)	2	1
Bioprocess Engineering - Fundamer	tal Practical Course (L0843)	Practical Course	2	2
Module Responsible	Prof. Andreas Liese			
Admission Requirements	None			
<b>Recommended Previous</b>	none, module "organic chemistry", module '	fundamentals for process engineering"		
Knowledge				
Educational Objectives	After taking part successfully, students have	reached the following learning results		
Professional Competence				
	enzymes and microorganisms, as well as rheology can be named and mass transpor fundamental bioprocess management, steril	epts of bioprocess engineering. They are able to differentiate different types of inhibition. rt processes in bioreactors can be explained ization technology and downstream processing	The parameters of I. The students are	of stoichiometry a
Skills	<ul> <li>After successful completion of this module, students should be able to</li> <li>describe different kinetic approaches for growth and substrate-uptake and to calculate the corresponding parame</li> <li>predict qualitatively the influence of energy generation, regeneration of redox equivalents and growth inhibit fermentation process</li> <li>analyze bioprocesses on basis of stoichiometry and to set up / solve metabolic flux equations</li> <li>distinguish between scale-up criteria for different bioreactors and bioprocesses (anaerobic, aerobic as well as mic to compare them as well as to apply them to current biotechnical problem</li> <li>propose solutions to complicated biotechnological problems and to deduce the corresponding models</li> </ul>			wth inhibition on t
		ete industrial use and to formulate solutions. ures as well as results in a scientific manner		
Personal Competence				
Social Competence	After completion of this module participants should be able to debate technical questions in small teams to enhance the ability take position to their own opinions and increase their capacity for teamwork in engineering and scientific environments.			
Autonomy	After completion of this module participants will be able to solve a technical problem in a team independently by organizing the workflow and to present their results in a plenum.			
Workload in Hours	Independent Study Time 96, Study Time in I	ecture 84		
Credit points	6			
Course achievement	Compulsory         Bonus         Form           Yes         5 %         Subject theoretica practical work	<b>Description</b> and		
Examination	Written exam			
Examination duration and	90 min			
scale				
Assignment for the	General Engineering Science (German progr	am, 7 semester): Specialisation Process Engine	erina: Compulsory	
-				ory
	General Engineering Science (German program, 7 semester): Specialisation Bioprocess Engineering: Compulsory Bioprocess Engineering: Core Qualification: Compulsory			
		: Specialisation Bioresource Technology: Electi	ve Compulsory	
	5 55	cial Organs and Regenerative Medicine: Compu	1	
	5 5 1	ants and Endoprostheses: Elective Compulsory	-	
		cal Technology and Control Theory: Elective Co	mpulsory	
		gement and Business Administration: Elective		
	Technomathematics: Specialisation III. Engir	-	-	
	Process Engineering: Core Qualification: Cor			

Course L0841: Bioprocess Engineering - Fundamentals		
Тур	Lecture	
Hrs/wk	2	
CP	3	
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28	
Lecturer	Prof. Andreas Liese	
Language	DE	
Cycle	SoSe	
Content	<ul> <li>Introduction: state-of-the-art and development trends in the biotechnology, introduction to the lecture</li> <li>Enzyme kinetics: Michaelis-Menten, differnt types of enzyme inhibition, linearization, conversion, yield, selectivity (Prof. Liese)</li> <li>Stoichiometry: coefficient of respiration, electron balance, degree of reduction, coefficient of yield, theoretical oxygen demand (Prof. Liese)</li> <li>Microbial growth kinetic: batch- and chemostat culture (Prof. Zeng)</li> <li>Kinetic of subtrate consumption and product formation (Prof. Zeng)</li> <li>Rheology: non-newtonian fluids, viscosity, agitators, energy input (Prof. Liese)</li> <li>Transport process in a bioreactor (Prof. Zeng)</li> <li>Fundamentals of bioprocess management: bioreactors and calculation of batch, fed-batch and continuouse bioprocesses (Prof. Zeng/Prof. Liese)</li> <li>Downstream technology in biotechnology: cell breakdown, zentrifugation, filtration, aqueous two phase systems (Prof. Liese)</li> </ul>	
Literature	K. Buchholz, V. Kasche, U. Bornscheuer: Biocatalysts and Enzyme Technology, 2. Aufl. Wiley-VCH, 2012 H. Chmiel: Bioprozeßtechnik, Elsevier, 2006 R.H. Balz et al.: Manual of Industrial Microbiology and Biotechnology, 3. edition, ASM Press, 2010 H.W. Blanch, D. Clark: Biochemical Engineering, Taylor & Francis, 1997 P. M. Doran: Bioprocess Engineering Principles, 2. edition, Academic Press, 2013	

Course L0842: Bioprocess Engineering- Fundamentals	
Тур	Recitation Section (large)
Hrs/wk	2
СР	1
Workload in Hours	Independent Study Time 2, Study Time in Lecture 28
Lecturer	Prof. Andreas Liese
Language	DE
Cycle	SoSe
Content	1. Introduction (Prof. Liese, Prof. Zeng)
	2. Enzymatic kinetics (Prof. Liese)
	3. Stoichiometry I + II (Prof. Liese)
	4. Microbial Kinetics I+II (Prof. Zeng)
	5. Rheology (Prof. Liese)
	6. Mass transfer in bioprocess (Prof. Zeng)
	7. Continuous culture (Chemostat) (Prof. Zeng)
	8. Sterilisation (Prof. Zeng)
	9. Downstream processing (Prof. Liese)
	10. Repetition (Reserve) (Prof. Liese, Prof. Zeng)
Literature	siehe Vorlesung

