## **Module Manual**

Bachelor of Science (B.Sc.)

# General Engineering Science (German program, 7 semester)

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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 M0577: Non-technical Courses for Bachelors Module Responsible Dagmar Richter Admission Requirements None Recommended Previous Knowledge Educational Objectives After taking part successfully, students have reached the following learning results Professional Competence

### Knowledge The New tech

### 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 fully. Self-reliance, self-management, collaboration and professional and personnel management competences. The department implements these training objectives in its **teaching architecture**, in its **teaching and learning arrangements**, in **teaching areas** and by means of teaching offerings in which students can qualify by opting for **specific competences** and a **competence level** at the Bachelor's or Master's level. The teaching offerings are pooled in two different catalogues for nontechnical complementary courses.

### The Learning Architecture

consists of a cross-disciplinarily study offering. The centrally designed teaching offering ensures that courses in the nontechnical academic programms follow the specific profiling of TUHH degree courses.

The learning architecture demands and trains independent educational planning as regards the individual development of competences. It also provides orientation knowledge in the form of "profiles"

The subjects that can be studied in parallel throughout the student's entire study program - if need be, it can be studied in one to two semesters. In view of the adaptation problems that individuals commonly face in their first semesters after making the transition from school to university and in order to encourage individually planned semesters abroad, there is no obligation to study these subjects in one or two specific semesters during the course of studies.

### **Teaching and Learning Arrangements**

provide for students, separated into B.Sc. and M.Sc., to learn with and from each other across semesters. The challenge of dealing with interdisciplinarity and a variety of stages of learning in courses are part of the learning architecture and are deliberately encouraged in specific courses.

### **Fields of Teaching**

are based on research findings from the academic disciplines cultural studies, social studies, arts, historical studies, migration studies, communication studies and sustainability research, and from engineering didactics. In addition, from the winter semester 2014/15 students on all Bachelor's courses will have the opportunity to learn about business management and start-ups in a goal-priented way.

The fields of teaching are augmented by soft skills offers and a foreign language offer. Here, the focus is on encouraging goaloriented communication skills, e.g. the skills required by outgoing engineers in international and intercultural situations.

### The Competence Level

of the courses offered in this area is different as regards the basic training objective in the Bachelor's and Master's fields. These differences are reflected in the practical examples used, in content topics that refer to different professional application contexts, and in the higher scientific and theoretical level of abstraction in the B.Sc.

This is also reflected in the different quality of soft skills, which relate to the different team positions and different group leadership functions of Bachelor's and Master's graduates in their future working life.

### Specialized Competence (Knowledge)

### Students can

- locate selected specialized areas with the relevant non-technical mother discipline,
- outline basic theories, categories, terminology, models, concepts or artistic techniques in the disciplines represented in the learning area,
- different specialist disciplines relate to their own discipline and differentiate it as well as make connections,
- sketch the basic outlines of how scientific disciplines, paradigms, models, instruments, methods and forms of representation
  in the specialized sciences are subject to individual and socio-cultural interpretation and historicity,
- Can communicate in a foreign language in a manner appropriate to the subject.

### Skills Professional Competence (Skills)

In selected sub-areas students can

- apply basic methods of the said scientific disciplines,
- auestion a specific technical phenomena, models, theories from the viewpoint of another, aforementioned specialist discipline,
- to handle simple questions in aforementioned scientific disciplines in a sucsessful manner,
- justify their decisions on forms of organization and application in practical questions in contexts that go beyond the technical relationship to the subject.

### **Personal Competence**

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

#### Courses

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

Module M0743: Electrical Engineering I: Direct Current Networks and Electromagnetic Fields							
Courses							
Title					Тур	Hrs/wk	СР
Electrical Engineering I: Direct Curr					Lecture	3	5
Electrical Engineering I: Direct Curr	ent Networks and	Electroma	ignetic Fields (L0676)		Recitation Section (small)	2	1
Module Responsible	Prof. Matthias K	uhl					
Admission Requirements	None						
Recommended Previous							
Knowledge							
<b>Educational Objectives</b>	After taking par	t successf	fully, students have rea	ached the follow	ing learning results		
Professional Competence							
Knowledge							
Skills							
Personal Competence							
Social Competence							
Autonomy							
Workload in Hours	Independent Sti	udy Time	110, Study Time in Led	ture 70			
Credit points	6						
Course achievement	Compulsory Bonu	s Fo	orm	Description			
	No 10 %	6 Ex	xcercises				
Examination	Written exam						
Examination duration and	120 Minutes						
scale							
Assignment for the	General Engine	ering Scie	ence (German program,	7 semester): Co	ore qualification: Compulsory		
Following Curricula	Data Science: Specialisation Electrical Engineering: Compulsory						
	Electrical Engineering: Core qualification: Compulsory						
	Computational S	Science ar	nd Engineering: Core q	ualification: Con	npulsory		
	Mechatronics: Core qualification: Compulsory						
	Orientation Stud	dies: Core	qualification: Elective	Compulsory			

Course L0675: Electrical Eng	ineering I: Direct Current Networks and Electromagnetic Fields
Тур	Lecture
Hrs/wk	3
СР	5
Workload in Hours	Independent Study Time 108, Study Time in Lecture 42
Lecturer	Prof. Matthias Kuhl
Language	DE
Cycle	WiSe
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	
СР	1	
Workload in Hours	Independent Study Time 2, Study Time in Lecture 28	
Lecturer	Prof. Matthias Kuhl	
Language	DE	
Cycle	WiSe	
Content		
Literature	Übungsaufgaben zur Elektrotechnik 1, TUHH, 2013     Ch. Kautz: Tutorien zur Elektrotechnik, Pearson Studium, 2010	

Courses           Title         Typ         Hrs/wk         CP           Analysis I (L1010)         Lecture         2         2           Analysis I (L1012)         Recitation Section (small)         1         1           Analysis I (L1013)         Recitation Section (large)         1         1           Linear Algebra I (L0912)         Lecture         2         2           Linear Algebra I (L0913)         Recitation Section (small)         1         1	
Analysis I (L1010)       Lecture       2       2         Analysis I (L1012)       Recitation Section (small)       1       1         Analysis I (L1013)       Recitation Section (large)       1       1         Linear Algebra I (L0912)       Lecture       2       2         Linear Algebra I (L0913)       Recitation Section (small)       1       1	
Analysis I (L1012)       Recitation Section (small)       1       1         Analysis I (L1013)       Recitation Section (large)       1       1         Linear Algebra I (L0912)       Lecture       2       2         Linear Algebra I (L0913)       Recitation Section (small)       1       1	
Linear Algebra I (L0912)         Lecture         2         2           Linear Algebra I (L0913)         Recitation Section (small)         1         1	
Linear Algebra I (L0913) Recitation Section (small) 1 1	
Linear Algebra I (L0914) Recitation Section (large) 1 1	
Module Responsible Prof. Anusch Taraz	
Admission Requirements None	
Recommended Previous   School mathematics	
Knowledge	
Educational Objectives After taking part successfully, students have reached the following learning results	
Students can name the basic concepts in analysis and linear algebra. They are able to explain them using a examples.     Students can discuss logical connections between these concepts. They are capable of illustrating these connections the help of examples.     They know proof strategies and can reproduce them.	
<ul> <li>Students can model problems in analysis and linear algebra with the help of the concepts studied in this course. 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 ev results.</li> </ul>	
Personal Competence  Social Competence  Students are able to work together in teams. They are capable to use mathematics as a common language.  In doing so, they can communicate new concepts according to the needs of their cooperating partners. Moreover design examples to check and deepen the understanding of their peers.	r, they can
<ul> <li>Students are capable of checking their understanding of complex concepts on their own. They can specify open 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 problems.</li> </ul>	
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 I) + 60 min (Linear Algebra I)  scale	
Assignment for the General Engineering Science (German program, 7 semester): Core qualification: Compulsory  Following Curricula Civil- and Environmental Engineering: Core qualification: Compulsory	
Bioprocess Engineering: Core qualification: Compulsory	
Digital Mechanical Engineering: Core qualification: Compulsory	
Electrical Engineering: Core qualification: Compulsory	
Energy and Environmental Engineering: Core qualification: Compulsory	
Green Technologies: Energy, Water, Climate: Core qualification: Compulsory	
Computational Science and Engineering: Core qualification: Compulsory	
Logistics and Mobility: Core qualification: Compulsory	
Mechanical Engineering: Core qualification: Compulsory	
Mechatronics: Core qualification: Compulsory	
Orientation Studies: Core qualification: Elective Compulsory	
Naval Architecture: Core qualification: Compulsory	
Process Engineering: Core qualification: Compulsory	
Engineering and Management - Major in Logistics and Mobility: Core qualification: Compulsory	

Course L1010: Analysis I	
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	Foundations of differential and integrational calculus of one variable
	statements, sets and functions     natural and real numbers     convergence of sequences and series     continuous and differentiable functions     mean value theorems     Taylor series     calculus     error analysis     fixpoint iteration
Literature	http://www.math.uni-hamburg.de/teaching/export/tuhh/index.html

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

Course L0912: Linear Algebra	a I
Тур	Lecture
Hrs/wk	2
СР	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Prof. Anusch Taraz, Prof. Marko Lindner, Dr. Dennis Clemens
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	a I
Тур	Recitation Section (small)
Hrs/wk	1
СР	1
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14
Lecturer	Prof. Anusch Taraz, Prof. Marko Lindner, Dr. Dennis Clemens
Language	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	Course L0914: Linear Algebra I				
Тур	Typ Recitation Section (large)				
Hrs/wk	Hrs/wk 1				
СР					
Workload in Hours	dependent Study Time 16, Study Time in Lecture 14				
Lecturer	Dr. Christian Seifert, Dr. Dennis Clemens				
Language	DE				
Cycle	WiSe				
Content	Content See interlocking course				
Literature	See interlocking course				

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			
Recommended Previous	Solid school knowledge in mathematics and physics.			
Knowledge				
<b>Educational Objectives</b>	After taking part successfully, students have reached th	e following learning results		
<b>Professional Competence</b>				
Knowledge	The students can			
	describe the axiomatic procedure used in mechan	pical contoxts.		
	explain important steps in model design;	iicai contexts,		
	<ul> <li>present technical knowledge in stereostatics.</li> </ul>			
	present technical knowledge in stereostatics.			
Skills	The students can			
	ovulain the important elements of mathematical	/ mochanical analysis and model form	mation and anni	v it to the context of
	explain the important elements of mathematical     their own problems:	/ mechanical analysis and model for	пацоп, апи аррг	y it to the context of
	their own problems;	ome:		
	apply basic statical methods to engineering problem of statical methods and boundaries of statical methods.		lo to wider probl	om sots
	<ul> <li>estimate the reach and boundaries of statical me</li> </ul>	trious and exterio them to be applicat	ne to wider probi	em sets.
Personal Competence				
Social Competence	The students can work in groups and support each othe	r to overcome difficulties.		
Autonomy	Students are capable of determining their own strengths	and weaknesses and to organize the	ir time and learn	ing based on those.
Workload in Hours	Independent Study Time 110, Study Time in Lecture 70			
Credit points				
Course achievement				
Examination				
Examination duration and				
scale	36 11111			
Assignment for the	General Engineering Science (German program, 7 seme	ster); Core qualification; Compulsory		
Following Curricula				
	Bioprocess Engineering: Core qualification: Compulsory			
	Data Science: Specialisation Mechanics: Compulsory			
	Digital Mechanical Engineering: Core qualification: Comp	pulsory		
	Electrical Engineering: Core qualification: Elective Comp	•		
	Green Technologies: Energy, Water, Climate: Core quali	•		
	Computational Science and Engineering: Specialisation		e: Elective Compu	ilsory
	Logistics and Mobility: Core qualification: Compulsory	J 11 J 11 1		•
	Mechanical Engineering: Core qualification: Compulsory			
	Mechatronics: Core qualification: Compulsory			
	Orientation Studies: Core qualification: Elective Compuls	sory		
	Naval Architecture: Core qualification: Compulsory			
	Process Engineering: Core qualification: Compulsory			
	Engineering and Management - Major in Logistics and M	obility: Core qualification: Compulsory	,	
	Indicate the state of the	, , co. c quacution. computation		

Course L1001: Mechanics I (Statics)					
Тур	cture				
Hrs/wk					
СР	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			
СР	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	nt 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 M0687: Chem	nistry					
Courses						
Title Chemistry I+II (L0460) Chemistry I+II (L0475)		<b>Typ</b> Lecture Recitation Section (large)	Hrs/wk 4 2	<b>CP</b> 4 2		
-	Dr. Dorothea Rechtenbach					
Admission Requirements	None					
Recommended Previous Knowledge	none					
<b>Educational Objectives</b>	After taking part successfully, students have reached the fo	ollowing learning results				
Professional Competence Knowledge	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 basis, they are capable of explaining, choosing and applying specific methods and various reaction mechanisms.					
Personal Competence						
Social Competence	Students are able to take part in discussions on chemical is contribute to those discussion by their own statements.	ssues and problems as a membe	r of an interdiscipli	nary team. They can		
Autonomy	After successful completion of this module students are able to solve chemical problems independently by defending proposed approaches with arguments. They can also document their approaches.					
Workload in Hours	Independent Study Time 96, Study Time in Lecture 84					
Credit points	6					
Course achievement	None					
Examination	Written exam					
Examination duration and scale	120 min					
Assignment for the Following Curricula		ompulsory	У			

Course L04	60: Chemistry I+II
Тур	Lecture
Hrs/wk	4
СР	4
Workload in Hours	Independent Study Time 64, Study Time in Lecture 56
Lecturer	Dr. Christoph Wutz
Language	DE .
Cycle	WiSe
Content	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 apllications 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	I .				
Тур	Typ Recitation Section (large)				
Hrs/wk	Hrs/wk 2				
СР	2				
Workload in Hours	ndent Study Time 32, Study Time in Lecture 28				
Lecturer	Dorothea Rechtenbach				
Language	DE				
Cycle	WiSe				
Content	See interlocking course				
Literature	See interlocking course				

Module M1692: Computer Science for Engineers - Introduction and Overview							
Courses							
Title					Тур	Hrs/wk	СР
Computer Science for Engineers - Ir	ntroduction a	ind Overvi	ew (L2685)		Lecture	3	3
Computer Science for Engineers - Ir	ntroduction a	ind Overvi	ew (L2686)		Recitation Section (small)	2	3
Module Responsible	Prof. Görsc	hwin Fey					
Admission Requirements	None						
Recommended Previous							
Knowledge							
<b>Educational Objectives</b>	After takin	g part suc	cessfully, students ha	ave reached the follow	ing learning results		
Professional Competence							
Knowledge							
Skills							
Personal Competence							
Social Competence							
Autonomy							
Workload in Hours	Independe	nt Study 1	ime 110, Study Time	in Lecture 70			
Credit points	6						
Course achievement	Compulsory Bonus Form Description						
	No	10 %	Attestation	Testate finde	en semesterbegleitend statt.		
Examination	Written ex	am					
Examination duration and	90 min						
scale							
Assignment for the	General Engineering Science (German program, 7 semester): Core qualification: Compulsory						
Following Curricula	Electrical E	ngineerin	g: Core qualification:	Compulsory			
	Green Technologies: Energy, Water, Climate: Core qualification: Compulsory						
	Logistics and Mobility: Core qualification: Compulsory						
	Mechanical Engineering: Core qualification: Compulsory						
	Mechatronics: Core qualification: Compulsory						
	Orientation Studies: Core qualification: Elective Compulsory						
	Naval Architecture: Core qualification: Compulsory						
	Engineering and Management - Major in Logistics and Mobility: Core qualification: Compulsory						

Course L2685: Computer Science for Engineers - Introduction and Overview				
Тур	Lecture			
Hrs/wk	3			
СР	3			
Workload in Hours	Independent Study Time 48, Study Time in Lecture 42			
Lecturer	Prof. Görschwin Fey			
Language	DE/EN			
Cycle	WiSe			
Content				
Literature	<ul> <li>Informatik</li> <li>Helmut Herold, Bruno Lurz, Jürgen Wohlrab, Matthias Hopf: Grundlagen der Informatik, 3. Auflage, 816 Seiten, Pearson Studium, 2017.</li> <li>C++</li> <li>Bjarne Stroustrup, Einführung in die Programmierung mit C++, 479 Seiten, Pearson Studium, 2010.</li> <li>&gt; in der englischen Version bereits eine neuere Auflage!</li> <li>Jürgen Wolf: Grundkurs C++: C++-Programmierung verständlich erklärt, Rheinwerk Computing, 3. Auflage, 2016.</li> </ul>			

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

Module M0547: Electi	rical Engineering II: Alternating Cur	rent Networks and Basic I	Devices	
Courses				
	g Current Networks and Basic Devices (L0178) g Current Networks and Basic Devices (L0179)	<b>Typ</b> Lecture Recitation Section (small)	<b>Hrs/wk</b> 3 2	<b>CP</b> 5
Module Responsible	Prof. Christian Becker			
Admission Requirements	None			
Recommended Previous	Electrical Engineering I			
Knowledge	Mathematics I			
	Direct current networks, complex numbers			
Educational Objectives	After taking part successfully, students have reache	ed the following learning results		
Professional Competence				
Knowledge	Students are able to reproduce and explain funda	amental theories, principles, and meth	ods related to the	theory of alternating
	currents. They can describe networks of linear ele	ments using a complex notation for vo	tages and currents	. They can reproduce
	an overview of applications for the theory of alter explaining the behavior of fundamental passive and			dents are capable of
Skills	Students are capable of calculating parameters within simple electrical networks at alternating currents by means of a complex notation for voltages and currents. They can appraise the fundamental effects that may occur within electrical networks at alternating currents. Students are able to analyze simple circuits such as oscillating circuits, filter, and matching networks quantitatively and dimension elements by means of a design. They can motivate and justify the fundamental elements of an electrical power supply (transformer, transmission line, compensation of reactive power, multiphase system) and are qualified to dimension their main features.			
Personal Competence Social Competence	Students are able to work together on subject relat	ed tasks in small groups. They are able	to present their res	ults effectively.
Autonomy	Students are capable to gather necessary information from the references provided and relate that information to the context of the lecture. They are able to continually reflect their knowledge by means of activities that accompany the lecture, such as online tests and exercises that are related to the exam. Based on respective feedback, students are expected to adjust their individual learning process. They are able to draw connections between their knowledge obtained in this lecture and the content of other lectures (e.g. Electrical Engineering I, Linear Algebra, and Analysis).			
Workload in Hours	Independent Study Time 110, Study Time in Lectur	e 70		
Credit points				
Course achievement		Description		
Examination	Written exam			
Examination duration and scale	90 - 150 minutes			
Assignment for the	General Engineering Science (German program, 7 s	semester): Core qualification: Compulso	ry	
Following Curricula	Data Science: Specialisation Electrical Engineering:	Compulsory		
	Electrical Engineering: Core qualification: Compulso	•		
	Computational Science and Engineering: Core quali	fication: Compulsory		
	Mechatronics: Core qualification: Compulsory	and an		
	Orientation Studies: Core qualification: Elective Cor	npuisory		

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

Course L0179: Electrical Eng	ineering II: Alternating Current Networks and Basic Devices		
Тур	Recitation Section (small)		
Hrs/wk	2		
СР	1		
Workload in Hours	Independent Study Time 2, Study Time in Lecture 28		
	Prof. Christian Becker		
Language			
Cycle			
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)		

Module M0594: Funda	amentals of Mechanical Engineering	Design		
Courses				
Title Fundamentals of Mechanical Engineering Design (L0258) Fundamentals of Mechanical Engineering Design (L0259)		<b>Typ</b> Lecture Recitation Section (large)	Hrs/wk 2 2	<b>CP</b> 3 3
Module Responsible	Prof. Dieter Krause			
Admission Requirements	None			
Recommended Previous				
Knowledge	Basic knowledge about mechanics and producti     Internship (Stage I Practical)	on engineering		
Educational Objectives	After taking part successfully, students have reached	the following learning results		
Professional Competence				
Knowledge	After passing the module, students are able to:			
	<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, indica the background of dimensioning calculations.</li> </ul>			e elements, indicate
Skills	After passing the module, students are able to:			
	<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> <li>recognize the content of technical drawings and schematic sketches,</li> <li>technically evaluate basic designs.</li> </ul>			
Personal Competence Social Competence Autonomy	Students are able to discuss technical informati     Students are able to independently deepen the     Students are able to acquire additional knowle recordings of the lectures.	ir acquired knowledge in exercises.		. by using the video
	recordings of the receares.			
Workload in Hours	Independent Study Time 124, Study Time in Lecture 5	6		
Credit points	6			
Course achievement	None			
Examination	Written exam			
Examination duration and	120			
scale				
Assignment for the				
Following Curricula				
	Energy and Environmental Engineering: Core qualifica	• •		
	Green Technologies: Energy, Water, Climate: Specialis	sation Energy Technology: Elective Com	puisory	
	Logistics and Mobility: Core qualification: Compulsory	0,4		
	Mechanical Engineering: Core qualification: Compulsor Mechatronics: Core qualification: Compulsory	у		
	, , , , , , , , , , , , , , , , , , ,	dana.		
	Orientation Studies: Core qualification: Elective Compulsory			
	Naval Architecture: Core qualification: Compulsory  Technomathematics: Specialisation III. Engineering Science: Elective Compulsory			
	recimoniathematics, specialisation iii. Engineering Sc	ience. Liective Compuisory		

Course L0258: Fundamentals	s of Mechanical Engineering Design			
Тур	Lecture			
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	Lecture			
	Introduction to design     Introduction to the following machine elements     Screws			
	Shaft-hub joints			
	Rolling contact bearings			
	Welding / adhesive / solder joints			
	• Springs			
	Axes & shafts			
	Presentation of technical objects (technical drawing)			
	Exercise			
	Calculation methods for dimensioning the following machine elements:			
	Screws			
	Shaft-hub joints			
	Rolling contact bearings			
	Welding / adhesive / solder joints			
	• Springs			
	Axis & shafts			
Literature	Dubbel, Taschenbuch für den Maschinenbau; Grote, KH., Feldhusen, J.(Hrsg.); Springer-Verlag, aktuelle Auflage.			
	<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 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>			

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 M0671: Techr	ical Thermodynamics I			
Courses				
Title		Тур	Hrs/wk	СР
Technical Thermodynamics I (L043)	7)	Lecture	2	4
Technical Thermodynamics I (L043)		Recitation Section (large)	1	1
Technical Thermodynamics I (L044)	nics I (L0441) Recitation Section (small) 1 1			1
Module Responsible	NN			
Admission Requirements	None			
Recommended Previous	Elementary knowledge in Mathematics and Mechanic	cs		
Knowledge				
Educational Objectives	After taking part successfully, students have reached	I the following learning results		
Professional Competence				
Knowledge	Students are familiar with the laws of Thermodynar	mics. They know the relation of the kind	s of energy acc	ording to 1 <sup>st</sup> law of
	Thermodynamics and are aware about the limits of energy conversions according to 2 <sup>nd</sup> law of Thermodynamics. They are able to distinguish between state variables and process variables and know the meaning of different state variables like temperature enthalpy, entropy and also the meaning of exergy and anergy. They are able to draw the Carnot cycle in a Thermodynamics related diagram. They know the physical difference between an ideal and a real gas and are able to use the related equations of state. They know the meaning of a fundamental state of equation and know the basics of two phase Thermodynamics.			les like temperature, a a Thermodynamics related equations of
Skills	Students are able to calculate the internal energy, the enthalpy, the kinetic and the potential energy as well as work and heat for simple change of states and to use this calculations for the Carnot cycle. They are able to calculate state variables for an ideal an for a real gas from measured thermal state variables.			
Personal Competence				
•	The students are able to discuss in small groups and	develop an approach.		
Autonomy	The students are able to discuss in small groups and develop an approach.  Students are able to define independently tasks, to get new knowledge from existing knowledge as well as to find ways to use the knowledge in practice.			find ways to use the
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 program, 7 se	mester): Core qualification: Compulsory		
Following Curricula	Bioprocess Engineering: Core qualification: Compulso			
	Digital Mechanical Engineering: Core qualification: Co	ompulsory		
	Energy and Environmental Engineering: Core qualific	ation: Compulsory		
	Green Technologies: Energy, Water, Climate: Core qu	ualification: Compulsory		
	Logistics and Mobility: Specialisation Traffic Planning	and Systems: Elective Compulsory		
	Mechanical Engineering: Core qualification: Compulse	ory		
	Mechatronics: Core qualification: Compulsory			
	Orientation Studies: Core qualification: Elective Comp	oulsory		
	Naval Architecture: Core qualification: Compulsory			
	Technomathematics: Specialisation III. Engineering Science: Elective Compulsory			
	Process Engineering: Core qualification: Compulsory	Makiller Consistenti T (C. D.	1 C	and the Court of
	Engineering and Management - Major in Logistics and	a Mobility: Specialisation Traffic Planning	and Systems: El	ective Compulsory

Course L0437: Technical The	rmodynamics I
Тур	Lecture
Hrs/wk	2
СР	4
Workload in Hours	Independent Study Time 92, Study Time in Lecture 28
Lecturer	NN
Language	DE
Cycle	SoSe
Content	1. Introduction
	2. Fundamental terms
	Thermal Equilibrium and temperature
	·
	3.1 Thermal equation of state 4. First law
	4.1 Heat and work
	4.2 First law for closed systems
	4.3 First law for open systems
	4.4 Examples
	5. Equations of state and changes of state
	5.1 Changes of state
	5.2 Cycle processes
	6. Second law
	6.1 Carnot process
	6.2 Entropy
	6.3 Examples
	6.4 Exergy
	7. Thermodynamic properties of pure fluids
	7.1 Fundamental equations of Thermodynamics
	7.2 Thermodynamic potentials
	7.3 Calorific state variables for arbritary fluids
	7.4 state equations (van der Waals u.a.)
Literature	
	Schmitz, G.: Technische Thermodynamik, TuTech Verlag, Hamburg, 2009
	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 Thermodynamics I		
Тур	Recitation Section (large)	
Hrs/wk	1	
СР	1	
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14	
Lecturer	NN	
Language	DE	
Cycle	SoSe	
Content	See interlocking course	
Literature	See interlocking course	