Course L0843: Bioprocess Engineering - Fundamental Practical Course		
Тур	Practical Course	
Hrs/wk	2	
CP	2	
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28	
Lecturer	Prof. Andreas Liese, Prof. An-Ping Zeng	
Language	DE	
Cycle	SoSe	
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	

Admission Requirements		<b>Typ</b> Lecture Lecture	Hrs/wk	СР
Power Industry (L0316) Energy Systems and Energy Industr Renewable Energy (L0313) Renewable Energy (L1434) Module Responsible Admission Requirements		Lecture		СР
Energy Systems and Energy Industr Renewable Energy (L0313) Renewable Energy (L1434) Module Responsible Admission Requirements				
Renewable Energy (L0313) Renewable Energy (L1434) Module Responsible Admission Requirements		Lecture	2	1 2
Renewable Energy (L1434) Module Responsible Admission Requirements		Lecture	2	2
Module Responsible Admission Requirements		Recitation Section (small)	1	1
Admission Requirements	Prof. Martin Kaltschmitt			
Recommended Previous	None			
	none			
Knowledge				
Educational Objectives	After taking part successfully, students have reached	the following learning results		
Professional Competence				
	With completion of this module, the students can p efficiency. They can explain the issues occurring in th distribution and power trading wih regard to subj applicable to many energy systems in general, espe the students can explain the environmental benefits t	nis context. Furthermore, they can explai ject-related contexts. The students ca ecially for renewable energy systems an	n details of powe n explain these	er generation, pov aspects, which
	Students are able to apply methodologies for detailed determination of energy demand or energy production for various type energy systems. Furthermore, they can evaluate energy systems technically, environmentally and economically and design th under certain given conditions. Therefore, they can choose the necessary subject-specific calculation rules, also for standardized solutions of a problem. The students are able to explain questions and possible approaches to its processing from the field of renewable energies or and to put them them into the right context.			
Personal Competence				
	The students are able to analyze suitable technical criteria under sustainability aspects. This allows them			
	Students can independently exploit sources , acquir questions.	re the particular knowledge about the s	subject area and	transform it to
Workload in Hours	Independent Study Time 96, Study Time in Lecture 84	4		
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 ser	mester): Specialisation Process Engineer	ing: Compulsory	
-	General Engineering Science (German program, 7 ser			
	General Engineering Science (German program, 7	semester): Specialisation Mechanical I	Engineering, Foci	us Energy Syste
	Elective Compulsory	Civil Engineering, Elective Computer -		
	Civil- and Environmental Engineering: Specialisation ( Civil- and Environmental Engineering: Specialisation 7			
	Civil- and Environmental Engineering: Specialisation I Civil- and Environmental Engineering: Specialisation V			
	Energy and Environmental Engineering: Specialisation (		.501 y	
	General Engineering Science (English program, 7 Elective Compulsory		Engineering, Focu	us Energy Syste

Course L0316: Power Industr	γ
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	<ul> <li>Electrical energy in the energy system</li> <li>Demand and use of electrical energy (households, industry, "new" buyers (including e-mobility))</li> <li>Electricity generation <ul> <li>electricity generation technologies using fossil fuels and their characteristics</li> <li>combined heat and power technologies and their production characteristics</li> <li>electricity generation from renewable energy technologies and their characteristics</li> <li>electricity generation of electrical energy</li> <li>challenges of fluctuating electricity generation by distributed systems (electricity market, electricity stock exchange, emissions trading)</li> </ul> </li> <li>District heating industry</li> <li>Legal and administrative aspects <ul> <li>Energy Act</li> <li>support instruments for renewable energy</li> <li>CHP Act</li> </ul> </li> </ul>
Literature	Cost and efficiency calculation Folien der Vorlesung

Course L0315: Energy Systems 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	<ul> <li>Energy: development and significance</li> <li>Fundamentals and basic concepts</li> <li>Energy demand and future trends (heat, electricity, fuels)</li> <li>Energy reserve and sources</li> <li>Cost and efficiency calculation</li> <li>Final and effective energy from petroleum, natural gas, coal, uranium and other</li> <li>Legal, administrative and organizational aspects of energy systems</li> <li>Energy systems as a permanent optimization task</li> </ul>	
Literature	• Kopien der Folien	

Course L0313: Renewable Er	nergy
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/EN
Cycle	SoSe
Content	<ul> <li>introduction</li> <li>solar energy for heat and power generation</li> <li>wind power for electricity generation</li> <li>hydropower for electricity generation</li> <li>ocean energy for electricity generation</li> <li>geothermal energy for heat and electricity generation</li> </ul>
Literature	<ul> <li>Kaltschmitt, M.; Streicher, W.; Wiese, A. (Hrsg.): Erneuerbare Energien - Systemtechnik, Wirtschaftlichkeit, Umweltaspekte; Springer, Berlin, Heidelberg, 2006, 4. Auflage</li> <li>Kaltschmitt, M.; Streicher, W.; Wiese, A. (Hrsg.): Renewable Energy - Technology, Economics and Environment; Springer, Berlin, Heidelberg, 2007</li> </ul>

Course L1434: Renewable En	lergy
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	<ul> <li>Kaltschmitt, M.; Streicher, W.; Wiese, A. (Hrsg.): Erneuerbare Energien - Systemtechnik, Wirtschaftlichkeit, Umweltaspekte; Springer, Berlin, Heidelberg, 2006, 4. Auflage</li> <li>Kaltschmitt, M.; Streicher, W.; Wiese, A. (Hrsg.): Renewable Energy - Technology, Economics and Environment; Springer, Berlin, Heidelberg, 2007</li> </ul>

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Course L0204: Chemical Reaction Engineering (Fundamentals)		
Тур	Lecture	
Hrs/wk	2	
CP	2	
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28	
Lecturer	Prof. Raimund Horn	
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 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 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, CST
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

Course L0244: Chemical Read	ction Engineering (Fundamentals)
Тур	Recitation Section (large)
Hrs/wk	2
СР	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Prof. Raimund Horn, Dr. Oliver Korup
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, rireversible 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 reactor, 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 reactor, integration of the batch reactor mole balance for various kinetics, partial fraction decomposition, mole balance of a batch reactor, mole balance of the balance of the plug flow reactor, design of plug flow reactors for reactions with volume change and
Literature	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)
	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
	<ul> <li>H. S. Fogler, Essentials of Chemical Reaction Engineering, Prentice Hall</li> <li>O. Levenspiel, Chemical Reaction Engineering, John Wiley &amp; Sons, 1998</li> <li>L. D. Schmidt, The Engineering of Chemical Reactions, Oxford Univ. Press, 2009</li> <li>J. B. Butt, Reaction Kinetics and Reactor Design, 2000, Marcel Dekker</li> <li>R. Aris, Elementary Chemical Reactor Analysis, Dover Pubn. Inc., 2000</li> <li>M. E. Davis, R. J. Davis, Fundamentals of Chemical Reaction Engineering, McGraw Hill</li> <li>G. F. Froment, K. B. Bischoff, J. De Wilde, Chemical Reactor Analysis and Design, John Wiley &amp; Sons, 2010</li> <li>A. Jess, P. Wasserscheid, Chemical Technology An Integrated Textbook, WILEY-VCH</li> </ul>

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 M1275: Enviro	onmental Tech	nology				
Module M1275. Enviro	Jimentai recin	liology				
Courses						
Title			1	Гур	Hrs/wk	СР
Practical Exercise Environmental Te	echnology (L1387)		F	Practical Course	1	1
Environmental Technologie (L0326)			l	ecture	2	2
Module Responsible	Prof. Martin Kaltschm	itt				
Admission Requirements	None					
<b>Recommended Previous</b>	Fundamentals of inor	ganic/organic chemistry	and biology			
Knowledge						
Educational Objectives	After taking part succ	essfully, students have	reached the following	g learning results		
Professional Competence						
Knowledge	With the completion of	of this modul the studen	ts obtain profound kr	nowledge of environm	ental technology. They	are able to describe
	the behaviour of che	micals in the environme	ent. Students can give	e an overview of scie	ntific disciplines involve	ed. They can explair
	terms and allocate th	em to related methods.				
CI-:!!-	Chudanta ana akla ta					
SKIIIS		propose appropriate m	-	-		
	determine geochemical parameters and to assess the potential of pollutants to migrate and transform. The students are able to					
	work out well founded opinions on how Environmental Technology contributes to sustainable development, and they can presen and defend these opinons in front of and against the group.					
	und derend these opi	nons in none of and agai	inst the group.			
Personal Competence						
Social Competence	The students are able	e to discuss the various t	echnical and scientif	ic tasks, both subject-	specific and multidiscip	olinary. They are abl
	to develop different a	pproaches to the task a	s a group as well as t	o discuss their theore	tical or practical impler	mentation.
Autonomy	Students can indeper	idently exploit sources a	bout of the cubiect	equire the particular	knowledge and tranfer	it to now problems
Autonomy	Students can indeper	identity exploit sources a	ibout of the subject, a	acquire the particular	knowledge and trailier	it to new problems.
Workload in Hours	Independent Study Ti	me 48, Study Time in Le	ecture 42			
Credit points	3					
Course achievement	Compulsory Bonus	Form	Description			
	Yes None	Subject theoretical	and			
		practical work				
Examination	Written exam					
Examination duration and	1 hour					
scale						
Assignment for the	General Engineering	Science (German progra	m, 7 semester): Spec	cialisation Bioprocess	Engineering: Elective C	ompulsory
Following Curricula	General Engineering	Science (German progra	m, 7 semester): Spec	cialisation Process Eng	gineering: Elective Com	pulsory
	Bioprocess Engineeri	ng: Core Qualification: El	lective Compulsory			
	Energy and Environm	ental Engineering: Core	Qualification: Compu	ilsory		
	Process Engineering:	Core Qualification: Elect	ive Compulsory			

Course L1387: Practical Exer	cise Environmental Technology	
Тур	Practical Course	
Hrs/wk	1	
СР	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 L0326: Environmenta	I Technologie		
Тур	Lecture		
Hrs/wk			
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	<ol> <li>Introductory seminar on environmental science:</li> <li>Environmental impact and adverse effects</li> <li>Wastewater technology</li> <li>Air pollution control</li> <li>Noise protection</li> <li>Waste and recycling management</li> <li>Soil and ground water protection</li> <li>Renewable energies</li> <li>Resource conservation and energy efficiency</li> </ol>		
Literature	Förster, U.: Umweltschutztechnik; 2012; Springer Berlin (Verlag) 8., Aufl. 2012; 978-3-642-22972-5 (ISBN)		