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

Module M0696: Mecha	anics II: Mechanics of Materials			
Courses				
<b>Title</b> Mechanics II (L0493) Mechanics II (L0494)	Typ         Hrs/wk         CP           Lecture         2         2           Recitation Section (small)         2         2			2
Mechanics II (L1691)		Recitation Section (large)	2	2
Module Responsible	Prof. Christian Cyron			
Admission Requirements	None			
Recommended Previous	Mechanics I			
Knowledge				
<b>Educational Objectives</b>	After taking part successfully, students have reached the	ne following learning results		
<b>Professional Competence</b>				
	Having accomplished this module, the students know and understand the basic concepts of continuum mechanics an elastostatics, in particular stress, strain, constitutive laws, stretching, bending, torsion, failure analysis, energy methods an stability of structures.			
SKIIIS	Having accomplished this module, the students are able- apply the fundamental concepts of mathematical and		arablams of their	choico
	- apply the basic methods of elastostatics to problems of			
	- to educate themselves about more advanced aspects		gir or incentance	Structures
	to caucate themselves about more davaneed aspects	or clastostatics		
Personal Competence				
Social Competence	-			
Autonomy	-			
Workload in Hours	Independent Study Time 96, Study Time in Lecture 84			
Credit points	6			
Course achievement	None			
Examination	Written exam			
Examination duration and	90 min			
scale				
Assignment for the	General Engineering Science (German program, 7 seme	ester): Core qualification: Compulsory		
Following Curricula	Civil- and Environmental Engineering: Core qualification	: Compulsory		
	Bioprocess Engineering: Core qualification: Compulsory			
	Data Science: Specialisation Mechanics: Compulsory			
	Digital Mechanical Engineering: Core qualification: Com			
	Electrical Engineering: Core qualification: Elective Comp	•		
	Green Technologies: Energy, Water, Climate: Core qual	fication: Compulsory		
	Logistics and Mobility: Core qualification: Compulsory			
	Mechanical Engineering: Core qualification: Compulsory			
	Mechatronics: Core qualification: Compulsory Orientation Studies: Core qualification: Elective Compul	sory		
	Naval Architecture: Core qualification: Compulsory	301 y		
	Process Engineering: Core qualification: Compulsory			
	Engineering and Management - Major in Logistics and N	lobility: Core qualification: Compulsory	,	
	rays and ranagement rajor in Logistics and r			

Course L0493: Mechanics II	
Тур	Lecture
Hrs/wk	2
СР	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Prof. Christian Cyron
Language	DE
Cycle	SoSe
Content	stresses and strains
	Hooke's law
	tension and compression
	torsion
	bending
	stability
	buckling
	energy methods
Literature	<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	ourse 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 M0851: Math	ematics II			
Courses				
Title Analysis II (L1025) Analysis II (L1026)		<b>Typ</b> Lecture Recitation Section (large)	Hrs/wk 2 1	<b>CP</b> 2 1
Analysis II (L1027) Linear Algebra II (L0915) Linear Algebra II (L0916)		Recitation Section (small) Lecture Recitation Section (small)	1 2 1	1 2 1
Linear Algebra II (L0917)		Recitation Section (large)	1	1
Module Responsible	Prof. Anusch Taraz			
•	None			
Recommended Previous Knowledge	Mathematics I			
Educational Objectives	After taking part successfully, students have reach	ned the following learning results		
Professional Competence	Arter taking part successionly, students have reach	red the following learning results		
Knowledge	Students can name further concepts in a examples. Students can discuss logical connections by the help of examples. They know proof strategies and can reprodu	etween these concepts. They are capable of		
Skills	<ul> <li>Students can model problems in analysis a they are capable of solving them by applyir</li> <li>Students are able to discover and verify fur</li> <li>For a given problem, the students can de results.</li> </ul>	g established methods. ther logical connections between the concep	ts studied in the	e course.
Personal Competence Social Competence	<ul> <li>Students are able to work together in teams</li> <li>In doing so, they can communicate new condesign examples to check and deepen the total</li> </ul>	ncepts according to the needs of their coope		-
Autonomy	<ul> <li>Students are capable of checking their und precisely and know where to get help in sol</li> <li>Students have developed sufficient persist problems.</li> </ul>	ving them.		
Workload in Hours	Independent Study Time 128, Study Time in Lectu	re 112		
Credit points		-		
Course achievement				
Examination	Written exam			
Examination duration and	60 min (Analysis II) + 60 min (Linear Algebra II)			
scale	Company Commany Commany 7	Company Company I Company		
Assignment for the Following Curricula	General Engineering Science (German program, 7 Civil- and Environmental Engineering: Core qualific			
	Bioprocess Engineering: Core qualification: Compu			
	Digital Mechanical Engineering: Core qualification:	Compulsory		
	Electrical Engineering: Core qualification: Compuls	•		
	Energy and Environmental Engineering: Core qual Green Technologies: Energy, Water, Climate: Core	• •		
	Computational Science and Engineering: Core qua			
	Logistics and Mobility: Core qualification: Compuls	• •		
	Mechanical Engineering: Core qualification: Compu	ulsory		
	Mechatronics: Core qualification: Compulsory  Orientation Studies: Core qualification: Flective Co	mouleary		
	Orientation Studies: Core qualification: Elective Co Naval Architecture: Core qualification: Compulsory			
	Process Engineering: Core qualification: Compulso			
	Engineering and Management - Major in Logistics	and Mobility: Core qualification: Compulsory		

Course L1025: Analysis II		
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	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	http://www.math.uni-hamburg.de/teaching/export/tuhh/index.html	

Course L1026: Analysis II	
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 L1027: Analysis II	
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 SoSe
Content	See interlocking course
Literature	See interlocking course

ourse L0915: Linear Algebra	a II
Тур	Lecture
Hrs/wk	2
СР	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Prof. Anusch Taraz, Prof. Marko Lindner, Dr. Dennis Clemens
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			
СР	1		
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14		
Lecturer	Prof. Anusch Taraz, Prof. Marko Lindner, Dr. Dennis Clemens		
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 II		
Тур	Recitation Section (large)	
Hrs/wk	1	
СР	1	
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14	
Lecturer	Prof. Anusch Taraz, Prof. Marko Lindner, Dr. Christian Seifert, Dr. Dennis Clemens	
Language	DE	
Cycle	SoSe	
Content	See interlocking course	
Literature	See interlocking course	

Module M0688: Techr	ical Thermodynamics II			
Courses				
Title		Тур	Hrs/wk	СР
Technical Thermodynamics II (L044		Lecture	2	4
Technical Thermodynamics II (L045		Recitation Section (large)	1	1
Technical Thermodynamics II (L045		Recitation Section (small)	1	1
Module Responsible				
Admission Requirements	None			
	Elementary knowledge in Mathematics, Mechanics and	d Technical Thermodynamics I		
Knowledge	A6			
Educational Objectives Professional Competence	After taking part successfully, students have reached	the following learning results		
Knowledge	Students are familiar with different cycle processes like Joule, Otto, Diesel, Stirling, Seiliger and Clausius-Rankine. They are able to derive energetic and exergetic efficiencies and know the influence different factors. They know the difference between anti clockwise and clockwise cycles (heat-power cycle, cooling cycle). They have increased knowledge of steam cycles and are able to draw the different cycles in Thermodynamics related diagrams. They know the laws of gas mixtures, especially of humid air processes and are able to perform simple combustion calculations. They are provided with basic knowledge in gas dynamics and know the definition of the speed of sound and 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 formulated message into an abstract formal procedure.			
Personal Competence				
Social Competence	The students are able to discuss in small groups and o	levelop an approach.		
Autonomy	Students are able to define independently tasks, to go knowledge in practice.	et new knowledge from existing knowled	dge as well as to	find ways to use the
Workload in Hours	Independent Study Time 124, Study Time in Lecture 5	6		
Credit points	6			
Course achievement	None			
Examination	Written exam			
Examination duration and	90 min			
scale				
Assignment for the	General Engineering Science (German program, 7 sen			
Following Curricula	Bioprocess Engineering: Core qualification: Compulsor			
	Energy and Environmental Engineering: Core qualifica Energy Systems: Technical Complementary Course Co			
	Engineering Science: Specialisation Mechanical Engine			
	General Engineering Science (English program, 7 sem		ering: Elective C	Compulsory
	Green Technologies: Energy, Water, Climate: Core qua		,	49
	Mechanical Engineering: Core qualification: Compulsor	• •		
	Mechatronics: Core qualification: Compulsory			
	Technomathematics: Specialisation III. Engineering Sc	ience: Elective Compulsory		
	Process Engineering: Core qualification: Compulsory			

Course L0449: Technical Thermodynamics II		
Тур	Lecture	
Hrs/wk	2	
СР	4	
Workload in Hours	Independent Study Time 92, Study Time in Lecture 28	
Lecturer	NN	
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 Thermodynamics II	
Тур	Recitation Section (large)
Hrs/wk	1
СР	1
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14
Lecturer	NN
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	NN
Language	DE
Cycle	WiSe
Content	See interlocking course
Literature	See interlocking course

Module M0959: Mech	anics III (Dynamics)			
Courses				
Title Mechanics III (Dynamics) (L1134)		<b>Typ</b> Lecture	Hrs/wk	<b>CP</b> 3
Mechanics III (Dynamics) (L1135) Mechanics III (Dynamics) (L1136)		Recitation Section (small) Recitation Section (large)	2 1	2 1
Module Responsible	Prof. Robert Seifried			
Admission Requirements	None			
Recommended Previous Knowledge	Mathematics I, II, Mechanics I (Statics)			
Educational Objectives	After taking part successfully, students have re	ached the following learning results		
Professional Competence				
Knowledge	The students can			
	describe the axiomatic procedure used in     explain important steps in model design;     present technical knowledge in stereosta  The students can			
	explain the important elements of math their own problems;     apply basic hydrostatical, kinematic and     estimate the reach and boundaries of sta	kinetic methods to engineering problems;		
Personal Competence				
Social Competence	The students can work in groups and support e	ach other to overcome difficulties.		
Autonomy	Students are capable of determining their own	strengths and weaknesses and to organize	their time and learr	ing based on those.
Workload in Hours	Independent Study Time 96, Study Time in Lect	ture 84		
Credit points	6			
Course achievement				
Examination duration and .	120 min			
scale	Canada Fraincarina Caianas (Carresa nos granos	7 compostory). Core qualification. Commules		
Assignment for the Following Curricula			ту	
	Digital Mechanical Engineering: Core qualification Energy and Environmental Engineering: Core qualification: Core qualification: Core qualification: Core qualification: Core qualification: Core qualification: Compulsory Naval Architecture: Core qualification: Compuls	on: Compulsory ualification: Elective Compulsory pecialisation Energy Technology: Elective Co npulsory	ompulsory	
	Technomathematics: Specialisation III. Enginee			

ourse 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>Planar and spatial motion of point systems and rigid bodies</li> <li>Dynamics</li> <li>Terms</li> <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>
	Vibrations •
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).

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

Course L1136: Mechanics III	Course L1136: Mechanics III (Dynamics)	
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	See interlocking course	
Literature	See interlocking course	

Module M0853: Math	ematics III			
Courses				
Title Analysis III (L1028) Analysis III (L1029)		<b>Typ</b> Lecture Recitation Section (small)	Hrs/wk 2 1	<b>CP</b> 2 1
Analysis III (L1030) Differential Equations 1 (Ordinary I Differential Equations 1 (Ordinary I		Recitation Section (large) Lecture Recitation Section (small)	1 2 1	1 2 1
Differential Equations 1 (Ordinary I	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 th	o following loarning results		
Professional Competence		e following learning results		
Knowledge		n these concepts. They are capable		
Skills	<ul> <li>Students can model problems in the area of anal course. Moreover, they are capable of solving the</li> <li>Students are able to discover and verify further le</li> <li>For a given problem, the students can develop results.</li> </ul>	em by applying established methods.  Orgical connections between the conce	pts studied in the	e course.
Personal Competence Social Competence		s according to the needs of their coop		-
Autonomy	Students are capable of checking their understal precisely and know where to get help in solving t     Students have developed sufficient persistence problems.	hem.		
Workload in Hours	Independent Study Time 128, Study Time in Lecture 11:	2		
Credit points	, , ,			
Course achievement	None			
Examination	Written exam			
Examination duration and				
scale Assignment for the		ster): Core qualification: Compulsory		
•	Civil- and Environmental Engineering: Core qualification			
	Bioprocess Engineering: Core qualification: Compulsory			
	Digital Mechanical Engineering: Core qualification: Com	pulsory		
	Electrical Engineering: Core qualification: Compulsory Energy and Environmental Engineering: Core qualification	on: Compulsory		
	Green Technologies: Energy, Water, Climate: Core quali			
	Computational Science and Engineering: Core qualificat	ion: Compulsory		
	Logistics and Mobility: Specialisation Traffic Planning an			
	Logistics and Mobility: Specialisation Production Manage Logistics and Mobility: Specialisation Information Techno	·	isory	
	Mechanical Engineering: Core qualification: Compulsory			
	Mechatronics: Core qualification: Compulsory			
	Naval Architecture: Core qualification: Compulsory			
	Process Engineering: Core qualification: Compulsory	obility. Specialization Treffic Plansis	and Sustance F	activa Compulsor:
	Engineering and Management - Major in Logistics and M Engineering and Management - Major in Logistics and Compulsory	Mobility: Specialisation Production N	Management and	l Processes: Elective
	Engineering and Management - Major in Logistics and M	obility: Specialisation Information Tec	nnology: Compu	sory

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

Course L1031: Differential Equations 1 (Ordinary Differential Equations)		
Тур	Lecture	
Hrs/wk	2	
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 the theory and numerical treatment of ordinary differential equations	
	Introduction and elementary methods Exsitence and uniqueness of initial value problems Linear differential equations Stability and qualitative behaviour of the solution Boundary value problems and basic concepts of calculus of variations Eigenvalue problems Numerical methods for the integration of initial and boundary value problems Classification of partial differential equations	
Literature	http://www.math.uni-hamburg.de/teaching/export/tuhh/index.html	

Course L1032: Differential Equations 1 (Ordinary 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	WiSe
Content	See interlocking course
Literature	See interlocking course

Course L1033: Differential Equations 1 (Ordinary 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	WiSe
Content	See interlocking course
Literature	See interlocking course

response, stability, linearity etc They can assess the impact of LTI systems on the signal properties in time and frequency doma  Personal Competence  Social Competence  Autonomy  The students can jointly solve specific problems.  Autonomy  The students are able to acquire relevant information from appropriate literature sources. They can control their level knowledge during the lecture period by solving tutorial problems, software tools, clicker system.  Workload in Hours  Independent Study Time 110, Study Time in Lecture 70  Credit points  Course achievement  None	Module M0672: Signa	Is and Systems			
Signals and Systems (L0432) Signals and Systems (L0433) Recitation Section (small) Recommended Previous Recommende	Courses				
Signals and Systems (L0433)  Module Responsible Admission Requirements Recommended Previous Knowledge Knowledge Knowledge Knowledge  Knowledge  Knowledge  Reductional Objectives Professional Competence Knowledge  Knowledge  Knowledge  Knowledge  The students are able to describe and analyse deterministic signals and linear time-invariant systems using methods of signal and systems. The can describe and analyse deterministic signals and linear time-invariant systems using methods of signal and systems. The students are able to describe and analyse deterministic signals and linear time-invariant systems using methods of signal and systems and linear time-invariant systems using methods of signal and systems and linear time-invariant systems using methods of signal and systems and linear time-invariant systems using methods of signal and systems and linear time-invariant systems using methods of signal and systems and linear time-invariant systems using methods of signal and systems and linear time-invariant systems using methods of signal and systems and the effects in time domain and image domain which are caused by the transition of a continuous-time signal to discrete-time signal.  Skills  The students are able to describe and analyse deterministic signals and linear time-invariant systems using methods of signal and system theory. They can analyse and design basic systems regarding important properties such as magnitude and phar response, stability, linearity etc They can assess the impact of LTI systems on the signal properties in time and frequency doma response, stability, linearity etc They can assess the impact of LTI systems on the signal properties in time and frequency doma response, stability, linearity etc They can assess the impact of LTI systems on the signal properties in time and frequency doma response, stability, linearity etc They can assess the impact of LTI systems on the signal properties in time and frequency doma response, stability, linearity etc They can assess the impact of	Title		Тур	Hrs/wk	СР
Module Responsible Prof. Gerhard Bauch  Admission Requirements None  Recommended Previous Knowledge  Mathematics 1-3  The modul is an introduction to the theory of signals and systems. Good knowledge in maths as covered by the moduls Mathematically in other required.  Educational Objectives After taking part successfully, students have reached the following learning results  Professional Competence Knowledge  Knowledge  Knowledge  Knowledge  The students are able to classify and describe signals and linear time-invariant (LTI) systems using methods of signal and system theory. They are able to apply the fundamental transformations of continuous-time and discrete-time signals and systems. The can describe and analyse deterministic signals and systems mathematically in both time and image domain. In particular, the understand the effects in time domain and image domain which are caused by the transition of a continuous-time signal to discrete-time signal.  Skills  Skills  Skills  Skills  Fersonal Competence  Social Competence  Autonomy  The students can jointly solve specific problems.  The students are able to acquire relevant information from appropriate literature sources. They can control their level knowledge during the lecture period by solving tutorial problems, software tools, clicker system.  Workload in Hours  Credit points  Course achievement  None	Signals and Systems (L0432)		Lecture	3	4
Admission Requirements Recommended Previous Knowledge The modul is an introduction to the theory of signals and systems. Good knowledge in maths as covered by the moduls Mathematics 1-3 is expected. Further experience with spectral transformations (Fourier series, Fourier transform, Laplace transform) is used 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 signals and linear time-invariant (LTI) systems using methods of signal and system theory. They are able to apply the fundamental transformations of continuous-time and discrete-time signals and systems. The can describe and analyse deterministic signals and systems mathematically in both time and image domain. In particular, the understand the effects in time domain and image domain which are caused by the transition of a continuous-time signal of discrete-time signal.  Skillis The students are able to describe and analyse deterministic signals and linear time-invariant systems using methods of signal and system theory. They can analyse and design basic systems regarding important properties such as magnitude and phase response, stability, linearity etc They can assess the impact of LTI systems on the signal properties in time and frequency domain and signal properties in time and frequency domain and properti	Signals and Systems (L0433)		Recitation Section (small)	2	2
Recommended Previous Knowledge  Robustional Objectives  Frofessional Competence  Knowledge  Knowled	Module Responsible	Prof. Gerhard Bauch			
The modul is an introduction to the theory of signals and systems. Good knowledge in maths as covered by the moduls Mathema 1-3 is expected. Further experience with spectral transformations (Fourier series, Fourier transform, Laplace transform) is usef 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 signals and linear time-invariant (LTI) systems using methods of signal and system theory. They are able to apply the fundamental transformations of continuous-time and discrete-time signals and systems. The can describe and analyse deterministic signals and systems mathematically in both time and image domain. In particular, the understand the effects in time domain and image domain which are caused by the transition of a continuous-time signal to discrete-time signal.  Skills  The students are able to describe and analyse deterministic signals and linear time-invariant systems using methods of signal and system theory. They can analyse and design basic systems regarding important properties such as magnitude and phase response, stability, linearity etc They can assess the impact of LTI systems on the signal properties in time and frequency doma response, stability, linearity etc They can assess the impact of LTI systems on the signal properties in time and frequency doma the sudents are able to acquire relevant information from appropriate literature sources. They can control their level knowledge during the lecture period by solving tutorial problems, software tools, clicker system.  Workload in Hours  Credit points  Course achievement  None	Admission Requirements	None			
The modul is an introduction to the theory of signals and systems. Good knowledge in maths as covered by the moduls Mathema 1-3 is expected. Further experience with spectral transformations (Fourier series, Fourier transform, Laplace transform) is used 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 signals and linear time-invariant (LTI) systems using methods of signal and system theory. They are able to apply the fundamental transformations of continuous-time and discrete-time signals and systems. The can describe and analyse deterministic signals and systems mathematically in both time and image domain. In particular, the understand the effects in time domain and image domain which are caused by the transition of a continuous-time signal to discrete-time signal.  Skills  Skills  The students are able to describe and analyse deterministic signals and linear time-invariant systems using methods of signal and system theory. They can analyse and design basic systems regarding important properties such as magnitude and phase response, stability, linearity etc They can assess the impact of LTI systems on the signal properties in time and frequency doma response, stability, linearity solve specific problems.  The students are able to acquire relevant information from appropriate literature sources. They can control their level knowledge during the lecture period by solving tutorial problems, software tools, clicker system.  Workload in Hours  Credit points  Course achievement  None	Recommended Previous	Mathematics 1-3			
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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 signals and linear time-invariant (LTI) systems using methods of signal and system theory. They are able to apply the fundamental transformations of continuous-time and discrete-time signals and systems. The can describe and analyse deterministic signals and systems mathematically in both time and image domain. In particular, the understand the effects in time domain and image domain which are caused by the transition of a continuous-time signal to discrete-time signal.  Skills The students are able to describe and analyse deterministic signals and linear time-invariant systems using methods of signal at system theory. They can analyse and design basic systems regarding important properties such as magnitude and phase response, stability, linearity etc They can assess the impact of LTI systems on the signal properties in time and frequency doma  Personal Competence The students can jointly solve specific problems.  Autonomy The students are able to acquire relevant information from appropriate literature sources. They can control their level knowledge during the lecture period by solving tutorial problems, software tools, clicker system.  Workload in Hours Independent Study Time 110, Study Time in Lecture 70  Credit points 6  Course achievement			•	-	
Professional Competence  Knowledge  The students are able to classify and describe signals and linear time-invariant (LTI) systems using methods of signal and system theory. They are able to apply the fundamental transformations of continuous-time and discrete-time signals and systems. The can describe and analyse deterministic signals and systems mathematically in both time and image domain. In particular, the understand the effects in time domain and image domain which are caused by the transition of a continuous-time signal to discrete-time signal.  Skills  Skills  The students are able to describe and analyse deterministic signals and linear time-invariant systems using methods of signal are system theory. They can analyse and design basic systems regarding important properties such as magnitude and phase response, stability, linearity etc They can assess the impact of LTI systems on the signal properties in time and frequency doma  Personal Competence  Social Competence  Autonomy  The students are able to acquire relevant information from appropriate literature sources. They can control their level knowledge during the lecture period by solving tutorial problems, software tools, clicker system.  Workload in Hours  Gredit points  Course achievement  None			ormations (Fourier series) Fourier a	ansionni, zapiace	transform, is ascial
The students are able to classify and describe signals and linear time-invariant (LTI) systems using methods of signal and system theory. They are able to apply the fundamental transformations of continuous-time and discrete-time signals and systems. The can describe and analyse deterministic signals and systems mathematically in both time and image domain. In particular, the understand the effects in time domain and image domain which are caused by the transition of a continuous-time signal to discrete-time signal.  Skills  The students are able to describe and analyse deterministic signals and linear time-invariant systems using methods of signal at system theory. They can analyse and design basic systems regarding important properties such as magnitude and phase response, stability, linearity etc They can assess the impact of LTI systems on the signal properties in time and frequency doma  Personal Competence  Social Competence  Autonomy  The students can jointly solve specific problems.  The students are able to acquire relevant information from appropriate literature sources. They can control their level knowledge during the lecture period by solving tutorial problems, software tools, clicker system.  Workload in Hours  Credit points  Course achievement  None	Educational Objectives	After taking part successfully, students have reached the	following learning results		
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understand the effects in time domain and image domain which are caused by the transition of a continuous-time signal to discrete-time signal.  Skills  The students are able to describe and analyse deterministic signals and linear time-invariant systems using methods of signal as system theory. They can analyse and design basic systems regarding important properties such as magnitude and phase response, stability, linearity etc They can assess the impact of LTI systems on the signal properties in time and frequency doma  Personal Competence  Social Competence  Autonomy  The students can jointly solve specific problems.  The students are able to acquire relevant information from appropriate literature sources. They can control their level knowledge during the lecture period by solving tutorial problems, software tools, clicker system.  Workload in Hours  Credit points  Course achievement  None		theory. They are able to apply the fundamental transfor	mations of continuous-time and dis-	crete-time signal	s and systems. They
discrete-time signal.  Skills  The students are able to describe and analyse deterministic signals and linear time-invariant systems using methods of signal and system theory. They can analyse and design basic systems regarding important properties such as magnitude and phase response, stability, linearity etc They can assess the impact of LTI systems on the signal properties in time and frequency doma  Personal Competence  Social Competence  Autonomy  The students can jointly solve specific problems.  The students are able to acquire relevant information from appropriate literature sources. They can control their level knowledge during the lecture period by solving tutorial problems, software tools, clicker system.  Workload in Hours  Credit points  Course achievement  None		can describe and analyse deterministic signals and syst	tems mathematically in both time a	nd image domai	n. In particular, they
The students are able to describe and analyse deterministic signals and linear time-invariant systems using methods of signal and system theory. They can analyse and design basic systems regarding important properties such as magnitude and phase response, stability, linearity etc They can assess the impact of LTI systems on the signal properties in time and frequency doma response, stability, linearity etc They can assess the impact of LTI systems on the signal properties in time and frequency doma response.  The students can jointly solve specific problems.  The students are able to acquire relevant information from appropriate literature sources. They can control their level knowledge during the lecture period by solving tutorial problems, software tools, clicker system.  Workload in Hours  Credit points  6  Course achievement  None		-	ain which are caused by the transi	tion of a continu	ous-time signal to a
system theory. They can analyse and design basic systems regarding important properties such as magnitude and phase response, stability, linearity etc They can assess the impact of LTI systems on the signal properties in time and frequency domain the students can jointly solve specific problems.  Autonomy  The students are able to acquire relevant information from appropriate literature sources. They can control their level knowledge during the lecture period by solving tutorial problems, software tools, clicker system.  Workload in Hours  Credit points  Course achievement  None		<u> </u>			
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Social Competence  Autonomy The students can jointly solve specific problems.  Autonomy The students are able to acquire relevant information from appropriate literature sources. They can control their level knowledge during the lecture period by solving tutorial problems, software tools, clicker system.  Workload in Hours Credit points 6  Course achievement None	Davisanal Commetence	response, stability, linearity etc They can assess the impact of LTI systems on the signal properties in time and frequency domain.			
Autonomy The students are able to acquire relevant information from appropriate literature sources. They can control their level knowledge during the lecture period by solving tutorial problems, software tools, clicker system.  Workload in Hours Independent Study Time 110, Study Time in Lecture 70 Credit points 6 Course achievement None	•	The students can jointly solve specific problems			
knowledge during the lecture period by solving tutorial problems, software tools, clicker system.  Workload in Hours Independent Study Time 110, Study Time in Lecture 70  Credit points 6  Course achievement None	,		n from appropriate literature cour	sos Thoy san s	antral their layed of
Workload in Hours Independent Study Time 110, Study Time in Lecture 70 Credit points 6 Course achievement None	Autonomy	·	· · · · · · · · · · · · · · · · · · ·		
Credit points 6 Course achievement None	Workload in Hours		Toblems, software tools, clicker syste	:111.	
Course achievement None					
Examination   Written exam					
Examination duration and 90 min					
scale		30 111111			
Assignment for the General Engineering Science (German program, 7 semester): Core qualification: Compulsory		General Engineering Science (German program, 7 semes	ter): Core qualification: Compulsory		
Following Curricula   Computer Science: Core qualification: Compulsory	-		ter). Core qualification. Compaisory		
Computer Science: Specialisation II. Mathematics and Engineering Science: Elective Compulsory			gineering Science: Elective Compuls	orv	
Data Science: Core qualification: Compulsory			5 5 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1	•	
Electrical Engineering: Core qualification: Compulsory					
Computational Science and Engineering: Core qualification: Compulsory			on: Compulsory		
Mechanical Engineering: Specialisation Mechatronics: Elective Compulsory		Mechanical Engineering: Specialisation Mechatronics: Ele	ctive Compulsory		
Mechatronics: Core qualification: Compulsory		Mechatronics: Core qualification: Compulsory			
Technomathematics: Specialisation III. Engineering Science: Elective Compulsory		Technomathematics: Specialisation III. Engineering Scien	ce: Elective Compulsory		