Courses					
Title			Тур	Hrs/wk	СР
Practical Course Measurement Tec	hnology (L2270)		Practical Course	2	2
Measurement Technology (L2268)			Lecture	2	2
Physical Fundamentals of Measure	ment Technology (L	.2269)	Lecture	2	2
Module Responsible	Prof. Alexander F	Penn			
Admission Requirements	None				
Recommended Previous Knowledge		t, logical skills, integral-	and differential calculus, basic physical cor	ncepts such as tempera	iture, mass, veloci
Educational Objectives	After taking part	successfully, students ha	ave reached the following learning results		
Professional Competence					
Knowledge			ics (theory of motion), rotation of rigid t nperature and heat, ideal gas.	podies, energy and mo	omentum, electric
			neasurement uncertainty, basics of sensor t vel measurement, flow measurement. Usage		nciples, temperati
			calorimetry, image data acquisition, flow me of solid concentrations, spectroscopy, error c		
Skills	Literature research, categorisation of thematical topics, analysis of an experimental test stand, preparation of test protocol, fi programming with Matlab, use of relevant laboratory measurement technology, preparation of a test protocol, execution calculations.				
Personal Competence					
Social Competence	experimental st		ctical training and learning groups, assessm ation with persons responsible for teachin		
Autonomy	Time management of the workload, independent development of the thematic basics, personal responsibility 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	Independent Stu	dy Time 96, Study Time i	n Lecture 84		
Credit points	6				
Course achievement	CompulsoryBonusNo20 %		Description Popup-Quizzes währen der Vorlesu	ng	
Examination	Written exam				
Examination duration and	120 min				
scale					
-	-		ogram, 7 semester): Specialisation Process El		
Following Curricula			ogram, 7 semester): Specialisation Green Tec ogram, 7 semester): Specialisation Chemical		mulcon
				and bioengineering: Co	mpulsory
		neering: Core Qualification	n: Compulsory re Qualification: Compulsory		
			re Qualification: Compulsory ate: Core Qualification: Compulsory		
		ies: Core Qualification: El			

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	<ul> <li>Hug, H.: Instrumentelle Analytik. Theorie und Praxis. Verlag Europa-Lehrmittel, Haan-Gruiten, 2015.</li> <li>Kamke, W.: Der Umgang mit experimentellen Daten, insbesondere Fehleranalyse, im physikalischen Anfänger-Praktikum. Eine elementare Einführung. W. Kamke, Kirchzarten [Keltenring 197], 2010.</li> <li>Strohrmann, G.: Messtechnik im Chemiebetrieb. Einführung in das Messen verfahrenstechnischer Größen. Oldenbourg, München, 2004.</li> </ul>

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
	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.
	<ul> <li>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&amp;scope=site&amp;db=nlebk&amp;AN=1081958.</li> <li>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.</li> <li>Strohrmann, Günther (2004): Messtechnik im Chemiebetrieb. Einführung in das Messen verfahrenstechnischer Größen. 10., durchges. Aufl. München: Oldenbourg.</li> <li>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.</li> <li>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.</li> </ul>

Course L2269: Physical Fund	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			
Literature			

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	41)	Recitation Section (large)	1	1
Separation Processes (L1159)		Practical Course	1	1
Module Responsible	Prof. Irina Smirnova			
Admission Requirements	None			
<b>Recommended Previous</b>	Recommended requirements: Thermodynar	mics III		
Knowledge				
Educational Objectives	After taking part successfully, students have	e reached the following learning results		
Professional Competence				
Knowledge	<ul><li>adsorption</li><li>The students develop an understand energy demand of a process, the post</li></ul>	describe different types of separation proces ding for the course of concentration during a s ssibilities of energy saving, and the selection of ning methods for separation processes and dev	separation process, separation systems	the estimation of
Skills Personal Competence Social Competence	<ul> <li>close the associated energy and mate</li> <li>The students can use different grap theoretical stages required</li> <li>They can select and design a basic disadvantages of the process</li> <li>The students are capable to obtain it tables)</li> <li>They can calculate continuous and di</li> <li>The students are able to prove their for The students are able to discuss the colloquium.</li> </ul>	phical methods for the designing of a separa to type of thermal separation process for a gi independently the needed material properties iscontinuous processes theoretical knowledge in the experimental lab theoretical background and the content of the ined knowledge with the content of other lectu thermodynamics, fluid mechanics and chemica	ation process and o ven case based on from appropriate so work. e experimental work res and use it toget I engineering.	lefine the amoun the advantages purces (diagrams c with the teacher her for the solutio
	• The students are able to carry out p	gnments in small groups and present the comb practical lab work in small groups and organiz results and to document them scientifically in a	ze a functional divis	
Autonomy		he needed information from suitable sources by of their knowledge with exam resembling as:		
Workload in Hours	Independent Study Time 96, Study Time in	Lecture 84		
Credit points				
Course achievement				
Examination				
		sulations		
	120 minutes; theoretical questions and calc	uiduofis		
scale				
-		ram, 7 semester): Specialisation Green Techno	logies, Focus Renew	able Energy: Elec
Following Curricula	Compulsory			
	General Engineering Science (German pr	ogram, 7 semester): Specialisation Green T	ēchnologies, Focus	Renewable Ener
	Compulsory			
	General Engineering Science (German prog	ram, 7 semester): Specialisation Bioprocess En	gineering: Compuls	ory
	General Engineering Science (German prog	ram, 7 semester): Specialisation Process Engin	eering: Compulsory	
		ram, 7 semester): Specialisation Chemical and		
	Bioprocess Engineering: Core Qualification:			,
	Chemical and Bioprocess Engineering: Core			
	Energy and Environmental Engineering: Cor			
	Green Technologies: Energy, Water, Climate	e: Specialisation Energy Systems: Elective Com	pulsory	
			ipaisory	
		e: Specialisation Bioresource Technology: Elect		

Тур	Lecture
Hrs/wk	
CP	
_	Independent Study Time 32, Study Time in Lecture 28
	Prof. Irina Smirnova
Language	
Cycle	
Content	<ul> <li>Introduction in the thermal process engineering and to the main features of separation processes</li> <li>Simple equilibrium processes, several steps processes</li> <li>Distillation of binary mixtures, enthalpy-concentration diagrams</li> <li>Extractive and azeotrope distillation, water vapor distillation, stepwise distillation</li> <li>Extraction: separation ternary systems, ternary diagram</li> <li>Multiphase separation including complex mixtures</li> <li>Designing of separation devices without discrete stages</li> <li>Drying</li> <li>Chromatographic separation processes</li> <li>Membrane separation</li> <li>Energy demand of separation processes</li> <li>Advance overview of separation processes</li> <li>Selection of separation processes</li> </ul>
Literature	<ul> <li>G. Brunner: Skriptum Thermische Verfahrenstechnik</li> <li>J. King: Separation Processes, McGraw-Hill, 2. Aufl. 1980</li> <li>Sattler: Thermische Trennverfahren, VCH, Weinheim 1995</li> <li>J.D. Seader, E.J. Henley: Separation Process Principles, Wiley, New York, 1998.</li> <li>Mersmann: Thermische Verfahrenstechnik, Springer, 1980</li> <li>Grassmann, Widmer, Sinn: Einführung in die Thermische Verfahrenstechnik, 3. Aufl., Walter de Gruyter, Berlin 1997</li> <li>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 .</li> <li>R. Goedecke (Hrsg.): Fluid-Verfahrenstechnik, Wiley-VCH Verlag, Weinheim, 2006.</li> <li>Perry"s Chemical Engineers" Handbook, R.H. Perry, D.W. Green, J.O. Maloney (Hrsg.), 6th ed., McGraw-Hill, New Yor 1984 Ullmann"s Enzyklopädie der Technischen Chemie</li> </ul>

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	<ul> <li>Introduction in the thermal process engineering and to the main features of separation processes</li> <li>Simple equilibrium processes, several steps processes</li> <li>Distillation of binary mixtures, enthalpy-concentration diagrams</li> <li>Extractive and azeotrope distillation, water vapor distillation, stepwise distillation</li> <li>Extraction: separation ternary systems, ternary diagram</li> <li>Multiphase separation including complex mixtures</li> <li>Designing of separation devices without discrete stages</li> <li>Drying</li> <li>Chromatographic separation processes</li> <li>Membrane separation</li> <li>Energy demand of separation processes</li> <li>Advance overview of separation processes</li> <li>Selection of separation processes</li> <li>The students work on tasks in small groups and present their results in front of all students.</li> </ul>
Literature	<ul> <li>G. Brunner: Skriptum Thermische Verfahrenstechnik</li> <li>J. King: Separation Processes, McGraw-Hill, 2. Aufl. 1980</li> <li>Sattler: Thermische Trennverfahren, VCH, Weinheim 1995</li> <li>J.D. Seader, E.J. Henley: Separation Process Principles, Wiley, New York, 1998.</li> <li>Mersmann: Thermische Verfahrenstechnik, Springer, 1980</li> <li>Grassmann, Widmer, Sinn: Einführung in die Thermische Verfahrenstechnik, 3. Aufl., Walter de Gruyter, Berlin 1997</li> <li>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.</li> <li>R. Goedecke (Hrsg.): Fluid-Verfahrenstechnik, Wiley-VCH Verlag, Weinheim, 2006.</li> <li>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</li> </ul>

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	<ul> <li>Introduction in the thermal process engineering and to the main features of separation processes</li> <li>Simple equilibrium processes, several steps processes</li> <li>Distillation of binary mixtures, enthalpy-concentration diagrams</li> <li>Extractive and azeotrope distillation, water vapor distillation, stepwise distillation</li> <li>Extraction: separation ternary systems, ternary diagram</li> <li>Multiphase separation including complex mixtures</li> <li>Designing of separation devices without discrete stages</li> <li>Drying</li> <li>Chromatographic separation processes</li> <li>Membrane separation</li> <li>Energy demand of separation processes</li> <li>Advance overview of separation processes</li> <li>Selection of separation processes</li> </ul>
Literature	<ul> <li>G. Brunner: Skriptum Thermische Verfahrenstechnik</li> <li>J. King: Separation Processes, McGraw-Hill, 2. Aufl. 1980</li> <li>Sattler: Thermische Trennverfahren, VCH, Weinheim 1995</li> <li>J.D. Seader, E.J. Henley: Separation Process Principles, Wiley, New York, 1998.</li> <li>Mersmann: Thermische Verfahrenstechnik, Springer, 1980</li> <li>Grassmann, Widmer, Sinn: Einführung in die Thermische Verfahrenstechnik, 3. Aufl., Walter de Gruyter, Berlin 1997</li> <li>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.</li> <li>R. Goedecke (Hrsg.): Fluid-Verfahrenstechnik, Wiley-VCH Verlag, Weinheim, 2006.</li> <li>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</li> </ul>

ourse L1159: Separation Pr	ocesses
Тур	Practical Course
Hrs/wk	1
CP	1
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14
Lecturer	Prof. Irina Smirnova
Language	DE/EN
Cycle	WiSe
	The students work on eight different experiments in this practical course. For every one of the eight experiments, a colloquium takes place in which the students explain and discuss the theoretical background and its translation into practice with staff and fellow students. The students work small groups with a high degree of division of labor. For every experiment, the students write a report. They 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 processes     Drying     Chromatographic separation processes     Membrane separation     Energy demand of separation processes     Advance overview of separation processes     Selection of separation processes
Literature	<ul> <li>G. Brunner: Skriptum Thermische Verfahrenstechnik</li> <li>J. King: Separation Processes, McGraw-Hill, 2. Aufl. 1980</li> <li>Sattler: Thermische Trennverfahren, VCH, Weinheim 1995</li> <li>J.D. Seader, E.J. Henley: Separation Process Principles, Wiley, New York, 1998.</li> <li>Mersmann: Thermische Verfahrenstechnik, Springer, 1980</li> <li>Grassmann, Widmer, Sinn: Einführung in die Thermische Verfahrenstechnik, 3. Aufl., Walter de Gruyter, Berlin 1997</li> <li>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.</li> <li>R. Goedecke (Hrsg.): Fluid-Verfahrenstechnik, Wiley-VCH Verlag, Weinheim, 2006.</li> <li>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</li> </ul>