Тур	Lecture	
Hrs/wk	3	
СР	4	
Workload in Hours	ndependent 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  Continuous-time and discrete-time signals  Analog and digital signals  Deterministic and random signals  Description of LTI systems by differential equations or difference equations, respectively  Basic properties of signals and operations on signals  Elementary signals  Distributions (Generalized Functions)  Power and energy of signals  Correlation functions of deterministic signals  Autocorrelation function  Crosscorrelation function  Applications of correlation  Applications of correlation  Linear time-invariant (LTI) systems	
	Linearity     Time-invariance	

- Description of LTI systems by impulse response and frequency response
- Convolution
- Convolution and correlation
- · Properties of LTI-systems
- Causal systems
- o 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
  - o 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
  - o Transfer function of LTI-systems
  - Relation of Laplace transform, magnitude response and phase response
  - o 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
  - Aliasino
  - 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)
  - $\circ \ \ \mathsf{Application} \ \mathsf{of} \ \mathsf{the} \ \mathsf{DFT:} \ \mathsf{Orthogonal} \ \mathsf{Frequency} \ \mathsf{Division} \ \mathsf{Multiplex} \ (\mathsf{OFDM})$
- Z-Transform
  - Relation of Laplace transform, DTFT, and z-transform
  - o Properties of the z-transform
  - o Z-transform of some basic discrete-time signals
- Discrete-time systems, digital filters
  - FIR and IIR filters
  - Z-transform of digital filters
  - Analysis of discrete-time systems using pole-zero plots in the z-domain
  - Stability
  - Allpass filters
  - Minimum-phase, maximum-phase and mixed-phase filters
  - Linear phase filters

## Literature

- T. Frey , M. Bossert , Signal- und Systemtheorie, B.G. Teubner Verlag 2004
- K. Kammeyer, K. Kroschel, Digitale Signalverarbeitung, Teubner Verlag.
- B. Girod ,R. Rabensteiner , A. Stenger , Einführung in die Systemtheorie, B.G. Teubner, Stuttgart, 1997
- J.R. Ohm, H.D. Lüke , Signalübertragung, Springer-Verlag 8. Auflage, 2002
- S. Haykin, B. van Veen: Signals and systems. Wiley.
- Oppenheim, A.S. Willsky: Signals and Systems. Pearson.
- Oppenheim, R. W. Schafer: Discrete-time signal processing. Pearson.

ourse L0433: Signals and Systems		
Тур	Recitation Section (small)	
Hrs/wk	2	
СР	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	

	duction to Control Systems			
Courses				
Title		ур	Hrs/wk	CP
Introduction to Control Systems (L0 Introduction to Control Systems (L0		ecture ecitation Section (small)	2	4 2
Module Responsible	T	(,		
Admission Requirements				
-	Representation of signals and systems in time and frequency doma	ain. Laplace transform		
Knowledge		, <sub> </sub>		
-	After taking part successfully, students have reached the following	learning results		
Professional Competence  Knowledge				
rano meage	Students can represent dynamic system behavior in time at	nd frequency domain, and o	an in particular	explain properties
	first and second order systems			
	<ul> <li>They can explain the dynamics of simple control loops and i root locus</li> </ul>	nterpret dynamic propertie	s in terms of freq	uency response ar
	They can explain the Nyquist stability criterion and the stab	ility margins derived from it		
	They can explain the role of the phase margin in analysis ar			
	They can explain the way a PID controller affects a control to			
	They can explain issues arising when controllers designed in	continuous time domain a	e implemented o	digitally
Skills				
Skiiis	Students can transform models of linear dynamic systems fi	om time to frequency doma	ain and vice vers	а
	They can simulate and assess the behavior of systems and of the systems and of the systems.			
	They can design PID controllers with the help of heuristic (Zi	-		
	They can analyze and synthesize simple control loops with t     They can calculate discrete-time approximations of col			
	implementation	itioliers designed in cont	illuous-tillie alle	use it for digit
	They can use standard software tools (Matlab Control Toolbo	ox, Simulink) for carrying ou	t these tasks	
Personal Competence				
	Students can work in small groups to jointly solve technical problem			
Autonomy	Students can obtain information from provided sources (lecture when solving given problems.	notes, software documenta	ition, experimen	t guides) and use
	when solving given problems.			
	They can assess their knowledge in weekly on-line tests and there	by control their learning pro	gress.	
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56			
Credit points	6			
Course achievement	None			
Examination	Written exam			
Examination duration and	120 min			
scale				
Assignment for the	General Engineering Science (German program, 7 semester): Core	qualification: Compulsory		
	General Engineering Science (German program, 7 semester): Core Bioprocess Engineering: Core qualification: Compulsory	qualification: Compulsory		
	Bioprocess Engineering: Core qualification: Compulsory Computer Science: Specialisation Computational Mathematics: Ele- Data Science: Core qualification: Elective Compulsory			
	Bioprocess Engineering: Core qualification: Compulsory Computer Science: Specialisation Computational Mathematics: Ele Data Science: Core qualification: Elective Compulsory Electrical Engineering: Core qualification: Compulsory	ctive Compulsory		
	Bioprocess Engineering: Core qualification: Compulsory Computer Science: Specialisation Computational Mathematics: Ele Data Science: Core qualification: Elective Compulsory Electrical Engineering: Core qualification: Compulsory Energy and Environmental Engineering: Core qualification: Compul	ctive Compulsory	ingu Compulsony	
	Bioprocess Engineering: Core qualification: Compulsory Computer Science: Specialisation Computational Mathematics: Ele Data Science: Core qualification: Elective Compulsory Electrical Engineering: Core qualification: Compulsory Energy and Environmental Engineering: Core qualification: Compul General Engineering Science (English program, 7 semester): Speci	ctive Compulsory sory alisation Electrical Engineer		
	Bioprocess Engineering: Core qualification: Compulsory Computer Science: Specialisation Computational Mathematics: Ele Data Science: Core qualification: Elective Compulsory Electrical Engineering: Core qualification: Compulsory Energy and Environmental Engineering: Core qualification: Compul General Engineering Science (English program, 7 semester): Speci General Engineering Science (English program, 7 semester): Speci	ctive Compulsory sory alisation Electrical Engineer alisation Civil Engineering: (	Compulsory	v
	Bioprocess Engineering: Core qualification: Compulsory Computer Science: Specialisation Computational Mathematics: Ele Data Science: Core qualification: Elective Compulsory Electrical Engineering: Core qualification: Compulsory Energy and Environmental Engineering: Core qualification: Compul General Engineering Science (English program, 7 semester): Speci General Engineering Science (English program, 7 semester): Speci General Engineering Science (English program, 7 semester): Speci	sory alisation Electrical Engineer alisation Civil Engineering: ( alisation Bioprocess Engine	Compulsory ering: Compulsor	-
	Bioprocess Engineering: Core qualification: Compulsory Computer Science: Specialisation Computational Mathematics: Ele Data Science: Core qualification: Elective Compulsory Electrical Engineering: Core qualification: Compulsory Energy and Environmental Engineering: Core qualification: Compul General Engineering Science (English program, 7 semester): Speci General Engineering Science (English program, 7 semester): Speci	sory alisation Electrical Engineer alisation Civil Engineering: ( alisation Bioprocess Enginee	Compulsory ering: Compulsor mental Engineeri	-
	Bioprocess Engineering: Core qualification: Compulsory Computer Science: Specialisation Computational Mathematics: Ele Data Science: Core qualification: Elective Compulsory Electrical Engineering: Core qualification: Compulsory Energy and Environmental Engineering: Core qualification: Compul General Engineering Science (English program, 7 semester): Speci	sory alisation Electrical Engineer alisation Civil Engineering: ( alisation Bioprocess Enginee alisation Energy and Enviror alisation Computer Science	Compulsory ering: Compulsor mental Engineeri Compulsory	ng: Compulsory
	Bioprocess Engineering: Core qualification: Compulsory Computer Science: Specialisation Computational Mathematics: Ele Data Science: Core qualification: Elective Compulsory Electrical Engineering: Core qualification: Compulsory Energy and Environmental Engineering: Core qualification: Compul General Engineering Science (English program, 7 semester): Speci	sory alisation Electrical Engineer alisation Civil Engineering: ( alisation Bioprocess Enginee alisation Energy and Enviror alisation Computer Science	Compulsory ering: Compulsor mental Engineeri Compulsory	ng: Compulsory
	Bioprocess Engineering: Core qualification: Compulsory Computer Science: Specialisation Computational Mathematics: Ele Data Science: Core qualification: Elective Compulsory Electrical Engineering: Core qualification: Compulsory Energy and Environmental Engineering: Core qualification: Compul General Engineering Science (English program, 7 semester): Speci General Engineering Science (English program, 7 semester):	sory alisation Electrical Engineer alisation Civil Engineering: ( alisation Bioprocess Enginee alisation Energy and Enviror alisation Computer Science: Specialisation Mechanical	Compulsory ering: Compulsor mental Engineeri Compulsory Engineering, F	ng: Compulsory
	Bioprocess Engineering: Core qualification: Compulsory Computer Science: Specialisation Computational Mathematics: Ele- Data Science: Core qualification: Elective Compulsory Electrical Engineering: Core qualification: Compulsory Energy and Environmental Engineering: Core qualification: Compulsory General Engineering Science (English program, 7 semester): Speci General Engineering Science (English program, 7 semester): Compulsory General Engineering Science (English program, 7 semester): S Compulsory	sory alisation Electrical Engineer alisation Civil Engineering: ( alisation Bioprocess Enginee alisation Energy and Enviror alisation Computer Science: Specialisation Mechanical pecialisation Mechanical E	Compulsory ering: Compulsor mental Engineeri Compulsory Engineering, F	ng: Compulsory ocus Biomechanic us Energy System
	Bioprocess Engineering: Core qualification: Compulsory Computer Science: Specialisation Computational Mathematics: Ele Data Science: Core qualification: Elective Compulsory Electrical Engineering: Core qualification: Compulsory Energy and Environmental Engineering: Core qualification: Compulsory Energy and Environmental Engineering: Core qualification: Compul General Engineering Science (English program, 7 semester): Speci General Engineering Science (English program, 7 semester): Compulsory General Engineering Science (English program, 7 semester): S Compulsory General Engineering Science (English program, 7 semester): S Compulsory General Engineering Science (English program, 7 semester): S	sory alisation Electrical Engineer alisation Civil Engineering: ( alisation Bioprocess Enginee alisation Energy and Enviror alisation Computer Science: Specialisation Mechanical pecialisation Mechanical E	Compulsory ering: Compulsor mental Engineeri Compulsory Engineering, F	ng: Compulsory ocus Biomechanic us Energy System
	Bioprocess Engineering: Core qualification: Compulsory Computer Science: Specialisation Computational Mathematics: Ele Data Science: Core qualification: Elective Compulsory Electrical Engineering: Core qualification: Compulsory Energy and Environmental Engineering: Core qualification: Compulsory Energy and Environmental Engineering: Core qualification: Compulsory General Engineering Science (English program, 7 semester): Speci General Engineering Science (English program, 7 semester): Compulsory General Engineering Science (English program, 7 semester): S Compulsory General Engineering Science (English program, 7 semester): S Engineering: Compulsory	sory alisation Electrical Engineer alisation Civil Engineering: ( alisation Bioprocess Enginee alisation Energy and Enviror alisation Computer Science: Specialisation Mechanical pecialisation Mechanical E	Compulsory ering: Compulsor mental Engineeri Compulsory Engineering, F ngineering, Focu	ng: Compulsory  ocus Biomechanic  us Energy System  us Aircraft Systen
	Bioprocess Engineering: Core qualification: Compulsory Computer Science: Specialisation Computational Mathematics: Ele Data Science: Core qualification: Elective Compulsory Electrical Engineering: Core qualification: Compulsory Energy and Environmental Engineering: Core qualification: Compulsory Energy and Environmental Engineering: Core qualification: Compulsory General Engineering Science (English program, 7 semester): Speci General Engineering Science (English program, 7 semester): Compulsory General Engineering Science (English program, 7 semester): Scompulsory General Engineering Science (English program, 7 semester): Senester Engineering: Compulsory General Engineering Science (English program, 7 semester): Senester Engineering: Compulsory General Engineering Science (English program, 7 semester): Senester Engineering: Compulsory	sory alisation Electrical Engineer alisation Civil Engineering: ( alisation Bioprocess Enginee alisation Energy and Enviror alisation Computer Science: Specialisation Mechanical pecialisation Mechanical E	Compulsory ering: Compulsor mental Engineeri Compulsory Engineering, F ngineering, Focu	ng: Compulsory  ocus Biomechanic  us Energy System  us Aircraft Systen
	Bioprocess Engineering: Core qualification: Compulsory Computer Science: Specialisation Computational Mathematics: Ele Data Science: Core qualification: Elective Compulsory Electrical Engineering: Core qualification: Compulsory Energy and Environmental Engineering: Core qualification: Compulsory Energy and Environmental Engineering: Core qualification: Compulsory General Engineering Science (English program, 7 semester): Speci General Engineering Science (English program, 7 semester): Compulsory General Engineering Science (English program, 7 semester): S Compulsory General Engineering Science (English program, 7 semester): S Engineering: Compulsory General Engineering Science (English program, 7 semester): S Engineering: Compulsory General Engineering Science (English program, 7 semester): S Especial Engineering Science (English program, 7 semester): S Engineering: Compulsory	sory alisation Electrical Engineer alisation Civil Engineering: ( alisation Bioprocess Engineer alisation Energy and Enviror alisation Computer Science: Specialisation Mechanical pecialisation Mechanical E specialisation Mechanical E alisation Mechanical Engine	Compulsory ering: Compulsory mental Engineeri Compulsory Engineering, F ngineering, Focusingineering, Focus ering, Focus Mat	ng: Compulsory ocus Biomechanic us Energy System us Aircraft Systen erials in Engineeri
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General Engineering Science (English program, 7 semester): Specialisation Biomedical Engineering: Compulsory Green Technologies: Energy, Water, Climate: Core qualification: Compulsory Computational Science and Engineering: Core qualification: Compulsory Logistics and Mobility: Specialisation Engineering Science: Elective Compulsory Logistics and Mobility: Specialisation Information Technology: Elective Compulsory Logistics and Mobility: Specialisation Traffic Planning and Systems: Elective Compulsory Logistics and Mobility: Specialisation Production Management and Processes: Elective Compulsory Mechanical Engineering: Core qualification: Compulsory Mechatronics: Core qualification: Compulsory Technomathematics: Specialisation III. Engineering Science: Elective Compulsory Theoretical Mechanical Engineering: Technical Complementary Course Core Studies: Elective Compulsory Process Engineering: Core qualification: Compulsory Engineering and Management - Major in Logistics and Mobility: Specialisation Information Technology: Elective Compulsory Engineering and Management - Major in Logistics and Mobility: Specialisation Traffic Planning and Systems: Elective Compulsory Engineering and Management - Major in Logistics and Mobility: Specialisation Production Management and Processes: Elective Compulsory

Course L0654: Introduction t	o Control Systems		
Тур	Lecture		
Hrs/wk	2		
СР	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		
	a Linear systems differential equations and transfer functions		
	Linear systems, differential equations and transfer functions     First and second order systems, pales and gross, impulse and step response.		
	<ul> <li>First and second order systems, poles and zeros, impulse and step response</li> <li>Stability</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		
	Nyquist plot, Nyquist stability criterion, phase and gain margin		
	Loop shaping, lead lag compensation		
	Frequency response interpretation of PID control		
	Time delay systems		
Root locus and frequency response of time delay systems			
Smith predictor			
	Digital control		
	Sampled-data systems, difference equations		
	Tustin approximation, digital implementation of PID controllers		
	Software tools		
	Introduction to Matlab, Simulink, Control toolbox		
	Computer-based exercises throughout the course		
Literature			
Literature	Werner, H., Lecture Notes "Introduction to Control Systems"		
	G.F. Franklin, J.D. Powell and A. Emami-Naeini "Feedback Control of Dynamic Systems", Addison Wesley, Reading, MA, 2009		
	K. Ogata "Modern Control Engineering", Fourth Edition, Prentice Hall, Upper Saddle River, NJ, 2010		
	R.C. Dorf and R.H. Bishop, "Modern Control Systems", Addison Wesley, Reading, MA 2010		

Course L0655: Introduction to Control Systems		
Тур	Recitation Section (small)	
Hrs/wk	2	
СР	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	

Module M0829: Foun	dations of Management			
Courses				
Title		Тур	Hrs/wk	СР
Management Tutorial (L0882)		Recitation Section (small)	2	3
Introduction to Management (L088	(0)	Lecture	3	3
Module Responsible	Prof. Christoph Ihl			
Admission Requirements	None			
Recommended Previous	Basic Knowledge of Mathematics and Business			
Knowledge				
<b>Educational Objectives</b>	After taking part successfully, students have reached the	e following learning results		
Professional Competence Knowledge	After taking this module, students know the important b and Organisation to Marketing and Innovation, and also			
Skills	explain the differences between Economics an important definitions from the field of Managemer     explain the most important aspects of and goals projects     describe and explain basic business functions organization and human ressource management,     explain the relevance of planning and decision uncertainty, and explain some basic methods from     state basics from accounting and costing and selections are able to analyse business units with respect out an Entrepreneurship project in a team. In particular,     analyse Management goals and structure them apply analyse organisational and staff structures of company methods for decision making under multiple analyse production and procurement systems and	in Management and name the most as production, procurement and so information management, innovation making in Business, esp. in situal mathematical Finance cted controlling methods.  It to different criteria (organization, obthey are able to appropriately panies objectives, under uncertainty and un	t important aspe purcing, supply management ar tions under mul sjectives, strateg	cts of entreprneurial chain management, id marketing tiple objectives and
Personal Competence Social Competence	<ul> <li>analyse and apply basic methods of marketing</li> <li>select and apply basic methods from mathematica</li> <li>apply basic methods from accounting, costing and</li> </ul> Students are able to	·		
Autonomy	work successfully in a team of students     to apply their knowledge from the lecture to an er     to communicate appropriately and     to cooperate respectfully with their fellow student  Students are able to     work in a team and to organize the team themselve to write a report on their project.	5.	herent report on	the project
Workload in Hours	Independent Study Time 110, Study Time in Lecture 70			
Credit points	• • • • • • • • • • • • • • • • • • • •			
Course achievement	None			
Examination	Subject theoretical and practical work			
Examination duration and				
scale	-			
Assignment for the	General Engineering Science (German program, 7 semes	ter): Core qualification: Compulsory		
Following Curricula	Civil- and Environmental Engineering: Specialisation Civi Civil- and Environmental Engineering: Specialisation Wat Civil- and Environmental Engineering: Specialisation Traf Bioprocess Engineering: Core qualification: Compulsory Computer Science: Core qualification: Compulsory Data Science: Core qualification: Compulsory Electrical Engineering: Core qualification: Compulsory Energy and Environmental Engineering: Core qualification General Engineering Science (English program, 7 semest General Engineering Science (English program, 7 ser Compulsory General Engineering Science (English program, 7 ser Compulsory General Engineering Science (English program, 7 ser	er and Environment: Elective Compul fic and Mobility: Elective Compulsory er: Specialisation Electrical Engineer er: Specialisation Civil Engineering: Ger: Specialisation Bioprocess Engineerer: Specialisation Energy and Environment: Specialisation Computer Science: Emester): Specialisation Mechanical Enester): Specialisation Mechanical Enester	ring: Compulsory Compulsory ering: Compulsor mental Engineeri : Compulsory Engineering, Foc Engineering, Foc	y ing: Compulsory ocus Biomechanics us Energy Systems:
	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

General Engineering Science (English program, 7 semester): Specialisation Naval Architecture: Compulsory General Engineering Science (English program, 7 semester): Specialisation Process Engineering: Compulsory General Engineering Science (English program, 7 semester): Specialisation Biomedical Engineering: Compulsory

Green Technologies: Energy, Water, Climate: Core qualification: Compulsory Computational Science and Engineering: Core qualification: Compulsory

Logistics and Mobility: Core qualification: Compulsory Mechanical Engineering: Core qualification: Compulsory

Mechatronics: Core qualification: Compulsory

Orientation Studies: Core qualification: Elective Compulsory Orientation Studies: Core qualification: Elective Compulsory Naval Architecture: Core qualification: Compulsory

Technomathematics: Core qualification: Compulsory
Process Engineering: Core qualification: Compulsory

Engineering and Management - Major in Logistics and Mobility: Core qualification: Compulsory

Course L08	382: Management Tutorial
Тур	Recitation Section (small)
Hrs/wk	2
СР	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
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 so 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 busin knowledge from the lecture should come to practical use. The group projects are guided by a mentor.
Literature	Relevante Literatur aus der korrespondierenden Vorlesung.

Course L0880: Introduction t	to 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. Thorsten Blecker, Prof. Christian Lüthje, Prof. Christian Ringle, Prof. Kathrin Fischer, Prof. Cornelius
	Herstatt, Prof. Wolfgang Kersten, Prof. Matthias Meyer, Prof. Thomas Wrona
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</li> <li>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>
Literature	Bamberg, G., Coenenberg, A.: Betriebswirtschaftliche Entscheidungslehre, 14. Aufl., München 2008  Eisenführ, F., Weber, M.: Rationales Entscheiden, 4. Aufl., Berlin et al. 2003  Heinhold, M.: Buchführung in Fallbeispielen, 10. Aufl., Stuttgart 2006.  Kruschwitz, L.: Finanzmathematik. 3. Auflage, München 2001.  Pellens, B., Fülbier, R. U., Gassen, J., Sellhorn, T.: Internationale Rechnungslegung, 7. Aufl., Stuttgart 2008.  Schweitzer, M.: Planung und Steuerung, in: Bea/Friedl/Schweitzer: Allgemeine Betriebswirtschaftslehre, Bd. 2: Führung, 9. Aufl., Stuttgart 2005.  Weber, J., Schäffer, U.: Einführung in das Controlling, 12. Auflage, Stuttgart 2008.  Weber, J./Weißenberger, B.: Einführung in das Rechnungswesen, 7. Auflage, Stuttgart 2006.

Module M1273: Advanced Internship AIW/ ES				
Courses				
Title		Тур	Hrs/wk	СР
Advanced Intenship AIW/ ES: Internship-accompanying Seminar (L2687) Advanced Internship AIW/ ES: Preparation (L2682)		Seminar Seminar	1 1	0
Module Responsible				0
Admission Requirements				
•	150 Creditpoints in General Engineering Science			
Knowledge	,			
Educational Objectives	After taking part successfully, students have reach	ed the following learning results		
Professional Competence				
Knowledge	Students of the different specialisations get experi	ences in typical scope of duties of en	gineers, who are workin	ig in a development
	division, planning division or in the management of a company. In the framework of this environment the knowledge from			
	university can used a first time for real engineering	g tasks.		
Skills	Students of the different specialisations should be integrated in typical day's work. By this they are learning typical tasks and			
	functions of engineers. They are able to structure and organize their working day and to finish tasks in a certain time.			
Personal Competence				
Social Competence	Students are able to cooperate with co-workers 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 Lecture 28			
Credit points	18			
Course achievement	None			
Examination	Written elaboration (accord. to Internship Regulations)			
Examination duration and	see Internship Regulations			
scale				
_	General Engineering Science (German program, 7	·	Isory	
Following Curricula	Engineering Science: Core qualification: Compulso	•		
	General Engineering Science (English program, 7 s	semester): Core qualification: Compul	sory	

Course I 2697, Advanced Inte	anchin ANN/ EC. Internehin accompanying Comings
	enship AIW/ ES: Internship-accompanying Seminar Seminar
Hrs/wk	
CP	
	Independent Study Time -14, Study Time in Lecture 14
	Prof. Robert Seifried, Eilika Schwenke
Language	DE/EN
Cycle	WiSe/SoSe
Content	The aim of the internship-accompanying seminar is the acquisition and consolidation of competences relevant for successfull 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 student 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 it 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 certait 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 give 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 Internship 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			
Content	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 skill 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.

Module M0580: Princi	ples of Building Materials and	Building Physics				
Courses						
Title		Тур	Hrs/wk	СР		
Building Physics (L0217)		Lecture	2	2		
Building Physics (L0219)		Recitation Section (large)	1	1		
Building Physics (L0247)	ME)	Recitation Section (small)	1	1		
Principles of Building Materials (L02	Prof. Frank Schmidt-Döhl	Lecture	2	2		
Admission Requirements						
	Knowledge of physics, chemistry and mathem	natics from school				
Knowledge	introvicage of physics, elembery and matricin	dates from seriour				
Educational Objectives	After taking part successfully, students have r	reached the following learning results				
Professional Competence						
Knowledge	The students are able to identify fundamental	effects of action to materials and structures, to	explain different	types of mechanical		
	behaviour, to describe the structure of bui	liding materials and the correlations between	n structure and	other properties, to		
	show methods of joining and of corrosion pr	ocesses and to describe the most important r	egularities and p	roperties of building		
	materials and structures and their measureme	ent in the field of protection against moisture, c	oldness, fire and	noise.		
Skille	The students are able to work with the most	important standardized methods and regulariti	ios in the field of	moisture protection		
Skills		protection and noise protection in the case of a		moisture protection,		
		,				
Personal Competence						
Social Competence	The students are able to support each other to	o learn the very extensive specialist knowledge				
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 96, Study Time in Le	cture 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 program	m, 7 semester): Specialisation Civil Engineering	: Compulsory			
Following Curricula	Civil- and Environmental Engineering: Core qu	alification: Compulsory				
	Orientation Studies: Core qualification: Electiv	Orientation Studies: Core qualification: Elective Compulsory				
	Technomathematics: Specialisation III. Engine	ering Science: Elective Compulsory				

Course L0217: Building Phys	ics
Тур	Lecture
Hrs/wk	2
СР	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	ourse L0219: Building Physics		
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	ourse L0247: Building Physics		
Тур	Recitation Section (small)		
Hrs/wk	1		
СР	1		
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14		
Lecturer	Prof. Frank Schmidt-Döhl		
Language	DE		
Cycle	WiSe		
Content	See interlocking course		
Literature	See interlocking course		

Course L0215: Principles of E	Building Materials				
Тур	Lecture				
Hrs/wk	2				
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				
	ndamentals of mechanical behaviour				
	aterial testing				
	rinciples of metals				
	Joining methods				
Literature	Wendehorst, R.: Baustoffkunde. ISBN 3-8351-0132-3				
	Scholz, W.:Baustoffkenntnis. ISBN 3-8041-4197-8				

Module M0740: Struct	tural Analysis I					
Courses						
Title				Тур	Hrs/wk	СР
Structural Analysis I (L0666)				Lecture	2	3
Structural Analysis I (L0667)	T			Recitation Section (large)	2	3
Module Responsible	Prof. Uwe Starossek					
Admission Requirements	None					
	Mechanics I, Mathema	atics I				
Knowledge						
-	After taking part succ	essfully, students have re	ached the followi	ng learning results		
Professional Competence						
Knowledge	systems.	npleting this module, stud	ents can express	the basic aspects of linear fra	ame analysis of st	tatically determinate
Skills	After successful comp	oletion of this module, the	students are abl	e to distinguish between stat	ically determinat	e and indeterminate
	structures. They are	able to analyze state var	riables and to co	nstruct influence lines of sta	tically determina	te plane and spatial
	frame and truss struc	tures.				
Personal Competence						
Social Competence	Students can					
	narticinate in s	ubject-specific and interdi	scinlinary discuss	ions		
		vn work results in front of	, ,	510113,		
		ientific development of co				
	·	Furthermore, they can give and accept professional constructive criticism				
Autonomy				ue to the in-term feedback,	tney are enabled	to self-assess their
	learning progress dur	ing the lecture period, alr	eady.			
Workload in Hours	Independent Study Ti	me 124, Study Time in Le	cture 56			
Credit points	6					
Course achievement	Compulsory Bonus	Form	Description			
	No 10 %	Written elaboration	Hausubunger	n mit Testat, betreut durch St	udentische Tutor	en (Tutorium)
Examination						
Examination duration and	90 Minuten					
scale	0 15 1 1		7		0 1	
Assignment for the						
Following Curricula	Civil- and Environmental Engineering: Core qualification: Compulsory					
	Logistics and Mobility: Specialisation Traffic Planning and Systems: Elective Compulsory Technomathematics: Specialisation III. Engineering Science: Elective Compulsory					
				pecialisation Traffic Planning	and Systems: Fle	ective Compulsory
	Engineering and Man	agement - Major III Logisti	es and Mobility. 3	pecialisation frame ranning	ana Jystems. Lie	cave compaisory

Course L0666: Structural Ana	alysis I
Тур	Lecture
Hrs/wk	2
СР	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Prof. Uwe Starossek
Language	DE
Cycle	WiSe
Content	basics: statically determinacy, equilibrium, method of sections forces: determination of support reactions and internal forces influence lines of forces displacements: calculation of discrete displacements and rotations, calculation of deflection curves principle of virtual displacements and virtual forces work-engergy theorem differential equation of beam
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	Course L0667: Structural Analysis I		
Тур	Recitation Section (large)		
Hrs/wk	2		
СР	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		

Module M0590: Buildi	ing Materials ar	nd Building (	Chemistry			
Courses						
Title				Тур	Hrs/wk	СР
Building Materials and Building Che				Lecture	4	4
Building Materials and Building Che				Recitation Section (small)	1	2
Module Responsible	†	öhl				
Admission Requirements	None					
Recommended Previous	Module Principles of B	uilding Materials a	and Building Physics			
Knowledge						
Educational Objectives	After taking part succ	essfully, students	have reached the following	ng learning results		
Professional Competence						
Knowledge	characteristics of the	The students are able to explain the most important components, the manufacture, the structure, the most important characteristics of the mechanical behaviour and the corrosion behaviour, the material testing and the fields of utilization of all relevant building materials.				
Skills	according to their spe and to consider the r	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 concrete 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						
Social Competence	The students are able to support each other to learn the very extensive specialist knowledge in learning groups and to carry out 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						
Course achievement	No 10 %	Form Presentation	Description			
Examination	Written exam					
Examination duration and	2 h written exam					
scale						
Assignment for the	General Engineering S	Science (German p	program, 7 semester): Sp	ecialisation Civil Engineering	g: Compulsory	
Following Curricula						
	Orientation Studies: C	ore qualification:	Elective Compulsory			

Course L0248: Building Mate	rials 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			
СР	2			
Workload in Hours	Independent Study Time 46, Study Time in Lecture 14			
Lecturer	Prof. Frank Schmidt-Döhl, André Rössler			
Language	DE			
Cycle	SoSe			
Content	See interlocking course			
Literature	See interlocking course			

Module M0613: Reinfo	orced Concrete	Structures I				
Courses						
Title	Title			Тур	Hrs/wk	СР
Project Seminar Concrete I (L0896)				Seminar	1	1
Reinforced Concrete Design I (L030)				Lecture	2	3
Reinforced Concrete Design I (L030)				Recitation Section (large)	2	2
Module Responsible						
Admission Requirements						
Recommended Previous	Basic knowledge in str	uctural analysis and l	ouilding materials.			
Knowledge	Modules: Structural A	nalysis I, Mechanics I	+II			
Educational Objectives	After taking part succe	essfully, students hav	e reached the following	ng learning results		
Professional Competence						
Knowledge	The students can outli	ne the history of con-	crete construction an	d explain the basics of struc	tural engineering,	including usual load
	combinations and safe	ety concepts. They ar	e able to draft and d	imension simple structures,	as well as to eval	uate and discuss the
	behaviour of the mate	rials and of structural	members.			
Skills	The students are able	to apply basic proce	dures of the concepti	on and dimensioning to pra-	ctical cases. They	are capable to draft
	simple concrete struc	ctures and to design	them for bending	and bending with axial fo	rce, and to plan	their detailing and
	execution. Moreover, t	hey can make design	and construction ske	etches and draw up technica	l descriptions.	
Personal Competence						
Social Competence						
Autonomy	The students are able	to carry out simple ta	sks in the conception	and dimensioning of structi	ures and to critica	lly reflect the results.
Workload in Hours	Independent Study Time 110, Study Time in Lecture 70					
	6					
Course achievement	Compulsory Bonus	Form	Description			
	Yes None	Excercises				
Examination	Written exam					
Examination duration and	120 minutes					
scale						
Assignment for the	General Engineering S	cience (German prog	ram, 7 semester): Sp	ecialisation Civil Engineering	: Compulsory	
Following Curricula	Civil- and Environment	tal Engineering: Core	qualification: Compul	sory		

Course L0896: Project Semin	ourse L0896: Project Seminar Concrete I				
Тур	Seminar				
Hrs/wk	1				
СР	1				
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14				
Lecturer	Prof. Günter Rombach				
Language	DE				
Cycle	SoSe				
Content	In the course of the project seminar, a simple structure is drafted and dimensioned.				
Literature	Download der Unterlagen zur Vorlesung über Stud.IP!				

Course L0303: Reinforced Co	oncrete Design I
Тур	Lecture
Hrs/wk	2
CP	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:
	<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>
Literature	<ul> <li>Download der Unterlagen zur Vorlesung über Stud.IP!</li> <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</li> <li>Fingerlos F., Hegger J., Zilch K.: Eurocode 2 für Deutschland. Berlin 2016</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> </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						
Title				Тур	Hrs/wk	СР
Structural Analysis II (L0673)				Lecture	2	3
Structural Analysis II (L0674)	1			Recitation Section (large)	2	3
Module Responsible	Prof. Uwe Starossek					
Admission Requirements						
Recommended Previous	<ul> <li>Mechanics I/II</li> </ul>					
Knowledge	<ul> <li>Mathematics</li> </ul>	/II				
	Differential Ed	uations I				
	Structural Ana	lysis I				
Educational Objectives		cessfully, students have re	eached the following	ng learning results		
Professional Competence  Knowledge		moletion of this module	students can ex	xpress the basic aspects	of linear frame a	nalysis of statically
Knowieuge	indeterminate system		students can ex	kpress the basic aspects	or inical traffic a	narysis or statically
Skille	After successful con	aplatian of this modula, th	ao studonts aro a	ble to analyze state variab	los and to constru	ct influence lines of
Skills		e plane and spatial frame			ies and to constru	ct iiiidelice iiiles oi
	Statically macriminal	e piane ana spaciai name	a.i.a ci a.s.s sci accai.			
Personal Competence						
Social Competence	Students can					
	<ul> <li>participate in</li> </ul>	subject-specific and interd	isciplinary discuss	sions,		
		wn work results in front of				
	*	cientific development of c				
	Furtnermore,	they can give and accept <sub>l</sub>	orofessional consti	ructive criticism		
Autonomy	The students are ab	e to work in-term homew	ork assignments.	Due to the in-term feedback	k, they are enabled	d to self-assess their
	learning progress du	ring the lecture period, alr	eady.			
Workload in Hours	Independent Study 1	ime 124, Study Time in Le	ecture 56			
Credit points						
Course achievement	No 10 %	Form Written elaboration	Description Hausübunger	n mit Testat, betreut durch S	Studentische Tutor	en (Tutorium)
Examination		vinten elaboration	riausuburiger	Time restat, betreut duftil s	Audentische Tuton	cii (Tucoriulli)
Examination duration and						
scale						
Assignment for the		Science (German program	n, 7 semester): Sp	ecialisation Civil Engineering	g: Compulsory	
Following Curricula	5 5	ntal Engineering: Core qua			,	

Course L0673: Structural Ana	alysis II
Тур	Lecture
Hrs/wk	2
СР	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Prof. Uwe Starossek
Language	DE
Cycle	SoSe SoSe
Content	<ul> <li>Linear structural analysis: statically indeterminate systems</li> <li>force method</li> <li>slope-deflection method for sway and non-sway frames</li> <li>general displacement method and finite element method</li> </ul>
Literature	Krätzig, W. B.; Harte, R.; Meskouris, K.; Wittek, U.: Tragwerke 2 - Theorie und Berechnungsmethoden statisch unbestimmter Stabtragwerke, 4. Auflage, Berlin, 2004

Course L0674: Structural Analysis II		
Тур	Recitation Section (large)	
Hrs/wk	2	
СР	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	

Module M0611: Steel	Structures I					
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						
Knowledge						
	Mechanics I, Mechanics II     Puilding Materials and Building Chamistry					
	Building Materials and Building Chemistry      Dringings of Building Materials and Building Blue	:				
	<ul> <li>Principles of Building Materials and Building Phys</li> </ul>	ICS				
Educational Objectives	After taking part successfully, students have reached the	ne following learning results				
Professional Competence						
Knowledge	After passing this module students are able to					
	give a summary of the security concept					
	explain the priciples of the design process					
	describe and illustrate the bhaviour of memers in	tension, compression and bending				
Skills	Students can rate and apply the material steel appropiately with respect to its properties and usage.					
	They can use the security concept with respect to loads	, forces and resistances.				
	They can check the ultimate limit state and the services	ability of simple members in tension,	compression and	bending.		
Personal Competence						
Social Competence	After participation of an optional course (building of a	simple truss) they are able to organ	ize themselves in	groups. They will be		
	successful in guided building a truss with bolted connec	tions according to design drawings.				
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	120 minutes					
scale						
Assignment for the	General Engineering Science (German program, 7 seme	ester): Specialisation Civil Engineering	g: Compulsory			
Following Curricula	Civil- and Environmental Engineering: Core qualification	: Compulsory				
	General Engineering Science (English program, 7 seme	ster): Specialisation Civil Engineering	: Compulsory			

Course L0299: Steel Structur	res I
Тур	Lecture
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	Introduction to steel constructions  Materials  Design and security model  Tension rods  Beams (elsatic and plastic design  Column design  Bolted connections
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 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 M0728: Hydro	omechanics and	l Hydrology				
Courses						
Title Hydrology (L0909) Hydrology (L0956) Hydromechanics (L0615) Hydromechanics (L0616)				Typ Lecture Project-/problem-based Learning Lecture Project-/problem-based Learning	Hrs/wk 1 1 2 1	CP 1 2 2
Module Responsible	Prof. Peter Fröhle			Troject/problem basea zeaming		-
Admission Requirements						
Recommended Previous		III				
Knowledge	Mechanics I und II					
<b>Educational Objectives</b>	After taking part succ	essfully, students have r	eached the followi	ng learning results		
Professional Competence						
Knowledge	The students are able to define the basic terms of hydromechanics, hydrology groundwater hydrology and water management. They are able to derive the basic formulations of i) hydrostatics, ii) kinematics of flows and iii) conservation laws and to describe and quantify the relevant processes of the hydrological water cycle. Besides, the students can describe the main aspects of rainfall-run-off-modelling and of established reservoir / storage models as well as the concepts of the determination of a unit-hydrograph.					
Skills		to apply the fundament nd document basic hydra		hydromechanics to basic practica	al problems. Fi	urthermore, they are
	Besides, they are able to apply basic hydrological approaches and methods to simple hydrological problems. The students have the capability to exemplarily apply simple reservoir/storage models and a unit-hydrograph to given problems.  In addition, the basic concepts of field-measurements of hydrological and hydrodynamic values can be described and the students are able to perform, analyze and assess respective measurements.					
Personal Competence						
Social Competence	The students are able to work in groups in a goal-orientated, structured manner. They can explain their results sustainably in plenary sessions by use of peer learning approaches. Furthermore, they are able to prepare and present technical presentations for given topics in groups.					
Autonomy	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	Independent Study Ti	Independent Study Time 110, Study Time in Lecture 70				
Credit points	6					
Course achievement	Yes None	Form Group discussion	Hydrologie ir	ine Posters zu einer Themat	ik aus dem	Themengebiet der
	Yes None Yes None		andDurchführun	ben Hydrologie g, Dokumentation und Präs	sentation zu	einem Versuchs
Production (1	Multipa au au	practical work	нуаготесна	nik oder Hydraulik in Gruppen		
Examination Examination duration and						
examination duration and scale	150 minutes					
Assignment for the	General Engineering	Science (German program	m 7 semester). Sn	ecialisation Civil Engineering: Co	mnulsory	
Following Curricula	Civil- and Environmen General Engineering S	ital Engineering: Core qu Science (English program	alification: Compu n, 7 semester): Spe	Isory ecialisation Civil Engineering: Cor		
	,	: Specialisation Traffic Pl agement - Major in Logis	,	ns: Elective Compulsory  Specialisation Traffic Planning and	d Systems: Ele	ctive Compulsory

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

Course L0956: Hydrology	
Тур	Project-/problem-based Learning
Hrs/wk	1
СР	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
СР	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 Conservation of Energy 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	Course L0616: Hydromechanics		
Тур	Project-/problem-based Learning		
Hrs/wk	1		
СР	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		

Module M0706: Geote	echnics 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	Prof. Jürgen Grabe					
Admission Requirements	None					
Recommended Previous	Modules :					
Knowledge	Mechanics I-II					
Educational Objectives	After taking part succ	essfully, students	have reached the following	ng learning results		
Professional Competence						
Knowledge	The students know th	e basics of soil m	echanics as the structure	and characteristics of soil, s	tress distribution	due to weight, water
	or structures, consolid	or structures, consolidation and settlement calculations, as well as failure of the soil due to ground- or slope failure.				
Skills	After the successful of	After the successful completion of the module the students should be able to describe the mechanical properties and to evaluate				
	them with the help of geotechnical standard tests. They can calculate stresses and deformation in the soils due to weight or					
	influence of structures. They are are able to prove the usability (settlements) for shallow foundations.					
Damanal Committee						
Personal Competence						
Social Competence						
Autonomy						
Workload in Hours	Independent Study Ti	me 96, Study Tim	ie in Lecture 84			
Credit points						
Course achievement	Compulsory Bonus	Form	Description			
	No 20 %	Attestation				
Examination						
Examination duration and	60 minutes					
scale						
Assignment for the				ecialisation Civil Engineering	: Compulsory	
Following Curricula			Core qualification: Compu	•		
			raffic Planning and System			
	Technomathematics:	Specialisation III.	Engineering Science: Elec	tive Compulsory		
	Engineering and Mana	agement - Major i	n Logistics and Mobility: S	pecialisation Traffic Planning	and Systems: Ele	ective Compulsory

Course L0550: Soil Mechanic	s
Тур	Lecture
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	<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	ourse L0551: Soil Mechanics		
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	ourse L1493: Soil Mechanics		
Тур	Recitation Section (small)		
Hrs/wk	2		
СР	2		
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28		
Lecturer	Prof. Jürgen Grabe		
Language	DE		
Cycle	WiSe/SoSe		
Content	See interlocking course		
Literature	See interlocking course		

Module M0579: Struct	tural Design			
Courses				
Title	Тур		Hrs/wk	СР
Basics in Structural Design (L0209) Basics of Structural Design (L0205)	Project-/proble  Lecture	em-based Learning	2	4
Basics in Structural Design (L0208)	Recitation Sect	tion (large)	1	1
	Thomas Kölzer			
Admission Requirements	None			
Recommended Previous	Contents of module "Principles of Building Materials and Building Physics"			
Knowledge				
<b>Educational Objectives</b>	After taking part successfully, students have reached the following learning res	sults		
<b>Professional Competence</b>				
Knowledge	After attending the "Building Construction" module students are able			
	to define the basics of building regulations law			
	to explain load effects and associated concepts			
	to describe overriding conventions of the construction industry			
	<ul> <li>to specify typical building components</li> </ul>			
	<ul> <li>to distinguish between different possibilities of load bearing behaviour a</li> </ul>	ind risks due to lac	k of stability	
	<ul> <li>to explain the main objectivs of fire control.</li> </ul>			
Skills	After the successful completion of the "Building Construction" module, student	s will be able		
	to apply industry-specific drawing conventions			
	carry out preliminary dimensioning of basic building components			
	develop stability and foundation concepts			
	use BIM software			
	and to design and construct standard cross-sections due to structural as	spects.		
Personal Competence				
Social Competence	After attending the course students are able			
	to work in a team and to persent the results of the team work			
	• to use the feedback from other students to improve the own results			
	to give a feedback to other students in a constructive manner			
Autonomy	After attending the course students are able			
	to control and improve their knowledge with the help of weeekly present	tations (lecture roc	m) and tests	(STUD.IP)
	to divide the main task in different parts, to deduce the needed knowled			
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 scale	Desing, Construction and prelimnary design in a written form			
Assignment for the	General Engineering Science (German program, 7 semester): Specialisation Civ	vil Engineering: Co	mnulsory	
Following Curricula	Civil- and Environmental Engineering: Core qualification: Compulsory	vii Liigiileeliiig. Col	i i ipuisui y	
i onowing culticula		il Engineering: Con	npulsory	
	General Engineering Science (English program, 7 semester): Specialisation Civi	il Engineering: Con	npulsory	

Course L0209: Basics in Stru	ictural Design
Тур	Project-/problem-based Learning
Hrs/wk	2
СР	4
Workload in Hours	Independent Study Time 92, Study Time in Lecture 28
Lecturer	
Language	DE
Cycle	
Content	
	Constructing a small individuell building in groups of 4 persons
	Analysing the informations and the contents of development plans and building regulation laws  Analysing the informations and the contents of the functionality (see law fooder reaf).
	<ul> <li>Design of building components and approving of the funcionality (sealing, facades, roofs)</li> <li>Design and approve of the funcionality of the component interconnections</li> </ul>
	Proofing and assessing of moisture behaviour, energy comsumption, acoustic protection and fire control
	Assessing the building stabilty
	Basics of building services
	Each week the results of different work steps are presented in oral and written form
Literature	Vortragsfolien der Lehrveranstaltung stehen über STUD.IP zum download zur Verfügung
	L
	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
	The State 1. E.G. Teasher Verlag / GWV Tachverlage Glishi, Westaden, 2000
	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
	Plada Mara (Wannah Biidina)
	<b>Dierks, Klaus</b> (Wormuth, Rüdiger.)  Baukonstruktion: [Einführung, Grundlagen, Gründungen, technische Ausrüstung, Wände, Geschossdecken, Treppen, Dächer,
	Fenster, Türen, Konstruktionsatlas]
	ISBN: 3804150454 (Gb.) ISBN: 978-3-8041-5045-4
	Neuwied : Werner, 2007
	Schneider, Klaus-Jürgen (Goris, Alfons.; Berner, Klaus)
	Bautabellen für Ingenieure : mit Berechnungshinweisen und Beispielen ; [auf CD-ROM: Stabwerksprogramm IQ 100 B, Tools für
	den konstr. Ingenieurbau, Fachinformationen, Normentexte]
	ISBN: 3804152287
	Neuwied : Werner, 2006
	Wendehorst, Reinhard (Wetzell, Otto W.,; Baumgartner, Herwig,; Deutsches Institut für Normung)
	Wendehorst, Reimard (Wetzell, Otto W.,, Badingarther, Herwig,, Deutsches institut für Normung) Wendehorst Bautechnische Zahlentafeln
	ISBN: 978-3-8351-0055-8 ISBN: 3835100556
	Stuttgart [u.a.] : Teubner Berlin [u.a.] : Beuth, 2007
	Neufert, Ernst (Kister, Johannes)
	Bauentwurfslehre : Grundlagen, Normen, Vorschriften über Anlage, Bau, Gestaltung, Raumbedarf, Raumbeziehungen, Maße fü
	Gebäude, Räume, Einrichtungen, Geräte mit dem Menschen als Maß und Ziel ; Handbuch für den Baufachmann, Bauherrn
	Lehrenden und Lernenden
	ISBN: 978-3-8348-0732-8 (GB.)
	Wiesbaden : Vieweg + Teubner, 2009

Course L0205: Basics of Stru	ctural Design
Тур	Lecture
Hrs/wk	2
СР	1
Workload in Hours	Independent Study Time 2, Study Time in Lecture 28
Lecturer	
Language	
Cycle	
Content	Wide
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
Libonobuno	Marker refallor der Laberrarenskalkring stehen über CTUD ID zuge derrolend zur Verführung
Literature	Vortragsfolien der Lehrveranstaltung stehen über STUD.IP zum download zur Verfügung
	Schneider Bautabellen (Hrsg. A. Albert)
	23., überarbeitete Aufl.
	ISBN 978-3-8462-0880-9
	Reguvis Fachmedien GmbH, 2018
	Neumann, Dietrich (Hestermann, U.; Rongen, L.; Weinbrenner, U.)
	Frick/Knöll Baukonstructionslehre 1 / [Internet-Ressource]
	ISBN: 978-3-8351-9121-1
	Wiesbaden: Vieweg+Teubner Verlag, 2006
	Frick, Otto (Knöll, K.; Neumann, D.; Hestermann, U.; Rongen, L.)
	Baukonstruktionslehre 2 / [Internet-Ressource]
	ISBN: 978-3-8348-9486-1
	Wiesbaden: Vieweg+Teubner Verlag, 2008
	Dierks, Klaus (Wormuth, R.)
	Baukonstruktion
	ISBN: 978-3-8041-5045-4
	Neuwied : Werner, 2007
	Neufert, Ernst (Kister, J.)
	Bauentwurfslehre (42. Aufl.)
	ISBN: 978-3-8348-0732-8
	Wiesbaden : Vieweg + Teubner, 2018
	Wendehorst, Reinhard (Wetzell, O. W.,; Baumgartner, H.,)
	Wendehorst Bautechnische Zahlentafeln
	ISBN: 978-3-8351-0055-8
	Stuttgart/Berlin: Teubner/Beuth, 2018

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

Module M0631: Reinfo	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 Rombac	h				
Admission Requirements	None					
Recommended Previous Knowledge	3	loads on structure by format are requ	es and combination of actionized.	ons		
			and columns for ultimate li	imit state		
	3	3	tructures I, Structural Ana			
Educational Objectives	After taking part succ	cessfully, students	have reached the followi	ng learning results		
Professional Competence						
Knowledge	The students know t	he basic principle	es which are required for	design of reinforced concr	ete structures. Th	ey 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					
	serviceability limit state (crack and deflection control) including detailing (anchorage and links etc.).					
	The students of	The students can estimate the member forces of simple slabs.				
	The students l	now the content	and the layout of a structu	ıral analysis		
Personal Competence						
Social Competence	Cooperation in a proi	ect work where t	hey design in a team a rea	al concrete building and pre	sent the results at	the end
Autonomy	ocoperation in a proj	eet work, where t	ney acoign in a ceam a rec	ar corrected barraing and pre	serie and results de	and and
Workload in Hours	Independent Study T	ime 110, Study Ti	me in Lecture 70			
Credit points						
Course achievement	Compulsory Bonus	Form	Description			
	Yes None	Excercises				
Examination	Written exam					
Examination duration and	120 minutes					
scale						
Assignment for the	General Engineering	Science (German	program, 7 semester): Sp	ecialisation Civil Engineerin	g: Elective Compul	sory
Following Curricula	General Engineering	Science (German	program, 7 semester): Sp	ecialisation Civil Engineerin	g: Elective Compul	sory
		3 3	Core qualification: Compu	,		
			Specialisation Civil Engine			
			•	Mobility: Elective Compulsor	•	
			•	Environment: Elective Comp	-	
	General Engineering	Science (English p	program, 7 semester): Spe	ecialisation Civil Engineering	g: Elective Compuls	ory

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

Course L0348: Concrete Structures II		
Тур	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	Design of concrete members for shear, punching and torsion Design for serviceability limit state (durability): crack- and deflection control Detailing Design of discontinuity regions (e.g. corbels, frame corner) design of footings Introduction in the design of slabs Layout and content of a structural design	
Literature	<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	

Module M1634: Structural Mechanics				
Courses				
Title		Тур	Hrs/wk	СР
Stuctural Mechanics (L2475)		Integrated Lecture	2	3
Module Responsible	Prof. Christian Cyron			
Admission Requirements	None			
Recommended Previous				
Knowledge				
Educational Objectives	After taking part successfully, students have reached the foll	owing learning results		
Professional Competence				
Knowledge				
Skills				
Personal Competence				
Social Competence				
Autonomy				
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 Civil Engineering: Compulsory			
Following Curricula	Civil- and Environmental Engineering: Specialisation Civil Eng	gineering: Compulsory		