Courses							
Гitle		Тур	Hrs/wk	СР			
Case studies project assessment (L1	1054)	Recitation Section (small)	1	1			
Environmental Assessment (L0860)		Lecture	2	2			
Module Responsible	Prof. Martin Kaltschmitt						
Admission Requirements	None						
<b>Recommended Previous</b>	Fundamentals of inorganic/organic chemistry and biology						
Knowledge							
Educational Objectives	After taking part successfully, students have reach	ed the following learning results					
<b>Professional Competence</b>							
Knowledge	With the completion of this module the studer	ts acquire in-depth knowledge of import	ant cause-effect	chains of potent			
	environmental problems which might occur from	production processes, projects or construc	tion measures. T	hey have knowled			
	about the methodological diversity and are compe	etent in dealing with different methods and	instruments to a	ssess environmen			
	impacts. Besides the students are able to estimat	e the complexity of these environmental p	rocesses as well	as uncertainties a			
	difficulties with their measurement.						
Skills	The students are able to select a suitable method	for the respective case from the variety of	of assessment me	ethods. Thereby th			
	can develop suitable solutions for managing and i	mitigating environmental problems in a bu	siness context. T	hey are able to ca			
	out Life Cycle Impact Assessments independently	y and can apply the software programs O	penLCA and the	database Ecolnve			
	After finishing the course the students have the competence to critically judge research results or other publications of						
	environmental impacts.						
Personal Competence							
-	The students are able to discuss the various techn	ical and scientific tasks, both subject speci	ic and multidisci	olinary Thoy are a			
	to develop jointly different solutions and to discuss their theoretical or practical implementation. Due to the selected lecture topics, the students receive insights into the multi-layered issues of the environment protection and the concept of sustainability						
	Their sensitivity and consciousness towards these						
	social responsibilities in their role as engineers.	e subjects are raised and which helps to	Tube their unut				
Autonomy	The students learn to research, process and pre	sent a scientific topic independently. The	y are able to ca	rry out independe			
	scientific work. They can solve an environmental p	roblem in a business context and are able	to judge results o	f other publication			
	Independent Study Time 48, Study Time in Lecture	2 42					
	3						
	None						
Examination							
Examination duration and	1 hour written exam						
scale							
	General Engineering Science (German program, 7						
	General Engineering Science (German program, 7		ing: Elective Com	npulsory			
	Bioprocess Engineering: Core Qualification: Electiv						
	Energy and Environmental Engineering: Core Qual	ification: Compulsory					

project assessment
Recitation Section (small)
1
1
Independent Study Time 16, Study Time in Lecture 14
Prof. Martin Kaltschmitt, Dozenten des SD V
DE
WiSe
Presentation and application of free software programs in order to understand the concepts of environmental
assessment methods better.
Within the group exercise 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.
Power point Präsentationen

Course L0860: Environmenta	I Assessment
Тур	Lecture
Hrs/wk	2
СР	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Dr. Anne Rödl, Dr. Christoph Hagen Balzer
Language	DE/EN
Cycle	WiSe
Content	Contaminants: Impact- and Risk Assessment
	Environmental damage & precautionary principle: Environmental Risk Assessment (ERA)
	Resource and water consumption: Material flow analysis
	Energy consumption: Cumulated energy demand (CED), cost analysis
	Life cycle concept: Life cycle assessment (LCA)
	Sustainability: Comprehensive product system assessment , SEE-Balance
	Management: Environmental and Sustainability management (EMAS)
	Complex systems: MCDA and scenario method
Literature	Foliensätze der Vorlesung
	Studie: Instrumente zur Nachhaltigkeitsbewertung - Eine Synopse (Forschungszentrum Jülich GmbH)