Course L2475: Stuctural Mechanics		
Тур	Integrated Lecture	
Hrs/wk	2	
СР	3	
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28	
Lecturer	Prof. Christian Cyron	
Language	DE	
Cycle	SoSe	
Content		
Literature		

Module M1629: Geoinformation Science				
Courses				
Title		Тур	Hrs/wk	СР
Introduction to Geoinformation Scient	ence (L2465)	Project-/problem-based Learning	3	3
Module Responsible	Prof. Peter Fröhle			
Admission Requirements	None			
Recommended Previous	Principles of analysis and linear algebra			
Knowledge				
Educational Objectives	After taking part successfully, students have reache	ed the following learning results		
Professional Competence				
Knowledge	The students are able to define the tasks and term	s from the field of application of geo informa	tion systems.	They can report the
	basics, the basic approaches and methods of geo in	formation systems and are able to transfer th	ese to practic	al questions.
Skille	s Students are able to apply the basic methods used in geo-information systems to practical problems. They are able to apply then			able to apply them
JKIII3	to simple applications of geographic information s	, , ,	,	,
	simple GIS project and present their results.	ystems and to dansier them to other pros.		iems can process a
Personal Competence				
Social Competence	The students can work together groups cooperative	ly and productively.		
Autonomy	Students are able to organize their work flow to	prepare themselves before presentations a	nd discussion	. They can acquire
,	appropriate knowledge by making enquiries indepe			, ,
	Independent Study Time 48, Study Time in Lecture	42		
Credit points				
Course achievement	None			
	Subject theoretical and practical work			
	Computer aided GIS-Application and written-theoretical part			
scale				
_	General Engineering Science (German program, 7 semester): Specialisation Civil Engineering: Compulsory			
Following Curricula	Civil- and Environmental Engineering: Specialisation			
	Civil- and Environmental Engineering: Specialisation	Water and Environment: Compulsory		

Course L2465: Introduction to Geoinformation Science		
Тур	roject-/problem-based Learning	
Hrs/wk	3	
СР	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			3
Module Responsible	Prof. Marcus Rutner			
Admission Requirements	None			
Recommended Previous	Steel Structures I			
Knowledge				
<b>Educational Objectives</b>	After taking part successfully, students have reached the	e following learning results		
Professional Competence				
Knowledge	After successful completition students can			
	a describe and explain the behaviour of helted and	wolded connections		
	describe and explain the behaviour of bolted and welded connections  design and the algebraic halfs and buildings.			
	<ul> <li>design and check simple halls and buildings</li> <li>calculate forces and stresses of simple structures (trusses, beams, frames)</li> </ul>			
	illustrate and dimension he main details (framework)		into)	
	• illustrate and dimension he main details (framewo	irk, coluitiii base, load application po	IIILS)	
Skills	Students are able to design simple structures and connections, describe the load distribution and recognize the possible modes of			
	failure. They can apply structural imperfections, calculat	e according to 2nd order theory and	verify their results	i.
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	120 minutes			
scale				
Assignment for the	General Engineering Science (German program, 7 semes	ster): Specialisation Civil Engineering	: Elective Compul	sory
Following Curricula	Civil- and Environmental Engineering: Core qualification:	Compulsory		
	Civil- and Environmental Engineering: Specialisation Civi	l Engineering: Compulsory		
	Civil- and Environmental Engineering: Specialisation Traf	fic and Mobility: Elective Compulsory	,	
	Civil- and Environmental Engineering: Specialisation Wat	er and Environment: Elective Compu	Isory	

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

Course L0302: Steel Structures II	
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	SoSe
Content	See interlocking course
Literature	See interlocking course

Module M0755: Geote	echnics II				
Courses					
Title		Тур	Hrs/wk	СР	
Foundation Engineering (L0552)		Lecture	2	2	
Foundation Engineering (L0553)		Recitation Section (large)	2	2	
Foundation Engineering (L1494)		Recitation Section (small)	2	2	
Module Responsible	Prof. Jürgen Grabe				
Admission Requirements	None				
Recommended Previous	Modules:				
Knowledge	Mechanics I-II				
	Geotechnics I				
	• Geotechnics i				
-	After taking part successfully, students have re	eached the following learning results			
Professional Competence					
	The students know the basic principles and methods which are required to verificate the stability of geotechnical structures.				
Skills	After successful completion of the module the students are able to:				
	verificate the stability and usability of for	<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.		,		
Personal Competence					
Social Competence					
Autonomy					
Workload in Hours	Independent Study Time 96, Study Time in Lec	ture 84			
Credit points	6				
Course achievement		Description			
	No 20 % Attestation				
	Written exam				
Examination duration and	60 minutes				
scale					
Assignment for the				•	
Following Curricula	General Engineering Science (German program	n, 7 semester): Specialisation Civil Engineerin	g: Elective Compul	sory	
	Civil- and Environmental Engineering: Core qua				
	Civil- and Environmental Engineering: Specialis	ation Civil Engineering: Compulsory			
	Civil- and Environmental Engineering: Specialis	sation Traffic and Mobility: Elective Compulso	ry		
	Civil- and Environmental Engineering: Specialis	sation Water and Environment: Elective Comp	oulsory		
	General Engineering Science (English program	, 7 semester): Specialisation Civil Engineering	g: Elective Compuls	sory	
	Technomathematics: Specialisation III. Enginee	ring Science: Elective Compulsory			

Course L0552: Foundation En	agineering
Тур	Lecture
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	<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	Course L0553: Foundation Engineering		
Тур	Recitation Section (large)		
Hrs/wk	2		
СР	2		
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28		
Lecturer	Prof. Jürgen Grabe		
Language	DE		
Cycle	WiSe/SoSe		
Content	See interlocking course		
Literature	See interlocking course		

Course L1494: Foundation E	ourse L1494: Foundation Engineering			
Тур	Recitation Section (small)			
Hrs/wk	2			
СР	2			
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28			
Lecturer	Prof. Jürgen Grabe			
Language	DE			
Cycle	WiSe/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 Engineeri	ng and Material Engineering		
Courses				
Title		Тур	Hrs/wk	СР
Introduction into Process Engineering	ng/Bioprocess Engineering (L0829)	Lecture	2	1
Fundamentals of material engineer	ring (L0830)	Lecture	2	2
Module Responsible	Prof. Michael Schlüter			
Admission Requirements	None			
Recommended Previous	none			
Knowledge				
Educational Objectives	After taking part successfully, students have	e reached the following learning results		
Professional Competence				
Knowledge	After passing this module the students have	the ability to:		
	give an overview of the most importa	int fields on process and bioprocess engineer	ing,	
	explain some working methods for displaying the second secon	fferent fields in process engineering.		
Skills	After passing this module the students shou	lld have the ability to:		
Skills	Arter pussing this module the students shou	nd have the ability to.		
	<ul> <li>list and outline the most important field</li> </ul>	elds of process engineering,		
	<ul> <li>name the most important working ap</li> </ul>	proaches or methods of the different fields o	f process engineering,	
	<ul> <li>read and prepare an engineering drag</li> </ul>	wing,		
	explain the most important technologies for wastewater and exhaust air treatment			
	• scheme typical chemical and biotechnological processes independently with the aid of pointers.			
Personal Competence				
-	The students are able to			
,				
	<ul> <li>work out results in groups and docum</li> </ul>			
	provide appropriate feedback and handle feedback on their own performance constructively.			
Autonomv	The students are able to estimate their pro	ogress of learning by themselves and to del	iberate their lack of k	nowledge in Process
,	Engineering and Bioprocess Engineering.	3		
Workload in Hours	Independent Study Time 34, Study Time in I	Lecture 56		
Credit points				
Course achievement		Description		
Francisco de la	No 5 % Written elaboration			
Examination				
	90 min			
Scale	Conoral Engineering Science (Cormon and	ram 7 competer). Specialization Process Fac	incoring: Compulser:	
-	General Engineering Science (German progr	· · ·		un/
Following Curricula	Bioprocess Engineering: Core qualification: (	ram, 7 semester): Specialisation Bioprocess E	ingineering: Compulso	n y
	Orientation Studies: Core qualification: Elect	' '		
	Process Engineering: Core qualification: Con	• •		
	Trocess Engineering. Core qualification: Con	привогу		

Course L0829: Introduction into Process Engineering/Bioprocess Engineering			
Тур	Lecture		
Hrs/wk	2		
СР	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	of material engineering
Тур	Lecture
Hrs/wk	2
СР	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>

Module M1497: Measo	urement Techn	ology for VT/ I	BVT			
Courses						
<b>Title</b> Practical Course Measurement Tech	nnology (L2270)			<b>Typ</b> Practical Course	Hrs/wk	<b>CP</b> 2
Measurement Technology (L2268)				Lecture	2	2
Physical Fundamentals of Measurer	ment Technology (L2269	)		Lecture	2	2
Module Responsible	Prof. Alexander Penn	Prof. Alexander Penn				
Admission Requirements	None					
Recommended Previous	Technical interest, log	gical skills, integral-	and differential calcu	lus, basic physical cond	epts such as temperat	ture, mass, velocity,
Knowledge	etc					
Educational Objectives	After taking part succ	essfully, students ha	ve reached the follow	ing learning results		
Professional Competence	31			3 3		
-	Physical basics: kine magnetism, basics of	-		n), rotation of rigid bo eal gas.	odies, energy and mo	mentum, electricity,
				nty, basics of sensor te v measurement. Usage of		nciples, temperature
				ta acquisition, flow mea s, spectroscopy, error ca		
Skills	Literature research, categorisation of thematical topics, analysis of an experimental test stand, preparation of test protocol, first programming with Matlab, use of relevant laboratory measurement technology, preparation of a test protocol, execution of calculations.					
Personal Competence Social Competence	Arrangement and division of work in practical training and learning groups, assessment of own level of knowledge, work on the experimental stand in groups, consultation with persons responsible for teaching, presentation of the preparation of the experiment, tolerance of frustration					
Autonomy	Time management of the workload, independent development of the thematic basics, personal responsibility for the provision of protective equipment and work clothing, practice of presentation in front of a group, active participation in the lectures, formulation of enquiries/detailed questions by using clicker.					
Workload in Hours	Independent Study Ti	me 96, Study Time ir	n Lecture 84			
Credit points	6					
Course achievement	Compulsory Bonus	Form	Description	.,		
	No 20 %	Excercises	Popup-Quizz	es währen der Vorlesun	g	
	Written exam					
Examination duration and scale	120 min					
Assignment for the	General Engineering	Science (Gorman are	gram 7 semostor). C	pecialisation Process Eng	nineering: Compulsory	
Following Curricula			-	pecialisation Process Eng pecialisation Process Eng		
1 ollowing curricula			-	pecialisation Bioprocess		irv
			-	pecialisation Green Tech		
					gpa	
		Bioprocess Engineering: Core qualification: Compulsory  General Engineering Science (English program, 7 semester): Specialisation Process Engineering: Compulsory				
	Green Technologies: I			_	- , ,	
	-	Orientation Studies: Core qualification: Elective Compulsory				
	Process Engineering:	rocess Engineering: Core qualification: Compulsory				

Course L2270: Practical Cour	se 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
СР	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Prof. Alexander Penn
Language	DE
Cycle	WiSe
Content	Basic introduction to measurement technology for process engineers. Includes error calculation, measurement units, calibration, measurement data analysis, measurement techniques and sensors. Particular attention is paid to the measurement of temperature, pressure, flow and level. The lecture provides insights into the latest developments in sensor technology in measurement technology and process engineering.
Literature	Fraden, Jacob (2016): Handbook of Modern Sensors. Physics, Designs, and Applications. 5th ed. 2016. Cham, New York: Springer. Online verfügbar unter http://search.ebscohost.com/login.aspx?direct=true&scope=site&db=nlebk&AN=1081958.  Hering, Ekbert; Schönfelder, Gert (2018): Sensoren in Wissenschaft und Technik. Funktionsweise und Einsatzgebiete. 2. Aufl. 2018. Online verfügbar unter http://dx.doi.org/10.1007/978-3-658-12562-2.  Strohrmann, Günther (2004): Messtechnik im Chemiebetrieb. Einführung in das Messen verfahrenstechnischer Größen. 10., durchges. Aufl. München: Oldenbourg.  Tränkler, Hans-Rolf; Reindl, Leonhard M. (2014): Sensortechnik. Handbuch für Praxis und Wissenschaft. 2., völlig neu bearb. Aufl. Berlin: Springer Vieweg (VDI-Buch). Online verfügbar unter http://dx.doi.org/10.1007/978-3-642-29942-1.  Webster, John G.; Eren, Halit B. (2014): Measurement, Instrumentation, and Sensors Handbook, Second Edition. Electromagnetic, Optical, Radiation, Chemical, and Biomedical Measurement. 2nd ed. Hoboken: Taylor and Francis. Online verfügbar unter http://gbv.eblib.com/patron/FullRecord.aspx?p=1407945.

Course L2269: Physical Fund	ourse 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				

Module M0536: Fund	amentals of Fluid Mechanics			
Courses				
		<del>-</del>	Hara tarda	
<b>Fitle</b> Fundamentals of Fluid Mechanics (	10001)	<b>Typ</b> Lecture	Hrs/wk 2	<b>CP</b> 4
Fluid Mechanics for Process Engine		Recitation Section (large)	2	2
Module Responsible				
Admission Requirements				
Recommended Previous	None			
Knowledge	Mathematics I+II+III			
Kilowieuge	Technical Mechanics I+II			
	Technical Thermodynamics I+II			
	Working with force balances			
	Simplification and solving of partial differential e	equations		
	Integration			
Educational Objectives	After taking part successfully, students have reached t	he following learning results		
Professional Competence				
•	Students are able to:			
	explain the difference between different types of			
	give an overview for different applications of the			
	<ul> <li>explain simplifications of the Continuity- and Na</li> </ul>	vier-Stokes-Equation by using physical	boundary conditi	ons
Skills	The students are able to			
	describe and model incompressible flows mathe	•		
	reduce the governing equations of fluid mechan     retire the dependency between theory and tool		ative solutions e.	g. by integration
	notice the dependency between theory and tecl     was the learned basis for fluid dynamical applies			
	<ul> <li>use the learned basics for fluid dynamical applic</li> </ul>	actions in fields of process engineering		
Personal Competence				
Social Competence	The students			
	are capable to gather information from subject	related preferrional publications and	rolate that inform	action to the contovt
	of the lecture and	related, professional publications and	relate that illioni	iation to the context
	able to work together on subject related tasks	in small groups. They are able to pres	ent their results (	effectively in English
	(e.g. during small group exercises)	Sinan groups. They are able to pres	cite circle results .	anceavery in English
	are able to work out solutions for exercises by the second s	nemselves, to discuss the solutions ora	lly and to present	the results.
			,	
Autonomy	The students are able to			
	<ul> <li>search further literature for each topic and to ex</li> </ul>	pand their knowledge with this literatu	re,	
	work on their exercises by their own and to eval			
	*	-		
Workload in Hours	Independent Study Time 124, Study Time in Lecture 5	5		
Credit points				
Course achievement	Compulsory Bonus Form Des Yes 5 % Midterm	cription		
Evamination				
Examination Examination duration and				
	3 nours			
scale Assignment for the	General Engineering Science (German program, 7 sem	octor). Specialisation Process Engineer	ing: Compulsor:	
Following Curricula				n/
i onowing curricula	General Engineering Science (German program, 7 sem			• 7
	General Engineering Science (German program, 7 sem			ing: Compulsory
	Bioprocess Engineering: Core qualification: Compulsor		c.i.c.i Eligineel	
	Energy and Environmental Engineering: Core qualificat			
	Green Technologies: Energy, Water, Climate: Core qua			
	Logistics and Mobility: Specialisation Traffic Planning a			
	Technomathematics: Specialisation III. Engineering Sci			
	Process Engineering: Core qualification: Compulsory			
	Engineering and Management - Major in Logistics and	Mobility: Specialisation Traffic Planning	and Systems: Ele	ctive Compulsory
				-

Course L0091: Fundamentals	of Fluid Mechanics
Тур	Lecture
Hrs/wk	2
СР	4
Workload in Hours	Independent Study Time 92, Study Time in Lecture 28
Lecturer	Prof. Michael Schlüter
Language	DE
Cycle	SoSe SoSe
Content	<ul> <li>fluid properties</li> <li>hydrostatic</li> <li>overall balances - theory of streamline</li> <li>overall balances- conservation equations</li> </ul>
	differential balances - Navier Stokes equations irrotational flows - Potenzialströmungen flow around bodies - theory of physical similarity turbulent flows compressible flows
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
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>

Module M0544: Phase	Equilibria Thermodynamics			
Courses				
Title Phase Equilibria Thermodynamics (		Typ Lecture	Hrs/wk	<b>CP</b> 2
Phase Equilibria Thermodynamics ( Phase Equilibria Thermodynamics (		Recitation Section (small)  Recitation Section (large)	1 1	2
Module Responsible	Prof. Irina Smirnova			_
Admission Requirements	None			
Recommended Previous	Mathematics, Physical Chemistry, Thermodynamic	cs I and II		
Knowledge				
Educational Objectives	After taking part successfully, students have reach	hed the following learning results		
Professional Competence				
Knowledge	Starting from the very basics of thermody equilibria. They learn how state variables are influenthese properties. Moreover, the students learn how phase different phases (vapor, liquid, solid) coexis For different phase equilibria, several exaknowledge for plotting and interpreting the	equilibria can be described mathematically st in equilibrium. Furthermore the fundamentamples relevant for different kinds of pro	rn concepts to qu and which phen ntals of reaction e	omena may occur if quilibria are taught.
Skills	<ul> <li>Applying their knowledge, the students are able to identify the correct equation for the determination of the equilibrium 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 they 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 well as 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 many separation and reaction processes in chemical engineering.</li> </ul>			
Personal Competence Social Competence Autonomy	The students are able to work in small groups, to other students  The students are able to find necessary info  During the semester the students are all knowledge the students can adept their lea	ormation self-reliantly in literature sources ole to check their learning progress cont	and to judge their	quality.
Workload in Hours	Independent Study Time 124, Study Time in Lectu	ıre 56		
Credit points	6			
Course achievement	None			
Examination	Written exam			
Examination duration and	120 minutes; theoretical questions and calculation	ns		
scale				
	General Engineering Science (German program, 7			
Following Curricula	General Engineering Science (German program, 7			•
	General Engineering Science (German program, 7 Compulsory	semester): specialisation Green Technolog	nes, rocus Kenew	able Ellergy: Elective
	Bioprocess Engineering: Core qualification: Compu	ulsory		
	Green Technologies: Energy, Water, Climate: Spec		Compulsory	
	Green Technologies: Energy, Water, Climate: Spec			
	Process Engineering: Core qualification: Compulso	pry		

Course L0114: Phase Equilibria Thermodynamics				
Тур	Lecture			
Hrs/wk	2			
СР	2			
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28			
Lecturer	Prof. Irina Smirnova			
Language	DE			
Cycle	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 rd ed. Prentice Hall, 1997.J.P. O'Connell, J.M. Haile: Thermodynamics. Cambridge University Press, 2005.</li> </ul>			

Course L0140: Phase Equilib	Course L0140: Phase Equilibria Thermodynamics				
Тур	Recitation Section (small)				
Hrs/wk					
CP					
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. GE-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.  • Jürgen Gmehling, Bärbel Kolbe: Thermodynamik. VCH 1992 • I.M. Prausnitz, R.N. Lichtenthaler, E.G. de Azevedo: Molecular Thermodynamics of Fluid-Phase Equilibria, 3rd ed. Prentice				
	<ul> <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 Equilibria Thermodynamics				
Тур	Recitation Section (large)			
Hrs/wk	1			
СР				
Workload in Hours	Independent Study Time 46, Study Time in Lecture 14			
Lecturer	Prof. Irina Smirnova			
Language	DE			
Cycle	SoSe			
Content	Introduction: Applications of thermodynamics of mixtures     Thermodynamic equations in multi-component systems: Fundamental equations, chemical potential, fugacity     Phase equilibria of pure substances: thermodynamic equilibrium, vapor pressure, Gibbs' phase rule     Equations of state: virial equations, van-der-Waals equation, generalized equations of state     Mixing properties: ideal and real mixtures, excess properties, partial molar properties     Vapor-liquid-equilibria: binary systems, azeotropes, equilibrium condition     Gas-liquid-equilibria: equilibrium condition, Henry-coefficient     GE-Models: Hildebrand-model, Flory-Huggins-model, Wilson-model, UNIQUAC, UNIFAC     Liquid-liquid-equilibria: equilibrium condition, phase equilibria in binary and ternary systems     Solid-liquid-equilibria: equilibrium condition, binary systems     Chemical reactions: reaction coordinate, mass action law, influence of pressure and temperature     Osmotic pressure			
Literature	<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>			

Module M0757: Bioch	emistry and Microbiology			
Courses				
Title Biochemistry (L0351) Biochemistry (L0728) Microbiology (L0881)		pcture oject-/problem-based Learning cture	Hrs/wk 2 1 2	<b>CP</b> 2 1 2
Microbiology (L0888)		pject-/problem-based Learning	1	1
Module Responsible	Prof. Johannes Gescher			
Admission Requirements	None			
Recommended Previous	none			
Knowledge				
<b>Educational Objectives</b>	After taking part successfully, students have reached the following le	earning results		
<b>Professional Competence</b>				
Knowledge	At the end of this module the students can:			
	- explain the methods of biological and biochemical research to dete	ermine the properties of biom	olecules	
	- name the basic components of a living organism			
	- explain the principles of metabolism			
	- describe the structure of living cells			
	-			
Skills				
Personal Competence				
•	The students are able,			
	- to gather knowledge in groups of about 10 students			
	- to introduce their own knowledge and to argue their view in discussions 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 wr	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): Specia	lisation Bioprocess Engineeri	ng: Compulso	ry
Following Curricula	Bioprocess Engineering: Core qualification: Compulsory			
	Green Technologies: Energy, Water, Climate: Specialisation Bioresou	urce Technology: Elective Con	npulsory	
	Orientation Studies: Core qualification: Elective Compulsory			
	Technomathematics: Specialisation III. Engineering Science: Elective	e Compulsory		

Course L0351: Biochemistry	
Тур	Lecture
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Dr. Paul Bubenheim
Language	DE
Cycle	SoSe
Content	The molecular logic of Life     Biomolecules:
	1. Amino acids, peptides, proteins     2. Carbohydrates
	3. Lipids 3. Protein functions, Enzymes:
	Michaelis-Menten kinetics     Enzyme regulation     Enzyme nomenclature
	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 L0728: Biochemistry	
Тур	Project-/problem-based Learning
Hrs/wk	1
СР	1
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	1. 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> 2. 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> 3. 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> <li>extremophiles</li> <li>biotechnology</li> </ul>
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
	• <b>Grundlagen der Mikrobiologie</b> , 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	
СР	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  taxonomy and specific properties of Archaea, Bacteria, and viruses  structure and properties of the cell  growth  2. Metabolism  fermentation and anaerobic respiration  methanogenesis and the anaerobic food chain  degradation of polymers  chemolithotrophy  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
	• <b>Grundlagen der Mikrobiologie</b> , 4. Aufl., 2010, Cypionka, H., Springer Verlag (29,95 €), http://www.grundlagen-der-mikrobiologie.icbm.de/

Module M0938: Biopr	ocess Engineering - Fundamental	S		
Courses				
Title Bioprocess Engineering - Fundamentals (L0841)		<b>Typ</b> Lecture	Hrs/wk	<b>CP</b> 3
Bioprocess Engineering- Fundamen		Recitation Section (large)	2	1
Bioprocess Engineering - Fundamer		Practical Course	2	2
Module Responsible	Prof. Andreas Liese			
Admission Requirements	None			
Recommended Previous	none, module "organic chemistry", module "fund	amentals for process engineering"		
Knowledge				
Educational Objectives	After taking part successfully, students have read	ched the following learning results		
<b>Professional Competence</b>				
	Students are able to describe the basic concepts enzymes and microorganisms, as well as to drheology can be named and mass transport produdamental bioprocess management, sterilization of this module, students and the successful completion of this module, students are able to describe the basic concepts and the students are able to describe the basic concepts and the basic concepts and the basic concepts and the basic concepts are able to describe the basic concepts and the basic concepts are able to describe the basic concepts and the basic concepts are able to describe the basic concepts and the basic concepts are able to describe the basic concepts and the basic concepts and the basic concepts and the basic concepts are also described the basic concepts and the basic concepts are also described the basic concepts and the basic concepts are also described to the basic concepts are also described to the basic concepts are also described the basic concepts are also described the basic concepts are also described to the basic concepts are also described the basic concepts are also described the basic concepts are also described to the basic concepts are also described the basic concepts are also described to the bas	lifferentiate different types of inhibition. Trocesses in bioreactors can be explained. On technology and downstream processing in	The parameters The students ar	of stoichiometry and
	<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 on the 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 microaerobic 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>			
	After completion of this module participants shotake position to their own opinions and increase the following state of the completion of this module participants will	their capacity for teamwork in engineering at be able to solve a technical problem in a to	and scientific envi	ronments.
	workflow and to present their results in a plenun	n.		
Workload in Hours	Independent Study Time 96, Study Time in Lectu	re 84		
Credit points				
Course achievement		<b>Description</b> nd		
Examination	Written exam			
Examination duration and scale	90 min			
Assignment for the	General Engineering Science (German program,	7 semester): Specialisation Process Enginee	ring: Compulsory	
Following Curricula			neering: Compuls	ory
	Bioprocess Engineering: Core qualification: Comp	pulsory		
	Green Technologies: Energy, Water, Climate: Spe			
	Biomedical Engineering: Specialisation Artificial C	· ·	sory	
	Biomedical Engineering: Specialisation Implants			
	Biomedical Engineering: Specialisation Medical To			
	Biomedical Engineering: Specialisation Managem		ompulsory	
	Technomathematics: Specialisation III. Engineerin	· · ·		
	Process Engineering: Core qualification: Compuls	ory		

Course L0841: Bioprocess Engineering - Fundamentals			
Тур	Lecture		
Hrs/wk	2		
СР	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>Technology of sterilization (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 En	
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	
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	