C						
Courses						
Title		Тур	Hrs/wk	CP		
Heat and Mass Transfer (L0101) Heat and Mass Transfer (L0102)		Lecture Recitation Section (small)	2 1	2 2		
Heat and Mass Transfer (L0102)		Recitation Section (Iarge)	1	2		
	Dref luine Craimeure	Rectation Section (hige)	1	L		
•	Prof. Irina Smirnova					
Admission Requirements						
	Basic knowledge: Technical Thermodyn	amics				
Knowledge						
Educational Objectives	After taking part successfully, students	have reached the following learning results				
Professional Competence						
Knowledge						
	<ul><li>heat exchanger, chemical reacto</li><li>They are capable of distinguish a transfer and thermal radiation.</li><li>The students have the ability t qualitative and quantitative by used to the student of the transfer and transfer and the transfer and tran</li></ul>	aining qualitative and determining quantitative hea rs). and characterize different kinds of heat transfer me to explain the physical basis for mass transfer in sing suitable mass transfer theories. Igy between heat- and mass transfer and to describ	chanisms namely h n detail and to de	neat conduction, h		
Skills	<ul> <li>and to balance the corresponding</li> <li>They are capable to solve specifiand to calculate the correspondir</li> <li>Using dimensionless quantities, t</li> <li>They are able to distinguish betweet for the description and design of</li> <li>In this context, the students are application considering their advance</li> <li>In addition, they can calculate box</li> <li>The students are capable to the students are c</li></ul>	sonable system boundaries for a given transport p g energy and mass flow, respectively. The transfer problems (e.g. heated chemical re- ng heat flows. The students can execute scaling up of technical pro- veen diffusion, convective mass transition and mas apparatus (e.g. extraction column, rectification colu- capable to choose and design fundamental types of antages and disadvantages, respectively. Th, steady-state and non-steady-state processes in connect their knowledge obtained in this course mamics, fluid mechanics and chemical process en	actors, temperatur cesses or apparatu s transfer. They ca imn). heat and mass ex procedural apparat with knowlegde	re alteration in flu is. n use this knowled changer for a spec tus. of other courses		
Personal Competence Social Competence	• The students are capable to wor manner to tutors and other stude	k on subject-specific challenges in teams and to prents.	resent the results o	orally in a reasona		
Autonomy	• They are able to prove their let	l evaluate necessary information from suitable sour vel of knowledge during the course with accomp and on this basis they can control their learning pro	anying procedure	continuously (clicł		
Workload in Hours	Independent Study Time 124, Study Tin	ne in Lecture 56				
Credit points						
Course achievement						
Examination						
		colouistione				
	120 minutes; theoretical questions and	calculations				
scale						
Assignment for the	General Engineering Science (German p	program, 7 semester): Specialisation Green Technol	ogies: Compulsory			
Following Curricula	General Engineering Science (German p	program, 7 semester): Specialisation Bioprocess Eng	ineering: Compuls	ory		
	General Engineering Science (German p	program, 7 semester): Specialisation Process Engine	ering: Compulsory			
	General Engineering Science (German p	program, 7 semester): Specialisation Chemical and I	Bioengineering: Cor	mpulsory		
	Bioprocess Engineering: Core Qualificat	ion: Compulsory				
	Chemical and Bioprocess Engineering: 0	Core Qualification: Compulsory				
	Energy and Environmental Engineering: Core Qualification: Compulsory					
	Green Technologies: Energy, Water, Clir					

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	na Smirnova			
Language	DE			
Cycle	WiSe			
Content	<ol> <li>Heat transfer         <ul> <li>Introduction, one-dimensional heat conduction</li> <li>Convective heat transfer</li> <li>Multidimensional heat conduction</li> <li>Non-steady heat conduction</li> <li>Thermal radiation</li> </ul> </li> <li>Mass transfer         <ul> <li>one-way diffusion, equimolar countercurrent diffusion</li> <li>boundary layer theory, non-steady mass transfer</li> <li>Heat and mass transfer single particle/ fixed bed</li> <li>Mass transfer and chemical reactions</li> </ul> </li> </ol>			
Literature	<ol> <li>H.D. Baehr und K. Stephan: Wärme- und Stoffübertragung, Springer</li> <li>VDI-Wärmeatlas</li> </ol>			

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	ourse 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		

Module M0670: Partic	le Techn	ology	and Solids Proces	ss Engineerir	ıg		
Courses							
Title					Тур	Hrs/wk	СР
Particle Technology I (L0434)					Lecture	2	3
Particle Technology I (L0435)					Recitation Section (small)	1	1
Particle Technology I (L0440)					Practical Course	2	2
Module Responsible	Prof. Stefan	Heinrich					
Admission Requirements	None						
<b>Recommended Previous</b>	keine						
Knowledge							
Educational Objectives	After taking	part succ	essfully, students have re	ached the followin	g learning results		
Professional Competence							
Knowledge	After succes	sful comp	letion of the module stude	ents are able to			
	• • • • • • • •	and ovel	ain processes and unit or	porations of solids	aracacc anglessoring		
			ain processes and unit-op articles, particle distributio				
	• Clidic	icterize pa	inticles, particle distributio		their burk properties		
C1:11-	Churchenter						
SKIIIS	Students are	e able to					
	<ul> <li>choose</li> </ul>	se and des	sign apparatuses and proc	cesses for solids pr	ocessing according to the o	lesired solids prop	erties of the produ
	<ul> <li>asses</li> </ul>	solids wit	th respect to their behavio	or in solids process	ing steps		
	<ul> <li>docur</li> </ul>	ment their	work scientifically.				
Personal Competence							
Social Competence				pics orally with ot	her students or scientific	personal and to o	develop solutions f
			ues in a group.				
Autonomy	Students are	e able to a	analyze and solve question	ns regarding solid	particles independently.		
Workload in Hours	Independen	t Study Ti	me 110, Study Time in Le	cture 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 exa	m					
Examination duration and	90 minutes						
scale							
Assignment for the	General Eng	gineering	Science (German program	n, 7 semester): Sp	ecialisation Green Technolo	gies, Focus Wate	r and Environment
Following Curricula	Engineering	: Elective	Compulsory				
	General Eng	jineering S	Science (German program	, 7 semester): Spe	cialisation Bioprocess Engi	neering: Compulso	ory
	General Eng	jineering S	Science (German program	, 7 semester): Spe	cialisation Process Enginee	ring: Compulsory	
	General Eng	jineering S	Science (German program	, 7 semester): Spe	cialisation Chemical and Bi	oengineering: Cor	npulsory
	Bioprocess I	Engineerir	ng: Core Qualification: Con	npulsory			
	Chemical ar	nd Bioproc	ess Engineering: Core Qua	alification: Compul	sory		
	Energy and	Environm	ental Engineering: Core Q	ualification: Electiv	e Compulsory		
	Green Tech	nologies: I	Energy, Water, Climate: Sp	pecialisation Water	: Elective Compulsory		
	Process Eng	ineering:	Core Qualification: Compu	Ilsory			

Course L0434: Particle Techr	nology 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	<ul> <li>Description of particles and particle distributions</li> <li>Description of a separation process</li> <li>Description of a particle mixture</li> <li>Particle size reduction</li> <li>Agglomeration, particle size enlargement</li> <li>Storage and flow of bulk solids</li> <li>Basics of fluid/particle flows</li> <li>classifying processes</li> <li>Separation of particles from fluids</li> <li>Basic fluid mechanics of fluidized beds</li> <li>Pneumatic and hydraulic transport</li> </ul>
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.