Module M0538: Heat	and Mass Transfer			
Courses				
Title		Тур	Hrs/wk	СР
Heat and Mass Transfer (L0101)		Lecture	2	2
Heat and Mass Transfer (L0102)		Recitation Section (small)	1	2
Heat and Mass Transfer (L1868)		Recitation Section (large)	1	2
Module Responsible	Prof. Irina Smirnova			
Admission Requirements	None			
Recommended Previous	Basic knowledge: Technical Thermodynamics			
Knowledge				
Educational Objectives	After taking part successfully, students have reached th	e following learning results		
Professional Competence				
Knowledge				
	The students are capable of explaining qualitative	e and determining quantitative heat	transfer in proced	lural apparatus (e. g.
	heat exchanger, chemical reactors).			
	They are capable of distinguish and characterize	different kinds of heat transfer med	nanisms namely h	eat conduction, heat
	transfer and thermal radiation.			
	<ul> <li>The students have the ability to explain the p</li> </ul>	hysical basis for mass transfer in	detail and to des	scribe mass transfer
	qualitative and quantitative by using suitable ma			
	They are able to depict the analogy between hear	t- and mass transfer and to describe	complex linked pr	ocesses in detail.
Chille				
Skills	The students are able to set reasonable system	boundaries for a given transport pr	oblem by using th	ne gained knowledge
	and to balance the corresponding energy and ma	ss flow, respectively.		
	They are capable to solve specific heat transfer	problems (e.g. heated chemical rea	ctors, temperature	e alteration in fluids)
	and to calculate the corresponding heat flows.			
	Using dimensionless quantities, the students can	execute scaling up of technical proc	esses or apparatu	S.
	They are able to distinguish between diffusion, co	onvective mass transition and mass	transfer. They car	use this knowledge
	for the description and design of apparatus (e.g.	extraction column, rectification colur	nn).	
	<ul> <li>In this context, the students are capable to choos</li> </ul>	e and design fundamental types of h	neat and mass exc	changer for a specific
	application considering their advantages and disa	dvantages, respectively.		
	<ul> <li>In addition, they can calculate both, steady-state</li> </ul>	and non-steady-state processes in p	rocedural apparat	us.
	The students are capable to connect their kr	nowledge obtained in this course	with knowlegde	of other courses (In
	particular the courses thermodynamics, fluid m	echanics and chemical process eng	gineering) to solv	e concrete technical
	problems.			
Personal Competence				
Social Competence				
Secial competence	The students are capable to work on subject-specified.	cific challenges in teams and to pre	sent the results o	rally in a reasonable
	manner to tutors and other students.			
Autonomy	The students are able to find and evaluate necess	sary information from suitable source	es	
	They are able to prove their level of knowledg	•		ontinuously (clicker
	system, exam-like assignments) and on this basis			continuously (cheker-
	System, examinine assignments/ and on tills pasts	. a.e., can conduct their learning proc	20000.	
Mouldond in Harris	Independent Study Time 124 Study Times in Leakure 50			
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56			
Credit points				
Course achievement				
Examination				
	120 minutes; theoretical questions and calculations			
scale				
Assignment for the	General Engineering Science (German program, 7 seme	ster): Specialisation Process Enginee	ring: Compulsory	
Following Curricula	General Engineering Science (German program, 7 seme			ory
	General Engineering Science (German program, 7 seme	ster): Specialisation Green Technolog	gies: Compulsory	
	General Engineering Science (German program, 7 seme	ster): Specialisation Energy and Envi	romental Engineer	ring: Compulsory
	Bioprocess Engineering: Core qualification: Compulsory			
	Energy and Environmental Engineering: Core qualification	on: Compulsory		
	General Engineering Science (English program, 7 semes	ter): Specialisation Bioprocess Engin	eering: Compulsor	ry
	General Engineering Science (English program, 7 semes	ter): Specialisation Energy and Envir	omental Engineer	ing: Compulsory
	General Engineering Science (English program, 7 semes			-
	Green Technologies: Energy, Water, Climate: Core quali	fication: Compulsory		
	Technomathematics: Specialisation III. Engineering Scie			
	Process Engineering: Core qualification: Compulsory			

Course L0101: Heat and Mass Transfer		
Тур	Lecture	
Hrs/wk	2	
СР	2	
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28	
Lecturer	Prof. Irina Smirnova	
Language	DE	
Cycle	WiSe	
Content	1. Heat transfer  Introduction, one-dimensional heat conduction  Convective heat transfer  Multidimensional heat conduction  Non-steady heat conduction  Thermal radiation  Mass transfer  one-way diffusion, equimolar countercurrent diffusion  boundary layer theory, non-steady mass transfer  Heat and mass transfer single particle/ fixed bed  Mass transfer and chemical reactions	
Literature	H.D. Baehr und K. Stephan: Wärme- und Stoffübertragung, Springer     VDI-Wärmeatlas	

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

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

Module M0546: Therr	mal Separation Processes			
Courses				
Title		Тур	Hrs/wk	СР
Thermal Separation Processes (L01	118)	Lecture	2	2
Thermal Separation Processes (L01	119)	Recitation Section (small)	2	2
Thermal Separation Processes (L01	141)	Recitation Section (large)	1	1
Separation Processes (L1159)	In a contract	Practical Course	1	1
Module Responsible				
Admission Requirements				
Knowledge	Recommended requirements: Thermodynamics III			
Educational Objectives	After taking part successfully, students have reach	ned the following learning results		
Professional Competence				
Knowledge		different bound of annualism and		
	<ul> <li>The students can distinguish and describe adsorption</li> <li>The students develop an understanding for energy demand of a process, the possibilitie</li> <li>They have good knowledge of designing me</li> </ul>	the course of concentration during a se so of energy saving, and the selection of s	paration process, eparation systems	the estimation of the
Personal Competence Social Competence Autonomy	Using the gained knowledge the students of close the associated energy and material bate. The students can use different graphical in theoretical stages required. They can select and design a basic type of disadvantages of the process. The students are capable to obtain indepentables. They can calculate continuous and discontine. The students are able to prove their theoret. The students are able to discuss the theoret colloquium. The students are capable of linking their gained knowledge the students. Other lectures such as thermore technical problems. Other lectures such as thermore the students are able to carry out practication. The students are able to discuss their results.	alances methods for the designing of a separat of thermal separation process for a give indently the needed material properties from the separation processes ical knowledge in the experimental lab with the content of the mowledge with the content of other lecture dynamics, fluid mechanics and chemical its in small groups and present the combinal all lab work in small groups and organize and to document them scientifically in a sided information from suitable sources by	ion process and of en case based on or or appropriate so ork.  experimental work es and use it togetion end results in the togetion and assert end of the	define the amount of the advantages and curces (diagrams and curces) with the teachers in their for the solution of the utorial to the control of the curces are their quality.
Workload in Hours	Independent Study Time 96, Study Time in Lecture	e 84		
Credit points				
Course achievement				
Examination				
	120 minutes; theoretical questions and calculation	S		
Assignment for the Following Curricula	General Engineering Science (German program, 7 Compulsory General Engineering Science (German program, 7 Bioprocess Engineering: Core qualification: Compu Energy and Environmental Engineering: Core quali General Engineering Science (English program, 7 s General Engineering Science (English program, 7 s General Engineering Science (English program, 7 s Green Technologies: Energy, Water, Climate: Spec	semester): Specialisation Bioprocess Eng semester): Specialisation Green Technolo semester): Specialisation Energy and Env Isory fication: Elective Compulsory semester): Specialisation Bioprocess Engine semester): Specialisation Energy and Envi semester): Specialisation Process Enginee ialisation Energy Systems: Elective Comp	ineering: Compulso gies, Focus Renew irromental Enginee neering: Compulso romental Engineer ring: Compulsory ulsory	ory vable Energy: Elective ring: Compulsory ry
	Green Technologies: Energy, Water, Climate: Spec Process Engineering: Core qualification: Compulsor		e compulsory	

Course L0118: Thermal Sepa	ration Processes
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	Introduction in the thermal process engineering and to the main features of separation processes  Simple equilibrium processes, several steps processes  Distillation of binary mixtures, enthalpy-concentration diagrams  Extractive and azeotrope distillation, water vapor distillation, stepwise distillation  Extraction: separation ternary systems, ternary diagram  Multiphase separation including complex mixtures  Designing of separation devices without discrete stages  Drying  Chromatographic separation processes  Membrane separation  Energy demand of separation processes  Advance overview of separation processes  Selection of separation processes
Literature	<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 L0119: Thermal Sepa	ration Processes
Тур	Recitation Section (small)
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Prof. Irina Smirnova
Language	DE
Cycle	WiSe
Content	Introduction in the thermal process engineering and to the main features of separation processes  Simple equilibrium processes, several steps processes  Distillation of binary mixtures, enthalpy-concentration diagrams  Extractive and azeotrope distillation, water vapor distillation, stepwise distillation  Extraction: separation ternary systems, ternary diagram  Multiphase separation including complex mixtures  Designing of separation devices without discrete stages  Drying  Chromatographic separation processes  Membrane separation  Energy demand of separation processes  Advance overview of separation processes  Selection of separation processes  The students work on tasks in small groups and present their results in front of all students.
Literature	<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
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 1984 Ullmann"s Enzyklopädie der Technischen Chemie</li> </ul>

Course L1159: Separation Processes				
Тур	Practical Course			
Hrs/wk	1			
СР	1			
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14			
Lecturer	Prof. Irina Smirnova			
Language	DE/EN			
Cycle	WiSe			
Content	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 devices without discrete stages  Drying  Chromatographic separation processes  Membrane separation  Energy demand of separation processes  Advance overview of separation processes  Selection of separation processes			
Literature	<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>			

Module M0892: Chem	ical Reaction Engineering			
Courses				
Title		Тур	Hrs/wk	СР
Chemical Reaction Engineering (Fu	ndamentals) (L0204)	Lecture	2	2
Chemical Reaction Engineering (Fu		Recitation Section (large)	2	2
Experimental Course Chemical Eng	ineering (Fundamentals) (L0221)	Practical Course	2	2
Module Responsible	Prof. Raimund Horn			
Admission Requirements	None			
Recommended Previous	Contents of the previous modules mathematics I-I	II, physical chemistry, technical thermod	ynamics I+II as w	ell as computational
Knowledge	methods for engineers.			
Educational Objectives	After taking part successfully, students have reach	ed the following learning results		
Professional Competence				
Knowledge	The students are able to explain basic concepts of			
	thermodynamical and kinetical processes. The stu	udents have a strong ability to outline pa	arts of isotherma	l and non-isothermal
	ideal reactors and to describe their properties.			
Skills	After successful completion of the module, student	s are able to:		
	- apply different computational methods to dimens	ion isothermal and non-isothermal ideal re	eactors,	
	- determine and compute stable operation points for these reactors ,			
	- conduct experiments on a lab-scale pilot plants ar	nd document these according to scientific	guidelines.	
Personal Competence				
Social Competence	After successful completition of the lab-course the	students have a strong ability to organiz	e themselfes in s	small groups to solve
	issues in chemical reaction engineering. The stud	ents can discuss their subject related kr	nowledge among	each other and with
	their teachers.			
Autonomy	The students are able to obtain further inform	nation and assess their relevance auto	nomously. Stude	nts can apply their
	knowldege discretely to plan, prepare and conduct	experiments.		
Workload in Hours	Independent Study Time 96, Study Time in Lecture	84		
Credit points	6			
Course achievement	Compulsory Bonus Form	Description		
	Yes None Subject theoretical and			
	practical work			
	Written exam			
Examination duration and .	120 min			
scale				
-	General Engineering Science (German program, 7 s			
Following Curricula	General Engineering Science (German program, 7 s		neering: Compulso	ory
	Bioprocess Engineering: Core qualification: Comput	•	ooring: Compulse:	n.
	General Engineering Science (English program, 7 science (English program, 7 science (English program, 7 science)	· · · · · · · · · · · · · · · · · · ·		ıy
	General Engineering Science (English program, 7 so Green Technologies: Energy, Water, Climate: Speci	- · ·		
	Process Engineering: Core qualification: Compulsor		Compuisory	
	1.10cc35 Engineering. Core qualification. Compulsor	y .		

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

equation, activation energy and pre-exponential factor for komplex reactions, reactions of 0., 1. and 2. order, analytical integration of rate laws, Damköhler-number, differential and integral method of kinetic analysis, laboratory reactors for kinetic measurements, half life, kinetics of complex reactions, parallel reactions, reversible reactions, sequence of reactions, irreversible reaction with pre-equilibrium, reduction of reaction mechanisms, quasi-stationarity principle of Bodenstein, rate limiting step, Michaelis-Menten kinetics, analytical integration of first order differential equations - integrating factor, numerical integration of complex kinetics)

Types of chemical Reaktors (chemical reactors in industry and laboratory, ideal vs. real reaktors, discontinuous, half continuous and continuous reactors, single phase - biphasic- and multiphase reactors, batch-reactor, semi-batch reactor, CSTR, Plug Flow reactor, fixed bed reactor, adiabatic staged reactors, rotating furnaces, fluidized bed reactors, gas-liquid-reactors, multi-phase reactors)

Isothermal ideal reactors (mole-balance of a chemical reactor, mole balance of a batch reactor, integration of the batch reactor mole balance for various kinetics, partial fraction decomposition, mole balance of the semi-batch reactor, mole balance of the plug flow reactor, analogy batch reactor - plug flow reactor, design of plug flow reactors for reactions with volume change and complex reactions, mole balance of a fixed bed reactor, design of a membrane reactor, mole balance of a continuously stirred tank reactor, comparison of CSTR and PFR with respect to conversion and selectivity, mole-balance of a cascade of tank reactors, numerical-interative calculation of a cascade of tank reactors, Newton-Raphson method, graphical analysis of a cascade of tank reactors)

non-isothermal ideal reactors (energy balance of a reactor, adiabatic reactor, adiabatic temperature rise, staged reactor for adiabatic exothermic reactions limited by chemical equilibrium, design of an adiabatic plug flow reactor, Levenspiel-plots, heat transfer through a reactor wall, heat transfer by convection, heat conduction, heat transfer through a cylindrical wall, design of a plug flow reactor in parallel and counter flow, heat balance of the cooling fluid, CSTR with heat exchange, multiple stationary states, ignition-extinction behavior, stability of a CSTR, complex reactions in non-isothermal reactors, optimum temperature profile of a reactor)

## Literature

lecture notes Raimund Horn

skript Frerich Keil

Books:

- M. Baerns, A. Behr, A. Brehm, J. Gmehling, H. Hofmann, U. Onken, A. Renken, Technische Chemie, Wiley-VCH
- G. Emig, E. Klemm, Technische Chemie, Springer
- A. Behr, D. W. Agar, J. Jörissen, Einführung in die Technische Chemie
- E. Müller-Erlwein, Chemische Reaktionstechnik 2012, 2. Auflage, Teubner Verlag
- J. Hagen, Chemiereaktoren: Auslegung und Simulation, 2004, Wiley-VCH
- H. S. Fogler, Elements of Chemical Reaction Engineering, Prentice Hall B
- H. S. Fogler, Essentials of Chemical Reaction Engineering, Prentice Hall
- O. Levenspiel, Chemical Reaction Engineering, John Wiley & Sons, 1998
- L. D. Schmidt, The Engineering of Chemical Reactions, Oxford Univ. Press, 2009
- J. B. Butt, Reaction Kinetics and Reactor Design, 2000, Marcel Dekker
- R. Aris, Elementary Chemical Reactor Analysis, Dover Pubn. Inc., 2000
- 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 Rea	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, irreversible reaction with pre-equilibrium, reduction of reaction mechanisms, quasi-stationarity principle of Bodenstein, rate limiting step, Michaelis-Menten kinetics, analytical integration of first order differential equations - integrating factor, numerical integration of complex kinetics)

Types of chemical Reaktors (chemical reactors in industry and laboratory, ideal vs. real reaktors, discontinuous, half continuous and continuous reactors, single phase - biphasic- and multiphase reactors, batch-reactor, semi-batch reactor, CSTR, Plug Flow reactor, fixed bed reactor, adiabatic staged reactors, rotating furnaces, fluidized bed reactors, gas-liquid-reactors, multi-phase reactors)

Isothermal ideal reactors (mole-balance of a chemical reactor, mole balance of a batch reactor, integration of the batch reactor mole balance for various kinetics, partial fraction decomposition, mole balance of the semi-batch reactor, mole balance of the plug flow reactor, analogy batch reactor - plug flow reactor, design of plug flow reactors for reactions with volume change and complex reactions, mole balance of a fixed bed reactor, design of a membrane reactor, mole balance of a continuously stirred tank reactor, comparison of CSTR and PFR with respect to conversion and selectivity, mole-balance of a cascade of tank reactors, numerical-interative calculation of a cascade of tank reactors, Newton-Raphson method, graphical analysis of a cascade of tank reactors)

non-isothermal ideal reactors (energy balance of a reactor, adiabatic reactor, adiabatic temperature rise, staged reactor for adiabatic exothermic reactions limited by chemical equilibrium, design of an adiabatic plug flow reactor, Levenspiel-plots, heat transfer through a reactor wall, heat transfer by convection, heat conduction, heat transfer through a cylindrical wall, design of a plug flow reactor in parallel and counter flow, heat balance of the cooling fluid, CSTR with heat exchange, multiple stationary states, ignition-extinction behavior, stability of a CSTR, complex reactions in non-isothermal reactors, optimum temperature profile of a reactor)

## Literature

lecture notes Raimund Horn

skript Frerich Keil

Books:

- M. Baerns, A. Behr, A. Brehm, J. Gmehling, H. Hofmann, U. Onken, A. Renken, Technische Chemie, Wiley-VCH
- G. Emig, E. Klemm, Technische Chemie, Springer
- A. Behr, D. W. Agar, J. Jörissen, Einführung in die Technische Chemie
- E. Müller-Erlwein, Chemische Reaktionstechnik 2012, 2. Auflage, Teubner Verlag
- J. Hagen, Chemiereaktoren: Auslegung und Simulation, 2004, Wiley-VCH
- H. S. Fogler, Elements of Chemical Reaction Engineering, Prentice Hall B
- $\hbox{H. S. Fogler, Essentials of Chemical Reaction Engineering, Prentice Hall}\\$
- 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
СР	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Prof. Raimund Horn
Language	DE/EN
Cycle	SoSe 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 Techr	ology						
Courses								
Title Practical Exercise Environmental Te Environmental Technologie (L0326)	33				<b>Typ</b> Practical Course Lecture	Hrs/v 1 2	wk	<b>CP</b> 1 2
Module Responsible		tt						
Admission Requirements	None							
Recommended Previous Knowledge	Fundamentals of inorg	ganic/organ	ic chemistry	and biology				
Educational Objectives	After taking part succe	essfully, stu	udents have	reached the follow	ing learning results			
Professional Competence		-						
Knowledge		nicals in th	e environme		knowledge of environm ive an overview of scie	_		
Skills	determine geochemic	al paramet	ters and to a	ssess the potentia conmental Technology	nitigation measures for I of pollutants to migra	te and transforr	n. The	students are able to
Personal Competence								
Social Competence					tific tasks, both subject- s to discuss their theore			
Autonomy	Students can indepen	dently expl	oit sources a	bout of the subject	t, acquire the particular	knowledge and	tranfer	it to new problems.
Workload in Hours	Independent Study Tir	ne 48, Stu	dy Time in Le	cture 42				
Credit points	3							
Course achievement	Yes None	Form Subject practical	theoretical work	<b>Description</b> and				
Examination	Written exam							
	1 hour							
scale								
Assignment for the					ecialisation Process Eng	-		
Following Curricula		Science (Ge g: Core qu	rman progra alification: El	m, 7 semester): Spective Compulsory				
	General Engineering S General Engineering S	Science (En Science (En Science (En	glish prograr glish prograr glish prograr	n, 7 semester): Spo n, 7 semester): Spo n, 7 semester): Spo	ecialisation Bioprocess E ecialisation Energy and ecialisation Process Eng	Enviromental Er	ngineeri	ng: Compulsory

Typ Practical Course  Hrs/wk 1  CP 1  Workload in Hours Independent Study Time 16, Study Time in Lecture 14  Lecturer Prof. Martin Kaltschmitt, Dr. Isabel Höfer  Language DE  Cycle SoSe  Content The practical course Environmental Engineering currently consists of 6 experiments, which deal with the different focal points environmental engineering in the areas of air, water, soil, environment, biomass and noise. The following experiments are carried out for this purpose:  Determination of the calorific value of biomass,  soil purification,  waste water treatment, noise emissions,
Hrs/wk 1  CP 1  Workload in Hours Independent Study Time 16, Study Time in Lecture 14  Lecturer Prof. Martin Kaltschmitt, Dr. Isabel Höfer  Language DE  Cycle SoSe  Content The practical course Environmental Engineering currently consists of 6 experiments, which deal with the different focal points environmental engineering in the areas of air, water, soil, environment, biomass and noise. The following experiments are carrie out for this purpose:  Determination of the calorific value of biomass, soil purification, waste water treatment,
CP 1  Workload in Hours Independent Study Time 16, Study Time in Lecture 14  Lecturer Prof. Martin Kaltschmitt, Dr. Isabel Höfer  Language DE  Cycle SoSe  Content The practical course Environmental Engineering currently consists of 6 experiments, which deal with the different focal points environmental engineering in the areas of air, water, soil, environment, biomass and noise. The following experiments are carried out for this purpose:  Determination of the calorific value of biomass, soil purification, waste water treatment,
Workload in Hours Independent Study Time 16, Study Time in Lecture 14  Lecturer Prof. Martin Kaltschmitt, Dr. Isabel Höfer  Language DE  Cycle SoSe  Content The practical course Environmental Engineering currently consists of 6 experiments, which deal with the different focal points environmental engineering in the areas of air, water, soil, environment, biomass and noise. The following experiments are carrie out for this purpose:  Determination of the calorific value of biomass,  soil purification,  waste water treatment,
Lecturer Prof. Martin Kaltschmitt, Dr. Isabel Höfer  Language DE  Cycle SoSe  Content The practical course Environmental Engineering currently consists of 6 experiments, which deal with the different focal points environmental engineering in the areas of air, water, soil, environment, biomass and noise. The following experiments are carrie out for this purpose:  Determination of the calorific value of biomass, soil purification, waste water treatment,
Cycle SoSe  Content The practical course Environmental Engineering currently consists of 6 experiments, which deal with the different focal points environmental engineering in the areas of air, water, soil, environment, biomass and noise. The following experiments are carried out for this purpose:  Determination of the calorific value of biomass, soil purification, waste water treatment,
Cycle SoSe  Content The practical course Environmental Engineering currently consists of 6 experiments, which deal with the different focal points environmental engineering in the areas of air, water, soil, environment, biomass and noise. The following experiments are carried out for this purpose:  Determination of the calorific value of biomass, soil purification, waste water treatment,
Content The practical course Environmental Engineering currently consists of 6 experiments, which deal with the different focal points environmental engineering in the areas of air, water, soil, environment, biomass and noise. The following experiments are carried out for this purpose:  Determination of the calorific value of biomass, soil purification, waste water treatment,
environmental engineering in the areas of air, water, soil, environment, biomass and noise. The following experiments are carried out for this purpose:  Determination of the calorific value of biomass, soil purification, waste water treatment,
plastic waste, biowaste.  Translated with www.DeepL.com/Translator (free version)  Within the lab course students discuss the various technical and scientific tasks, both subject-specific and multidisciplinary. The discuss different approaches to the task as well as it's theoretical or practical implementation.
Literature

Course L0326: Environmenta	ıl Technologie
Тур	Lecture
Hrs/wk	2
СР	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Prof. Martin Kaltschmitt, Dr. Isabel Höfer
Language	DE
Cycle	WiSe
Content	1. Introductory seminar on environmental science: 2. Environmental impact and adverse effects 3. Wastewater technology 4. Air pollution control 5. Noise protection 6. Waste and recycling management 7. Soil and ground water protection 8. Renewable energies 9. Resource conservation and energy efficiency
Literature	Förster, U.: Umweltschutztechnik; 2012; Springer Berlin (Verlag) 8., Aufl. 2012; 978-3-642-22972-5 (ISBN)

Courses				
Title		Тур	Hrs/wk	СР
Bioprocess Engineering - Advanced	(L1107)	Lecture	2	4
Bioprocess Engineering - Advanced		Recitation Section (small)	2	2
Module Responsible				
Admission Requirements	None			
Recommended Previous	Content of module "Biochemical Engineering I"			
Knowledge	Content of module Biochemical Engineering (			
Educational Objectives	After taking part successfully, students have rea	ched the following learning results		
•	Arter taking part successionly, students have rea	ched the following learning results		
Professional Competence	After successful completion of this module, study	ante chauld be able to		
Knowieuge	After successful completion of this module, stude	ents should be able to		
	<ul> <li>describe and explain different kinetic appr</li> </ul>	roaches for growth and substrate-uptake		
	<ul> <li>identification of scientific problems with of</li> </ul>	concrete industrial use (cultivation of microor	ganisms and ma	mmalian cells)
	<ul> <li>describe and explain important downstr</li> </ul>	reaming steps for proteins and their applica	ation as well as	basic immobilizatio
	methods			
Skills	After successful completion of this module, stude	ents should be able to		
	- to identifiy scientific questions or possibl	e practical problems for concrete indust	rial applications	(eq cultivation (
	microorganisms and animal cells ) and to formula		паг аррпсасіон	s (eg cultivation (
	Thicroorganisms and animal cens , and to formal	ate solutions ,		
	- To assess the application of scale-up criteria fo	r different types of hioreactors and processe	s and to annly th	nese criteria to give
	<ul> <li>To assess the application of scale-up criteria for different types of bioreactors and processes and to apply these criteria to g problems (anaerobic , aerobic or microaerobically)</li> </ul>			
	problems (anderoble ) deroble of fineroderobledin	,,		
	- to formulate questions for the analysis and opti	imization of real biotechnological production	processes approi	oriate solutions .
	- To describe the effects of the energy generat	ion, the regeneration of reduction equivaler	ts , and the gro	wth inhibition of the
	behavior of microorganisms and to the total ferm			
	- Establish material flow balance equations and	solve them to determine the kinetic param	eters of differer	it approaches and t
	calculate immobilization and activity yields ,			
	- to select process control strategies (batch , fed	-batch , continuity ) appropriately and to cal-	culate basic type	s and evaluate then
Personal Competence				
Social Competence	After completion of this module participants sho	uld be able to debate technical questions in	small teams to e	enhance the ability t
	take position to their own opinions and increase	their capacity for teamwork.		
Autonomy	After completion of this module participants are	able to aquire new sources of knowledge an	d apply their kno	wledge to previousl
	unknown issues and to present these.			
Workload in Hours	Independent Study Time 124, Study Time in Lect	ture 56		
Credit points				
Course achievement				
Examination	Written exam			
<b>Examination duration and</b>	90 min			
scale				
Assignment for the	General Engineering Science (German program,	7 semester): Specialisation Bioprocess Engin	eering: Compulso	ory
Following Curricula	Bioprocess Engineering: Core qualification: Comp	oulsory		
	General Engineering Science (English program, 7	7 semester): Specialisation Bioprocess Engine	ering: Compulso	ry
	Green Technologies: Energy, Water, Climate: Spe	ecialisation Bioresource Technology: Elective	Compulsory	
	Technomathematics: Specialisation III. Engineeri	ng Science: Elective Compulsory		

Course L1107: Bioprocess En	igineering - Advanced
Тур	Lecture
Hrs/wk	2
СР	4
Workload in Hours	Independent Study Time 92, Study Time in Lecture 28
Lecturer	Prof. An-Ping Zeng
Language	DE
Cycle	WiSe
Content	<ul> <li>Introduction: state-of-the-art and development trends of microbial and biocatalytic bioprocesses, introduction to the lecture</li> <li>Enzymatic process I: reactor types and criteria for industrial biotransformations (Prof. Liese)</li> <li>Enzymatic process II (Prof. Liese)</li> <li>Immobilization technologies: basic methods for isoltaed enzymes/ cells (Prof. Liese)</li> <li>Anaerobic fermentation processes (Prof. Zeng)</li> <li>Microaerobic bioprocesses: kinetics, energetics, optimal O2-supply and scale-up (Prof. Zeng)</li> <li>Fedbatch process and cultivation with high cell density (Prof. Zeng)</li> <li>Downstream processing of protein bioproduction: basics of chromatography, membrane filtration (Prof. Liese)</li> <li>Cell culture technology and continuous culture: basics, kinetics, media, reactors (Prof. Zeng)</li> <li>Problem-based learning with selected bioprocesses (Prof. Liese, Prof. Zeng)</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  Skripte für die Vorlesung

Course L1108: Bioprocess En	gineering - Advanced
•	Recitation Section (small)
Hrs/wk	
СР	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Prof. An-Ping Zeng
Language	DE
Cycle	WiSe
Content	<ul> <li>Introduction: state-of-the-art and development trends of microbial and biocatalytic bioprocesses, introduction to the lecture</li> <li>Enzymatic process I: reactor types and criteria for industrial biotransformations (Prof. Liese)</li> <li>Enzymatic process II (Prof. Liese)</li> <li>Immobilization technologies: basic methods for isoltaed enzymes/ cells (Prof. Liese)</li> <li>Anaerobic fermentation processes (Prof. Zeng)</li> <li>Microaerobic bioprocesses: kinetics, energetics, optimal O2-supply and scale-up (Prof. Zeng)</li> <li>Fedbatch process and cultivation with high cell density (Prof. Zeng)</li> <li>Downstream processing of protein bioproduction: basics of chromatography, membrane filtration (Prof. Liese)</li> <li>Cell culture technology and continuous culture: basics, kinetics, media, reactors (Prof. Zeng)</li> <li>Problem-based learning with selected bioprocesses (Prof. Liese, Prof. Zeng)</li> <li>Problem-based learning with selected bioprocesses (Prof. Liese, Prof. Zeng)</li> <li>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.</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 Skripte für die Vorlesung

Module M1274: Enviro	onmental Technology			
Courses				
Title		Тур	Hrs/wk	СР
Environmental Assessment (L0860)		Lecture	2	2
Environmental Assessment (L1054)		Recitation Section (small)	1	1
Module Responsible	Prof. Martin Kaltschmitt			
Admission Requirements	None			
	Fundamentals of inorganic/organic chemistry and biology			
Knowledge				
Educational Objectives	After taking part successfully, students have reached the	following learning results		
<b>Professional Competence</b>				
Skills  Personal Competence  Social Competence	With the completion of this module the students acquenvironmental problems which might occur from product about the methodological diversity and are competent in impacts. Besides the students are able to estimate the codifficulties with their measurement.  The students are able to select a suitable method for the can develop suitable solutions for managing and mitigation out Life Cycle Impact Assessments independently and conference of the conference of the conference of the students have the comenvironmental impacts.  The students are able to discuss the various technical and to develop jointly different solutions and to discuss the topics, the students receive insights into the multi-layere	tion processes, projects or construct dealing with different methods and is omplexity of these environmental properties are respective case from the variety of the environmental problems in a buston apply the software programs Oppopetence to critically judge research discientific tasks, both subject-specificient theoretical or practical implement	ion measures. T instruments to a rocesses as well f assessment me iness context. Ti benLCA and the ch results or of c and multidiscip ntation. Due to	hey have knowledge ssess environmental as uncertainties and ethods. Thereby they hey are able to carry database Ecolovent. ther publications on olinary. They are able the selected lecture
Autonomy	Their sensitivity and consciousness towards these subjestical responsibilities in their role as engineers.  The students learn to research, process and present a scientific work. They can solve an environmental problem	ects are raised and which helps to r	raise their award	eness of their future
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				
-	General Engineering Science (German program, 7 semest			
	General Engineering Science (German program, 7 semest			
	General Engineering Science (German program, 7 semest Bioprocess Engineering: Core qualification: Elective Comp		mental Enginee	ring: Compulsory
	Energy and Environmental Engineering: Core qualification	•		
	General Engineering Science (English program, 7 semeste	' '	erina: Elective Co	ompulsory
	General Engineering Science (English program, 7 semeste		3	
	General Engineering Science (English program, 7 semeste			
	Process Engineering: Core qualification: Elective Compulsi		-	

Course L0860: Environmental 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)	

Course L1054: Environmental Assessment		
Тур	Recitation Section (small)	
Hrs/wk	1	
СР	1	
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14	
Lecturer	Prof. Martin Kaltschmitt, Dr. Anne Rödl	
Language	DE	
Cycle	WiSe	
Content	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.	
Literature	Power point Präsentationen	

Module M0539: Proce	ss and Plant Engineering I			
Courses				
Title		Тур	Hrs/wk	СР
Process and Plant Engineering I (L0095)		Lecture	2	2
Process and Plant Engineering I (L0096)		Recitation Section (large)	1	2
Process and Plant Engineering I (L1214)		Recitation Section (small)	1	2
Module Responsible	Prof. Mirko Skiborowski			
Admission Requirements	None			
Recommended Previous	unit operation of thermal an dmechanical separation processe	s		
Knowledge	chemical reactor eingineering			
	g			
Educational Objectives	After taking part successfully, students have reached the follo	wing learning results		
Professional Competence				
Knowledge	students can:			
	classify and formulate blobal balance equations of chemical pr	rocesses		
	specify linear component equations of complex chemical proce	esses		
	explain linear regression and data reconcilliation problems			
	explain pfd-diagrams			
Skills	students are capable of			
	- formulation of mass and energy balance equations and estim	nation of product streams		
	- estimation of component streams of chemical plants using lir	near component balance models	5	
	- solution of data reconcilliation tasks			
	- conduction of process synthesis			
	- economic evaluation of processes and the estimation of prod	uction costs		
Personal Competence				
Social Competence				
Autonomy				
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56			
Credit points	6			
Course achievement	Compulsory Bonus Form Description Yes 10 % Subject theoretical and			
	practical work			
Examination				
Examination duration and	120 Min. lectures notes and books			
scale				
Assignment for the	General Engineering Science (German program, 7 semester):	Specialisation Process Engineeri	ng: Compulsory	
Following Curricula	General Engineering Science (German program, 7 semester): 9	Specialisation Bioprocess Engine	eering: Compulso	ry
	Bioprocess Engineering: Core qualification: Compulsory			
	General Engineering Science (English program, 7 semester): S	pecialisation Bioprocess Engine	ering: Compulsor	у
	General Engineering Science (English program, 7 semeste Compulsory	r): Specialisation Energy and	Enviromental E	ngineering: Elective
	General Engineering Science (English program, 7 semester): S	pecialisation Process Engineering	ıg: Compulsorv	
	Green Technologies: Energy, Water, Climate: Specialisation Bio			
	Process Engineering: Core qualification: Compulsory		1 7	
	J J			

urse L0095: Process and Plant Engineering I			
Тур	Lecture		
Hrs/wk	2		
СР	2		
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28		
Lecturer	Prof. Mirko Skiborowski		
Language	DE		
Cycle	SoSe		
Content	1. Introduction  Structure and operation of production plants  Operational business process  Technical process design  Motivation and targets of process development  Life cycle of production plants  2. Engineering methods and tools  Mass and energy balances  Strategies of process synthesis  Graphical representation of processes  Multidimensional regression		

	Data reconciliation and data validation  3. Process Synthesis
	Decision levels
	Experimental process development
	Reactor synthesis
	Synthesis of separation processes (process alternatives and criteria for selection)  Integration of reaction systems/separation systems (interactions, recycle streams)
	4. Process safety
	5. Cost estimation of production plants
	Production costs, capital costs, economic evaluation
Literature	
Literature	S.D. Barnicki, J.R. Fair, Ind. End. Chem., 29(1990), S. 421, Ind. End. Chem., 31(1992), S. 1679
	H. Becker, S. Godorr, H. Kreis, Chemical Engineering, January 2001, S. 68-74
	Behr, W. Ebbers, N. Wiese, ChemIngTech. 72(2000)Nr. 10, S.1157
	E. Blass, Entwicklung verfahrenstechnischer Prozesse, Springer-Verlag, 2. Auflage 1997
	M. H. Bauer, J. Stichlmair, ChemIngTech., 68(1996), Nr. 8, 911-916
	R. Dittmeyer, W. Keim, G. Kreysa, A. Oberholz, Chemische Technik. Prozesse und Produkte,
	Band 2, Neue Technologien, 5. Auflage, Wiley-VCH GmbH&Co.KGaA, Weinheim, 2004
	J.M. Douglas, Conceptual Design of Chemical Processes, Mc Graw-Hill, NY, 1988
	G. Fieg, Inz. Chem. Proc., 5(1979), S.15-19
	G. Fieg, G. Wozny, L. Jeromin, Chem. Eng. Technol. 17(1994),5, 301-306
	G. Fieg, Heat and Mass Transfer 32(1996), S. 205-213
	G. Fieg, Chem. Eng. Processing, Vol. 41/2(2001), S. 123-133
	U.H. Felcht, Chemie eine reife Industrie oder weiterhin Innovationsmotor, Universitätsbuchhandlung Blazek und Bergamann, Frankfurt, 2000
	J.P. van Gigch, Systems Design, Modeling and Metamodeling, Plenum Press, New York, 1991
	T.F. Edgar, D.M. Himmelblau, L.S. Lasdon, Optimization of Chemical Processes, McGraw-Hill, 2001
	G. Gruhn, Vorlesungsmanuskript "Prozess- und Anlagentechnik, TU Hamburg-Harburg
	D. Hairston, Chemical Engineering, October 2001, S. 31-37
	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 Plant Engineering I		
Тур	Recitation Section (large)	
Hrs/wk	1	
СР	2	
Workload in Hours	Independent Study Time 46, 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 Plant Engineering I		
Тур	Recitation Section (small)	
Hrs/wk	1	
СР	2	
Workload in Hours	Independent Study Time 46, Study Time in Lecture 14	
Lecturer	Prof. Mirko Skiborowski, Dr. Thomas Waluga	
Language	DE	
Cycle	SoSe	
Content	See interlocking course	
Literature	See interlocking course	

Module M0670: Partic	le Technology	and Solids Proces	ss Engineerir	ng		
Courses						
Title Particle Technology I (L0434) Particle Technology I (L0435)				Typ Lecture Recitation Section (small)	Hrs/wk 2 1	<b>CP</b> 3 1
Particle Technology I (L0440)	Practical Course 2 2				2	
Module Responsible						
•	None					
Recommended Previous  Knowledge	keine					
Educational Objectives	After taking part succ	essfully, students have re	eached the following	n learning results		
Professional Competence	Arter taking part succ	essiting, students have re	sacrica the followin	g learning results		
	After successful comp	oletion of the module stud	lents are able to			
	•	lain processes and unit-o				
	characterize pa	articles, particle distribution	ons and to discuss	their bulk properties		
Skille	Students are able to					
Skills	Students are able to					
	<ul> <li>choose and de</li> </ul>	sign apparatuses and pro	cesses for solids pr	ocessing according to the d	esired solids prop	perties of the product
		th respect to their behavi	or in solids process	ing steps		
	document their	r work scientifically.				
Personal Competence						
Social Competence	The students are able to discuss scientific topics orally with other students or scientific personal and to develop solutions for					
	technical-scientific issues in a group.					
Autonomy	Students are able to a	analyze and solve questio	ns regarding solid p	particles independently.		
Workload in Hours	Independent Study Ti	me 110, Study Time in Le	ecture 70			
Credit points	6	.,,				
Course achievement	Compulsory Bonus	Form	Description			
	Yes None	Written elaboration	sechs Berichte	(pro Versuch ein Bericht) à	5-10 Seiten	
Examination	Written exam					
Examination duration and	90 minutes					
scale						
Assignment for the	General Engineering	Science (German program	n, 7 semester): Spe	cialisation Process Engineer	ring: Compulsory	
Following Curricula				cialisation Bioprocess Engin		
				cialisation Energy and Envir		
			n, 7 semester): Sp	ecialisation Green Technolo	gies, Focus Wate	r and Environmental
	Engineering: Elective					
		ng: Core qualification: Cor		o Compulsory		
		ental Engineering: Core q		e Compuisory ialisation Bioprocess Engine	eering: Compulso	rv.
				ialisation Energy and Enviro		
				ialisation Process Engineeri		ing. Compulsory
		Energy, Water, Climate: S			J. 22pa.55.y	
		Core qualification: Compu				
	Process Engineering:	Core qualification: Compu	ulsory			

Course L0434: Particle Techn	ology I		
Тур	Lecture		
Hrs/wk	2		
СР	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 Technology I		
Тур	Recitation Section (small)	
Hrs/wk	1	
СР	1	
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14	
Lecturer	Prof. Stefan Heinrich	
Language	DE	
Cycle	SoSe	
Content	See interlocking course	
Literature	See interlocking course	

Course L0440: Particle Technology I			
Тур	Practical Course		
Hrs/wk	2		
СР	2		
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28		
Lecturer	Prof. Stefan Heinrich		
Language	DE/EN		
Cycle	SoSe		
Content	<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.		

## **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: Electr	rical Engineering III: Circuit Theory and Transients				
Courses					
Title Circuit Theory (L0566) Circuit Theory (L0567)	Typ         Hrs/wk         CP           Lecture         3         4           Recitation Section (small)         2         2				
-	None				
	Electrical Engineering I and II, Mathematics I and II				
Knowledge					
<b>Educational Objectives</b>	After taking part successfully, students have reached the following learning results				
Professional Competence					
Knowledge	Students are able to explain the basic methods for calculating electrical circuits. They know the Fourier series analysis of linear networks driven by periodic signals. They know the methods for transient analysis of linear networks in time and in frequency domain, and they are able to explain the frequency behaviour and the synthesis of passive two-terminal-circuits.				
Skills	The students are able to calculate currents and voltages in linear networks by means of basic methods, also when driven by periodic signals. They are able to calculate transients in electrical circuits in time and frequency domain and are able to explain the respective transient behaviour. They are able to analyse and to synthesize the frequency behaviour of passive two-terminal-circuits.				
Personal Competence Social Competence	Students work on exercise tasks in small guided groups. They are encouraged to present and discuss their results within the group.				
Autonomy	The students are able to find out the required methods for solving the given practice problems. Possibilities are given to test their knowledge during the lectures continuously by means of short-time tests. This allows them to control independently their educational objectives. They can link their gained knowledge to other courses like Electrical Engineering I and Mathematics I.				
Workload in Hours	Independent Study Time 110, Study Time in Lecture 70				
	6				
Course achievement					
Examination					
Examination duration and					
scale					
Assignment for the	General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Mechatronics:				
Following Curricula	Compulsory				
	General Engineering Science (German program, 7 semester): Specialisation Electrical Engineering: Compulsory				
	Electrical Engineering: Core qualification: Compulsory				
	Engineering Science: Specialisation Electrical Engineering: Compulsory				
	General Engineering Science (English program, 7 semester): Specialisation Mechanical Engineering, Focus Mechatronics: Compulsory				
	Computational Science and Engineering: Specialisation II. Mathematics & Engineering Science: Elective Compulsory				
	Mechatronics: Core qualification: Compulsory				
	Technomathematics: Specialisation III. Engineering Science: Elective Compulsory				
	. See Process				

Course L0566: Circuit Theory			
Тур	Lecture		
Hrs/wk	3		
СР	4		
Workload in Hours	ndependent Study Time 78, Study Time in Lecture 42		
Lecturer	rof. 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	
СР	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	

Module M0730: Comp	uter Engineering			
Courses				
Title	Typ Hrs/wk CP			
Computer Engineering (L0321)	Lecture 3 4			
Computer Engineering (L0324)	Recitation Section (small) 1 2			
Module Responsible				
Admission Requirements				
Recommended Previous Knowledge	Basic knowledge in electrical engineering			
Educational Objectives	After taking part successfully, students have reached the following learning results			
Professional Competence	Price taking part successivity, stauches have reached the following realising results			
•	This module deals with the foundations of the functionality of computing systems. It covers the layers from the assembly-leve			
	programming down to gates. The module includes the following topics:			
	Introduction			
	Combinational logic: Gates, Boolean algebra, Boolean functions, hardware synthesis, combinational networks			
	Sequential logic: Flip-flops, automata, systematic hardware design			
	Technological foundations			
	Computer arithmetic: Integer addition, subtraction, multiplication and division			
	Basics of computer architecture: Programming models, MIPS single-cycle architecture, pipelining			
	Memories: Memory hierarchies, SRAM, DRAM, caches			
	<ul> <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 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 h			
	on the hardware-centric abstraction layers from the assembly language down to gates. This way, they will be enabled to evaluate			
	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	6			
Course achievement				
Evamination	Yes 10 % Excercises			
	Written exam			
Examination duration and	Written exam  90 minutes, contents of course and labs			
Examination duration and scale Assignment for the	Written exam  90 minutes, contents of course and labs			
Examination duration and scale Assignment for the	Written exam  90 minutes, contents of course and labs  General Engineering Science (German program, 7 semester): Specialisation Computer Science: Compulsory			
Examination duration and scale Assignment for the	Written exam  90 minutes, contents of course and labs  General Engineering Science (German program, 7 semester): Specialisation Computer Science: Compulsory General Engineering Science (German program, 7 semester): Specialisation Civil Engineering: Compulsory			
Examination duration and scale Assignment for the	Written exam  90 minutes, contents of course and labs  General Engineering Science (German program, 7 semester): Specialisation Computer Science: Compulsory General Engineering Science (German program, 7 semester): Specialisation Civil Engineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Process Engineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Mechatronic Compulsory			
Examination duration and scale Assignment for the	Written exam  90 minutes, contents of course and labs  General Engineering Science (German program, 7 semester): Specialisation Computer Science: Compulsory General Engineering Science (German program, 7 semester): Specialisation Civil Engineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Process Engineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Mechatronic Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Aircraft System			
Examination duration and scale Assignment for the	Written exam  90 minutes, contents of course and labs  General Engineering Science (German program, 7 semester): Specialisation Computer Science: Compulsory General Engineering Science (German program, 7 semester): Specialisation Civil Engineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Process Engineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Mechatronic Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Aircraft Syster Engineering: Compulsory			
Examination duration and scale Assignment for the	Written exam  90 minutes, contents of course and labs  General Engineering Science (German program, 7 semester): Specialisation Computer Science: Compulsory General Engineering Science (German program, 7 semester): Specialisation Civil Engineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Process Engineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Mechatronic Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Aircraft Syster Engineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Theoretical Mechanical Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Theoretical Mechanical			
Examination duration and scale Assignment for the	Written exam  90 minutes, contents of course and labs  General Engineering Science (German program, 7 semester): Specialisation Computer Science: Compulsory General Engineering Science (German program, 7 semester): Specialisation Civil Engineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Process Engineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Mechatronic Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Aircraft Syster Engineering: Compulsory			
Examination duration and scale Assignment for the	Written exam  90 minutes, contents of course and labs  General Engineering Science (German program, 7 semester): Specialisation Computer Science: Compulsory General Engineering Science (German program, 7 semester): Specialisation Civil Engineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Process Engineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Mechatronic Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Aircraft Syster Engineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Theoretical Mechanic Engineering: Compulsory			
Examination duration and scale Assignment for the	Written exam  90 minutes, contents of course and labs  General Engineering Science (German program, 7 semester): Specialisation Computer Science: Compulsory General Engineering Science (German program, 7 semester): Specialisation Civil Engineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Process Engineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Mechatronic Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Aircraft Syster Engineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Theoretical Mechanic Engineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Materials			
Examination duration and scale Assignment for the	Written exam  90 minutes, contents of course and labs  General Engineering Science (German program, 7 semester): Specialisation Computer Science: Compulsory General Engineering Science (German program, 7 semester): Specialisation Civil Engineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Process Engineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Mechatronic Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Aircraft Syster Engineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Theoretical Mechanic 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 Development and Production: Compulsory			
Examination duration and scale Assignment for the	Written exam  90 minutes, contents of course and labs  General Engineering Science (German program, 7 semester): Specialisation Computer Science: Compulsory General Engineering Science (German program, 7 semester): Specialisation Civil Engineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Process Engineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Mechatronic Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Aircraft Syster Engineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Theoretical Mechanic 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 Development and Production: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Product Development and Production: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Product Development and Production: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Energy System			
Examination duration and scale Assignment for the	Written exam  90 minutes, contents of course and labs  General Engineering Science (German program, 7 semester): Specialisation Computer Science: Compulsory General Engineering Science (German program, 7 semester): Specialisation Civil Engineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Process Engineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Mechatronic Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Aircraft Syster Engineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Theoretical Mechanic 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 Developmental Production: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Product Developmental Production: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Product Developmental Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Energy System			
Examination duration and scale Assignment for the	Written exam  90 minutes, contents of course and labs  General Engineering Science (German program, 7 semester): Specialisation Computer Science: Compulsory General Engineering Science (German program, 7 semester): Specialisation Civil Engineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Process Engineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Mechatronic Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Aircraft Syster Engineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Theoretical Mechanic 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 Developme and Production: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Energy Systen Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Energy Systen Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Energy Systen			
Examination duration and scale Assignment for the	Written exam  90 minutes, contents of course and labs  General Engineering Science (German program, 7 semester): Specialisation Computer Science: Compulsory General Engineering Science (German program, 7 semester): Specialisation Civil Engineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Process Engineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Mechatronic Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Aircraft Syster Engineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Theoretical Mechanic 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 Developme and Production: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Energy System Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Energy System Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Biomechanic Compulsory			
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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 Engineering		
Тур	ecture	
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 Engineering	
Тур	Recitation Section (small)
Hrs/wk	1
СР	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 M0567: Theor	retical Electrical Engineering I: T	ime-Independent Fields		
Courses				
Title Theoretical Electrical Engineering I Theoretical Electrical Engineering I		<b>Typ</b> Lecture Recitation Section (small)	Hrs/wk 3 2	<b>CP</b> 5
	Prof. Christian Schuster		<del>-</del>	<del>-</del>
Admission Requirements				
-	Basic principles of electrical engineering and ad	lvanced 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 fields. The students are aware of applications of these.	electrostatic, magnetostatic, and current complex electromagnetic fields by mean	density fields with s of superposition of	regard to respective f solutions for simple
Skills	Students can apply Maxwell's Equations in integral notation in order to solve highly symmetrical, time-independent, electromagnetic field problems. Furthermore, they are capable of applying a variety of methods that require solving Maxwell's Equations for more general problems. The students can assess the principal effects of given time-independent sources of fields and analyze these quantitatively. They can deduce meaningful quantities for the characterization of electrostatic, magnetostatic, and electrical flow fields (capacitances, inductances, resistances, etc.) from given fields and dimension them for practical applications.			
Personal Competence Social Competence	Students are able to work together on subject related tasks in small groups. They are able to present their results effectively (e.g. during exercise sessions).			
Autonomy	Students are capable to gather necessary information from provided references and relate this information to the lecture. They are able to continually reflect their knowledge by means of activities that accompany the lecture, such as short oral quizzes during the lectures and exercises that are related to the exam. Based on respective feedback, students are expected to adjust their individual learning process. They are able to draw connections between their knowledge obtained in this lecture and the content of other lectures (e.g. Electrical Engineering I, Linear Algebra, and Analysis).			
Workload in Hours	Independent Study Time 110, Study Time in Lea	cture 70		
Credit points				
Course achievement				
Examination	Written exam			
Examination duration and scale	90-150 minutes			
Assignment for the Following Curricula	General Engineering Science (German program Electrical Engineering: Core qualification: Comp Computational Science and Engineering: Special Technomathematics: Specialisation III. Engineer	ulsory Ilisation II. Mathematics & Engineering Sci		

Course L0180: Theoretical El	ectrical Engineering I: Time-Independent 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	DE
Cycle	SoSe
Content	- Maxwell's Equations in integral and differential notation
	- Boundary conditions
	- Laws of conservation for energy and charge
	- Classification of electromagnetic field properties
	- Integral characteristics of time-independent fields (R, L, C)
	- Generic approaches to solving Poisson's Equation
	- Electrostatic fields and specific methods of solving
	- Magnetostatic fields and specific methods of solving
	- Fields of electrical current density and specific methods of solving
	- Action of force within time-independent fields
	- Numerical methods for solving time-independent problems
	The practical application of numerical methods will be trained within specifically prepared lectures in an interactive manner 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 L0181: Theoretical Electrical Engineering I: Time-Independent Fields	
Тур	Recitation Section (small)
Hrs/wk	2
СР	1
Workload in Hours	Independent Study Time 2, Study Time in Lecture 28
Lecturer	Prof. Christian Schuster
Language	DE
Cycle	SoSe
Content	See interlocking course
Literature	See interlocking course

Module M0748: Materials in Electrical Engineering				
Courses				
Title		Тур	Hrs/wk	СР
Electrotechnical Experiments (L07)	14)	Lecture	1	1
Materials in Electrical Engineering	(L0685)	Lecture	2	3
Materials in Electrical Engineering	(Problem Solving Course) (L0687)	Recitation Section (small)	2	2
Module Responsible	Prof. Manfred Eich			
Admission Requirements	None			
Recommended Previous	Highschool level physics and mathematics			
Knowledge				
<b>Educational Objectives</b>	After taking part successfully, students have reached to	the following learning results		
Professional Competence				
Knowledge	1	Students can explain the composition and the structural properties of materials used in electrical engineering. Students can explicate the relevance of mechanical, electrical, thermal, dielectric, magnetic and chemical properties of materials in view of their applications in electrical engineering.		
Skills	Students can identify appropriate descriptive models and apply them mathematically. They can derive approximative solutions and judge factors influential on the performance of materials in electrical engineering applications.			
Personal Competence	Students can injectly solve subject related problems in	groups. They can present their results	Its affactively within	the framework of the
Social competence	Students can jointly solve subject related problems in groups. They can present their results effectively within the framework of the problem solving course.			
Autonomy	Students are capable to extract relevant information from the provided references and to relate this information to the content of the lecture. They can reflect their acquired level of expertise with the help of lecture accompanying measures such as exam typical exam questions. Students are able to connect their knowledge with that acquired from other lectures.			
Workload in Hours	Independent Study Time 110, Study Time in Lecture 7	0		
Credit points	6			
Course achievement	None	None		
Examination	Written exam	Written exam		
Examination duration and	60 minutes			
scale				
Assignment for the	General Engineering Science (German program, 7 sem	nester): Specialisation Electrical Eng	neering: Compulsor	Ŋ
Following Curricula	Electrical Engineering: Core qualification: Compulsory			
	Orientation Studies: Core qualification: Elective Compu	ulsory		