Course L0435: Particle Tech	ourse L0435: Particle Technology I		
Тур	Recitation Section (small)		
Hrs/wk	1		
CP	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		

Course L0440: Particle Techr	nology I
Тур	Practical Course
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Prof. Stefan Heinrich
Language	DE/EN
Cycle	SoSe
Content	<ul> <li>Sieving</li> <li>Bulk properties</li> <li>Size reduction</li> <li>Mixing</li> <li>Gas cyclone</li> <li>Blaine-test, filtration</li> <li>Sedimentation</li> </ul>
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.

Courses								
Title				Тур	Hrs/wk	СР		
Process and Plant Engineering I (L0 Process and Plant Engineering I (L0				Lecture Recitation Section (large)	2 1	4 1		
Process and Plant Engineering I (L1				Recitation Section (small)	1	1		
Module Responsible	Prof. Mirko Skiborows	ki						
Admission Requirements	None							
<b>Recommended Previous</b>	unit operation of them	mal an dmechanical sepa	aration processes					
Knowledge	chemical reactor eing	ineering						
Educational Objectives	After taking part succ	essfully, students have r	eached the following	g learning results				
Professional Competence								
Knowledge	students can:							
	classify and formulate	blobal balance equation	ns of chemical proce	sses				
	specify linear compor	ent equations of comple	ex chemical processe	25				
	explain linear regression and data reconcilliation problems							
	explain pfd-diagrams							
Skills	students are capable	of						
	- formulation of mass and energy balance equations and estimation of product streams							
	- estimation of component streams of chemical plants using linear component balance models							
	- solution of data reco	ncilliation tasks						
	- conduction of process synthesis							
	- economic evaluation of processes and the estimation of production costs							
Personal Competence								
Social Competence								
Autonomy								
Workload in Hours	Independent Study Ti	me 124, Study Time in L	ecture 56					
Credit points	6							
Course achievement	Compulsory Bonus Yes 10 %	Form Subject theoretical	Description					
	Yes 10 %	practical work	and					
Examination	Written exam	practical work						
Examination duration and		es and books						
scale								
	General Engineering	Science (German program	m, 7 semester): Spec	cialisation Bioprocess Engin	eering: Compulso	ory		
						-		
-	General Engineering Science (German program, 7 semester): Specialisation Process Engineering: 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: Specialisation Bioresource Technology: Elective Compulsory							
	Process Engineering: Core Qualification: Compulsory							

Course L0095: Process and Plant Engineering I	
Тур	Lecture
Hrs/wk	2
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 The basis of the second se
	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
	I

1	
	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) 4. Process safety
	5. Cost estimation of production plants
	Production costs, capital costs, economic evaluation
Literature	
	S.D. Barnicki, J.R. Fair, Ind. End. Chem., 29(1990), S. 421, Ind. End. Chem., 31(1992), S. 1679
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	Behr, W. Ebbers, N. Wiese, ChemIngTech. 72(2000)Nr. 10, S.1157
	E. Blass, Entwicklung verfahrenstechnischer Prozesse, Springer-Verlag, 2. Auflage 1997
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	Band 2, Neue Technologien, 5. Auflage, Wiley-VCH GmbH&Co.KGaA, Weinheim, 2004
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	G. Fieg, Inz. Chem. Proc., 5(1979), S.15-19
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	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
	J.L.A. Koolen, Design of Simple and Robust Process Plants, Wiley-VCH, Weinheim, 2002
	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	

ourse L1214: Process and Plant Engineering I	
Тур	Recitation Section (small)
Hrs/wk	1
СР	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

Thesis			
Module M-001: Bachelor 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 Professional Competence	After taking part successfully, students have reached the following learning results		
Knowledge Skills	<ul> <li>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).</li> <li>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.</li> <li>The students are able to outline the state of research on a selected issue in their subject area.</li> <li>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.</li> <li>With the aid of the methods they have learnt during their studies the students can analyze problems, make decisions on</li> </ul>		
<b>Personal Competence</b> Social Competence	<ul> <li>technical issues, and develop solutions.</li> <li>The students can take up a critical position on the findings of their own research work from a specialized perspective.</li> <li>Both in writing and orally the students can outline a scientific issue for an expert audience accurately, understandably and in a structured way.</li> <li>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.</li> </ul>		
Autonomy	<ul> <li>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.</li> <li>The students are able to identify, open up, and connect knowledge and material necessary for working on a scientific problem.</li> <li>The students can apply the essential techniques of scientific work to research of their own.</li> </ul>		
Workload in Hours	Independent Study Time 360, Study Time in Lecture 0		
Credit points	12		
Course achievement	None		
Examination			
	According to General Regulations		
scale	Constal Engineering Science (Corman program), Therin, Computer :		
Assignment for the Following Curricula			
contracting curriculu	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		