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

Course L0685: Materials in E	lectrical Engineering
Тур	Lecture
Hrs/wk	2
СР	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	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

Course L0687: Materials in Electrical Engineering (Problem Solving Course)		
Тур	Recitation Section (small)	
Hrs/wk	2	
СР	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: Mathe	ematics IV			
Courses				
<b>Title</b> Differential Equations 2 (Partial Diff Differential Equations 2 (Partial Diff	ferential Equations) (L1044)	Typ Lecture Recitation Section (small)	Hrs/wk 2 1	<b>CP</b> 1 1
Differential Equations 2 (Partial Diff 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)	Prof. Anusch Taraz	Recitation Section (large)	1	1
Module Responsible  Admission Requirements	None			
Recommended Previous	Mathematics 1 - III			
Knowledge				
<b>Educational Objectives</b>	After taking part successfully, students have reached the fo	ollowing learning results		
Professional Competence				
Knowledge Skills	Students can name the basic concepts in Mathemati Students can discuss logical connections between t the help of examples. They know proof strategies and can reproduce them	hese concepts. They are capable	of illustrating the	ese connections with
	<ul> <li>Students can model problems in Mathematics IV w capable of solving them by applying established me</li> <li>Students are able to discover and verify further logic</li> <li>For a given problem, the students can develop an results.</li> </ul>	thods. cal connections between the conce	pts studied in the	course.
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	6			
Course achievement	None			
Examination	Written exam			
Examination duration and scale	60 min (Complex Functions) + 60 min (Differential Equatio	ns 2)		
Assignment for the	General Engineering Science (German program, 7 semeste	r): Specialisation Electrical Enginee	ering: Compulsor	/
Following Curricula	General Engineering Science (German program, 7 ser Compulsory General Engineering Science (German program, 7 semeste General Engineering Science (German program, 7 semeste Engineering: Elective Compulsory Computer Science: Specialisation Computational Mathema Electrical Engineering: Core qualification: Compulsory	r): Specialisation Naval Architectur r): Specialisation Mechanical Engir	e: Compulsory	
	General Engineering Science (English program, 7 semester General Engineering Science (English program, 7 sen Compulsory General Engineering Science (English program, 7 semeste Engineering: Compulsory Computational Science and Engineering: Specialisation III. Nechanical Engineering: Specialisation Mechatronics: Com Mechanical Engineering: Specialisation Theoretical Mechan Mechatronics: Core qualification: Compulsory	nester): Specialisation Mechanical r): Specialisation Mechanical Engir Mathematics & Engineering Science pulsory	I Engineering, Interesting, Focus These Elective Compu	Focus Mechatronics: eoretical Mechanical
	Naval Architecture: Core qualification: Compulsory Theoretical Mechanical Engineering: Technical Complemen	tary Course Core Studies: Elective	Compulsory	

Course L1043: Differential Equations 2 (Partial Differential Equations)	
Тур	Lecture
Hrs/wk	2
СР	1
Workload in Hours	Independent Study Time 2, Study Time in Lecture 28
Lecturer	Dozenten des Fachbereiches Mathematik der UHH
Language	DE
Cycle	SoSe
Content	Main features of the theory and numerical treatment of partial differential equations
Literature	<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> </ul>
Literature	http://www.math.uni-hamburg.de/teaching/export/tuhh/index.html

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

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

Course L1038: Complex Functions	
Тур	Lecture
Hrs/wk	2
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 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> <li>http://www.math.uni-hamburg.de/teaching/export/tuhh/index.html</li> </ul>

Course L1041: Complex Functions	
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 L1042: Complex Functions	
Тур	Recitation Section (large)
Hrs/wk	1
СР	1
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14
Lecturer	Dozenten des Fachbereiches Mathematik der UHH
Language	DE
Cycle	SoSe
Content	See interlocking course
Literature	See interlocking course

Courses				
Title		Тур	Hrs/wk	СР
Electrical Machines and Actuators	(L0293)	Lecture	3	4
Electrical Machines and Actuators	(L0294)	Recitation Section (large)	2	2
Module Responsible	Prof. Thorsten Kern			
Admission Requirements	None			
Recommended Previous	Basics of mathematics, in particular complexe numbers	s, integrals, differentials		
Knowledge	Pacies of electrical angineering and mechanical angine	oring		
	Basics of electrical engineering and mechanical engine	ering		
<b>Educational Objectives</b>	After taking part successfully, students have reached t	he following learning results		
<b>Professional Competence</b>				
Knowledge	Students can to draw and explain the basic principles of	of electric and magnetic fields.		
	They can describe the function of the standard ty	nes of electric machines and prese	nt the correspon	nding equations a
	characteristic curves. For typically used drives they can			
	from the power grid to the driven engine.	rexplain the major parameters of the	energy emelency	of the whole syste
Skills	Students are able to calculate two-dimensional electric		rromagnetic circu	uits with air gap. F
	this they apply the usual methods of the design auf ele	ectric machines.		
	They can calulate the operational performance of elec	ctric machines from their given chara	cteristic data and	d selected quantitie
	and characteristic curves. They apply the usual equival	lent circuits and graphical methods.		
Personal Competence				
Social Competence	none			
Autonomy	Students are able independently to calculate electric a	and magnatic fields for applications. Th	ney are able to ar	nalyse independent
	the operational performance of electric machines from	n the charactersitic data and theycan	calculate thereo	f selected quantiti
	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 of desig			
scale		n files		
		ın files		
Assignment for the	General Engineering Science (German program, 7 sem		ering: Elective Co	mpulsory
Assignment for the Following Curricula		ester): Specialisation Electrical Enginee	-	
•		ester): Specialisation Electrical Enginee	-	
•	General Engineering Science (German program, 7 s	ester): Specialisation Electrical Enginee emester): Specialisation Mechanical	Engineering, Foc	us Energy System
•	General Engineering Science (German program, 7 s Compulsory General Engineering Science (German program, 7 Compulsory	ester): Specialisation Electrical Enginee emester): Specialisation Mechanical semester): Specialisation Mechanica	Engineering, Foc	us Energy System
•	General Engineering Science (German program, 7 s Compulsory General Engineering Science (German program, 7 Compulsory General Engineering Science (German program, 7 sem	ester): Specialisation Electrical Enginee emester): Specialisation Mechanical semester): Specialisation Mechanica	Engineering, Foc	us Energy System
•	General Engineering Science (German program, 7 s Compulsory General Engineering Science (German program, 7 Compulsory General Engineering Science (German program, 7 sem Engineering: Elective Compulsory	ester): Specialisation Electrical Engineer emester): Specialisation Mechanical semester): Specialisation Mechanical ester): Specialisation Mechanical Engin	Engineering, Foc	us Energy System Focus Mechatronic
•	General Engineering Science (German program, 7 s Compulsory General Engineering Science (German program, 7 Compulsory General Engineering Science (German program, 7 sem Engineering: Elective Compulsory General Engineering Science (German program, 7 sem	ester): Specialisation Electrical Enginee emester): Specialisation Mechanical semester): Specialisation Mechanical ester): Specialisation Mechanical Engineester): Specialisation Energy and Envir	Engineering, Foc	us Energy System Focus Mechatronic
•	General Engineering Science (German program, 7 s Compulsory General Engineering Science (German program, 7 Compulsory General Engineering Science (German program, 7 sem Engineering: Elective Compulsory General Engineering Science (German program, 7 sem Digital Mechanical Engineering: Core qualification: Com	ester): Specialisation Electrical Engineer emester): Specialisation Mechanical semester): Specialisation Mechanical ester): Specialisation Mechanical Engine ester): Specialisation Energy and Envir	Engineering, Foc	us Energy System Focus Mechatronic
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•	General Engineering Science (German program, 7 scompulsory General Engineering Science (German program, 7 compulsory General Engineering Science (German program, 7 semengineering: Elective Compulsory General Engineering Science (German program, 7 semengineering: Elective Compulsory General Engineering Science (German program, 7 semengial Mechanical Engineering: Core qualification: Compulsory Electrical Engineering: Core qualification: Elective Compulsory Energy and Environmental Engineering: Core qualification: Elective Compulsory General Engineering Science (English program, 7 semengia)	ester): Specialisation Electrical Engineer emester): Specialisation Mechanical semester): Specialisation Mechanical engineerester): Specialisation Mechanical Engineerester): Specialisation Energy and Environmental Engineerester): Specialisation Energy and Environmental Engineerester): Specialisation Mechanical Engineeresters	Engineering, Focal Engineering, Inneering, Focus Theomental Engineering: Elective C	us Energy System Focus Mechatronic neoretical Mechanic ring: Compulsory
•	General Engineering Science (German program, 7 s Compulsory General Engineering Science (German program, 7 Compulsory General Engineering Science (German program, 7 sem Engineering: Elective Compulsory General Engineering Science (German program, 7 sem Digital Mechanical Engineering: Core qualification: Com Electrical Engineering: Core qualification: Elective Com Energy and Environmental Engineering: Core qualification	ester): Specialisation Electrical Engineer emester): Specialisation Mechanical semester): Specialisation Mechanical ester): Specialisation Mechanical Engine ester): Specialisation Energy and Environ epulsory pulsory ion: Compulsory ester): Specialisation Mechanical Engine ation Energy Technology: Elective Com	Engineering, Focal Engineering, Inneering, Focus Theomental Engineering: Elective C	us Energy System Focus Mechatronic neoretical Mechanic ring: Compulsory
•	General Engineering Science (German program, 7 scompulsory General Engineering Science (German program, 7 compulsory General Engineering Science (German program, 7 semengineering: Elective Compulsory General Engineering Science (German program, 7 semengineering: Elective Compulsory General Engineering Science (German program, 7 semengial Mechanical Engineering: Core qualification: Compulsory Electrical Engineering: Core qualification: Elective Compulsory Electrical Engineering: Core qualification: Elective Compulsory Energy and Environmental Engineering: Core qualification: Elective Compulsory Energy and Environmental Engineering: Core qualification: Elective Compulsory Energy and Environmental Engineering: Core qualification: Elective Compulsory Energy Energy (English program, 7 semengental Engineering Science (English program, 7 semengental Engineering) Energy English English Energy (English program, 7 semengental Engineering)	ester): Specialisation Electrical Engineer emester): Specialisation Mechanical semester): Specialisation Mechanical ester): Specialisation Mechanical Engine ester): Specialisation Energy and Environ epulsory pulsory ion: Compulsory ester): Specialisation Mechanical Engine ation Energy Technology: Elective Com ice: Elective Compulsory	Engineering, Focal Engineering, Inneering, Focus Theomental Engineering: Elective C	us Energy System Focus Mechatronic neoretical Mechanic ring: Compulsory
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•	General Engineering Science (German program, 7 scompulsory General Engineering Science (German program, 7 compulsory General Engineering Science (German program, 7 semengineering: Elective Compulsory General Engineering Science (German program, 7 semengineering: Elective Compulsory General Engineering Science (German program, 7 semengial Mechanical Engineering: Core qualification: Compulsory Electrical Engineering: Core qualification: Elective Compulsory Electrical Engineering: Electrical Engineer	ester): Specialisation Electrical Engineer emester): Specialisation Mechanical semester): Specialisation Mechanical ester): Specialisation Mechanical Engineester): Specialisation Energy and Environgulsory pulsory ion: Compulsory ester): Specialisation Mechanical Engineester): Specialisation Energy Technology: Elective Compulsory end Systems: Elective Compulsory element and Processes: Elective Compulsory element and Processes: Elective Compulsory	Engineering, Focal Engineering, Inneering, Focus Theomental Engineering: Elective Copulsory	us Energy System Focus Mechatronic neoretical Mechanic ring: Compulsory
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•	General Engineering Science (German program, 7 scompulsory General Engineering Science (German program, 7 compulsory General Engineering Science (German program, 7 compulsory General Engineering Science (German program, 7 semengineering: Elective Compulsory General Engineering Science (German program, 7 semengiatal Mechanical Engineering: Core qualification: Compulsory General Engineering: Core qualification: Elective Compulsory Electrical Engineering: Core qualification: Elective Compulsory General Engineering: Core qualification: Elective Compulsory Electrical Engineering Science (English program, 7 semengemental Engineering Science) General Engineering Science (English program, 7 semengemental Engineering Science) Logistics and Mobility: Specialisation Engineering Science (English Engineering Science) Logistics and Mobility: Specialisation Production Managemental Engineering: Core qualification: Elective Compulsory	ester): Specialisation Electrical Engineer emester): Specialisation Mechanical semester): Specialisation Mechanical electrical Engineer ester): Specialisation Mechanical Engineester): Specialisation Energy and Environgulsory pulsory ion: Compulsory ester): Specialisation Mechanical Engineester): Specialisation Energy and Environmental Engineester): Specialisation Energy Environmental Engineester): Specialisation Environmental Engineester): Specialisation Energy Environmental Engineester): Specialisation Energy Environmental Engineester): Specialisation Engineester): Specialisation Environmental Engineester): Specialisation Engineester): Specialisation Environmental	Engineering, Focal Engineering, Inneering, Focus Theomental Engineering: Elective Copulsory	us Energy Systen Focus Mechatroni neoretical Mechani ring: Compulsory
•	General Engineering Science (German program, 7 scompulsory General Engineering Science (German program, 7 compulsory General Engineering Science (German program, 7 compulsory General Engineering Science (German program, 7 semengineering: Elective Compulsory General Engineering Science (German program, 7 semengiated Mechanical Engineering: Core qualification: Compulsory General Engineering: Core qualification: Elective Compulsory Electrical Engineering: Core qualification: Elective Compulsory General Engineering: Core qualification: Elective Compulsory General Engineering Science (English program, 7 semengeren Technologies: Energy, Water, Climate: Specialisation Engineering Science (English Engineering Science) Logistics and Mobility: Specialisation Traffic Planning and Logistics and Mobility: Specialisation Production Managemental Engineering: Core qualification: Elective Compulsory	ester): Specialisation Electrical Engineer emester): Specialisation Mechanical semester): Specialisation Mechanical electrical Engineer emester): Specialisation Mechanical Engineer ester): Specialisation Energy and Environmental Engineer	Engineering, Focal Engineering, Focus Thomeoring, Focus Thomeoring Engineering: Elective Cupulsory	us Energy Systen Focus Mechatronic neoretical Mechanic ring: Compulsory ompulsory
•	General Engineering Science (German program, 7 scompulsory General Engineering Science (German program, 7 compulsory General Engineering Science (German program, 7 compulsory General Engineering Science (German program, 7 semengineering: Elective Compulsory General Engineering Science (German program, 7 semengiated Mechanical Engineering: Core qualification: Compulsory General Engineering: Core qualification: Elective Compulsory Electrical Engineering: Core qualification: Elective Compulsory General Engineering Science (English program, 7 semengiated Engineering Science (English program, 7 semengemental Engineering Science) Logistics and Mobility: Specialisation Engineering Science (English Engineering Science) Logistics and Mobility: Specialisation Traffic Planning and Logistics and Mobility: Specialisation Production Managemental Engineering: Core qualification: Elective Compulsory Technomathematics: Specialisation III. Engineering Science	ester): Specialisation Electrical Engineer emester): Specialisation Mechanical semester): Specialisation Mechanical electrical Engineer emester): Specialisation Mechanical Engineer ester): Specialisation Energy and Environmental Engineer	Engineering, Focal Engineering, Focus Thomental Engineering: Elective Cupulsory	us Energy System Focus Mechatronic neoretical Mechanic ring: Compulsory ompulsory

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

Module M1340: Intro	duction to Waveguides, Antennas, and	d Electromagnetic Compa	tibility	
Courses				
Title .		Тур	Hrs/wk	СР
ntroduction to Waveguides, Anten	nas, and Electromagnetic Compatibility (L1669)	Lecture	3	4
ntroduction to Waveguides, Anten	nas, and Electromagnetic Compatibility (L1877)	Recitation Section (small)	2	2
Module Responsible	Prof. Christian Schuster			
Admission Requirements	None			
Recommended Previous	Basic principles of physics and electrical engineering			
Knowledge				
<b>Educational Objectives</b>	After taking part successfully, students have reached the	ne following learning results		
Professional Competence				
Knowledge	Students can explain the basic principles, relationships, and methods for the design of waveguides and antennas as well			ntennas as well as
	Electromagnetic Compatibility. Specific topics are:			
	Fundamental associate and above as of alcebrical	ai var vita		
	- Fundamental properties and phenomena of electrical	Circuits		
	- Steady-state sinusoidal analysis of electrical circuits	agnotic fields and wayes		
	- Fundamental properties and phenomena of electroma			
	<ul> <li>Steady-state sinusoidal description of electromagnetic</li> <li>Useful microwave network parameters</li> </ul>	tielus and waves		
	- Transmission lines and basic results from transmission	a line theory		
	- Plane wave propagation, superposition, reflection and			
	- General theory of waveguides	Tellaction		
	Most important types of waveguides and their propert	ios		
	- Radiation and basic antenna parameters			
	Most important types of antennas and their properties			
	- Numerical techniques and CAD tools for waveguide ar			
	- Fundamentals of Electromagnetic Compatibility	id differnid design		
	- Coupling mechanisms and countermeasures			
	- Shielding, grounding, filtering			
	- Standards and regulations			
	- EMC measurement techniques			
	·			
Skills	Students know how to apply various methods and mo-			
	able to assess and qualify their basic electromagne		Its and strategi	es from the field
	Electromagnetic Compatibilty to the development of ele	ectrical components and systems.		
Personal Competence				
	Students are able to work together on subject related	tasks in small groups. They are able	to present their	results effectively
	English (e.g. during small group exercises).			,
Autonomy	Students are capable to gather information from sub	pject related, professional publication	s and relate tha	at information to the
	context of the lecture. They are able to make a conne			
	other lectures (e.g. theory of electromagnetic fields, fu	undamentals of electrical engineering	/ physics). They	can discuss technic
	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	General Engineering Science (German program, 7 seme	ester): Specialisation Electrical Engine	ering: Elective Co	mpulsory
Following Curricula	Electrical Engineering: Core qualification: Elective Com	pulsory		
	Aircraft Systems Engineering: Core qualification: Electiv	ve Compulsory		
	Mechatronics: Specialisation System Design: Elective C	ompulsory		

Course L1669: Introduction t	o Waveguides, Antennas, and Electromagnetic Compatibility
Тур	Lecture
Hrs/wk	3
СР	4
Workload in Hours	Independent Study Time 78, Study Time in Lecture 42
Lecturer	Prof. Christian Schuster
Language	DE/EN
Cycle	SoSe
Content	This course is intended as an introduction to the topics of wave propagation, guiding, sending, and receiving as well as
	Electromagnetic Compatibility (EMC). It will be useful for engineers that face the technical challenge of transmitting high frequency
	/ high bandwidth data in e.g. medical, automotive, or avionic applications. Both circuit and field concepts of wave propagation
	and Electromagnetic Compatibility will be introduced and discussed.
	Topics:
	- Fundamental properties and phenomena of electrical circuits
	- Steady-state sinusoidal analysis of electrical circuits
	- Fundamental properties and phenomena of electromagnetic fields and waves
	- Steady-state sinusoidal description of electromagnetic fields and waves
	- Useful microwave network parameters
	- Transmission lines and basic results from transmission line theory
	- Plane wave propagation, superposition, reflection and refraction
	- General theory of waveguides
	- Most important types of waveguides and their properties
	- Radiation and basic antenna parameters
	- Most important types of antennas and their properties
	- Numerical techniques and CAD tools for waveguide and antenna design
	- Fundamentals of Electromagnetic Compatibility - Coupling mechanisms and countermeasures
	- Shielding, grounding, filtering
	- Standards and regulations
	- EMC measurement techniques
Literature	- Zinke, Brunswig, "Hochfrequenztechnik 1", Springer (1999)
	- J. Detlefsen, U. Siart, "Grundlagen der Hochfrequenztechnik", Oldenbourg (2012)
	- D. M. Pozar, "Microwave Engineering", Wiley (2011)
	- Y. Huang, K. Boyle, "Antenna: From Theory to Practice", Wiley (2008)
	- H. Ott, "Electromagnetic Compatibility Engineering", Wiley (2009)
	- A. Schwab, W. Kürner, "Elektromagnetische Verträglichkeit", Springer (2007)

Course L1877: Introduction 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 M0675: Introd	luction to Communications and R	landom Processes		
Courses				
Title Introduction to Communications an Introduction to Communications an Introduction to Communications an	d Random Processes (L0443)	<b>Typ</b> Lecture Recitation Section (large) Recitation Section (small)	Hrs/wk 3 1	CP 4 1
Module Responsible	Prof. Gerhard Bauch			
Admission Requirements	None			
Recommended Previous Knowledge	Mathematics 1-3     Signals and Systems			
Educational Objectives	After taking part successfully, students have rea	ched the following learning results		
Professional Competence				
Knowledge	The students know and understand the fundamental building blocks of a communications system. They can describe and analyse the individual building blocks using knowledge of signal and system theory as well as the theory of stochastic processes. The are aware of the essential resources and evaluation criteria of information transmission and are able to design and evaluate a basic communications system.			
Skills	The students are able to design and evaluate a basic communications system. In particular, they can estimate the required resources in terms of bandwidth and power. They are able to assess essential evaluation parameters of a basic communications system such as bandwidth efficiency or bit error rate and to decide for a suitable transmission method.		•	
Personal Competence				
Social Competence	The students can jointly solve specific problems	5.		
Autonomy	The students are able to acquire relevant in knowledge during the lecture period by solving to		-	ontrol their level of
Workload in Hours	Independent Study Time 110, Study Time in Lec	ture 70		
Credit points	6			
Course achievement	None			
Examination	Written exam			
Examination duration and	90 min			
scale				
Assignment for the Following Curricula	General Engineering Science (German program, Computer Science: Specialisation Computer and Computer Science: Specialisation Computationa Data Science: Core qualification: Elective Computerical Engineering: Core qualification: Computerical Engineering Science (English program, Computational Science and Engineering: Core qualification: Core q	Software Engineering: Elective Compulsor  I Mathematics: Elective Compulsory  ulsory  7 semester): Specialisation Electrical Engin  ualification: Compulsory	y	

Course L0442: Introduction t	o Communications and Random Processes
Тур	Lecture
Hrs/wk	3
СР	4
Workload in Hours	Independent Study Time 78, Study Time in Lecture 42
Lecturer	Prof. Gerhard Bauch
Language	DE/EN
Cycle	WiSe
Content	Fundamentals of random processes
	Introduction to communications engineering
	Quadrature amplitude modulation
	Description of radio frequency transmission in the equivalent complex baseband
	Transmission channels, channel models
	Analog digital conversion: Sampling, quantization, pulsecode modulation (PCM)
	Fundamentals of information theory, source coding, channel coding
	Digital baseband transmission: Pulse shaping, eye diagramm, 1. and 2. Nyquist condition, matched filter, detection, error probability
	Fundamentals of digital modulation
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.

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

Course L2354: Introduction t	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		

Module M0568: Theor	retical Electrical Engineering II:	Time-Dependent Fiel	lds		
Courses					
<b>Title</b> Theoretical Electrical Engineering II Theoretical Electrical Engineering II	-	<b>Typ</b> Lecture Recitation Se	ection (small)	Hrs/wk 3 2	<b>CP</b> 5 1
	Prof. Christian Schuster				
Recommended Previous Knowledge	Electrical Engineering I, Electrical Engineering Mathematics I, Mathematics II, Mathematics I		ering I		
<b>Educational Objectives</b>	After taking part successfully, students have	reached the following learning re	esults		
Professional Competence					
Knowledge	Students are able to explain fundament- electromagnetic fields. They can assess the regard to respective sources. They can dest solutions for simple fields. The students are a able to explicate these.	principal behavior and character cribe the properties of complex	ristics of quasista electromagnetic	tionary and fully fields by means	dynamic fields with s of superposition of
Skills	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 quantitatively. They can deduce meaningful quantities for the characterization of fully dynamic fields (wave impedance, skin depth, Poynting-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 during exercise sessions).	t related tasks in small groups.	They are able to	present their res	sults effectively (e.g.
Autonomy	Students are capable to gather necessary informable to continually reflect their knowledge by lectures and exercises that are related to the learning process. They are able to draw of University of Technology (TUHH), e.g. in the a	means of activities that accomp exam. Based on respective feed connections between acquired	pany the lecture, dback, students a knowledge and	such as short ora	al quizzes during the adjust their individual
Worldood in U	Independent Childry Time 110 Childry Time in I	Lastura 70			
	Independent Study Time 110, Study Time in I	_ecture /0			
Credit points  Course achievement					
Examination					
Examination duration and scale					
Assignment for the	General Engineering Science (German progra	ım, 7 semester): Specialisation E	Electrical Engineer	ring: Compulson	/
Following Curricula			<u> </u>	_ ,,	
	1	eering Science: Elective Compuls			

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	ourse 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 M0760: Elect	ronic Devices					
Courses						
Title				Тур	Hrs/wk	СР
Electronic Devices (L0720)				Lecture	3	4
Electronic Devices (L0721)	ī			Project-/problem-based Learning	2	2
Module Responsible	Prof. Hoc Khiem Trieu					
Admission Requirements	None					
Recommended Previous	Atomic model and qua	Atomic model and quantum theory, electrical currents in solid state materials, basics in solid-state physics				
Knowledge	Successful participation	Successful participation of Physics for Engineers and Materials in Electrical Engineering or courses with equivalent contents				
<b>Educational Objectives</b>	After taking part succe	essfully, students have r	eached the following	ng learning results		
<b>Professional Competence</b>						
Knowledge						
	Students are able					
	to represent the	e basics of semiconducto	or physics,			
1		perating principle of imp		ctor devices.		
	,			well as to explain their derivation	on and	
	to outline devic	e characteristics and eq	uivaient circuits as	well as to explain their derivation	on and	
	to discuss the li	imitation of device mode	els.			
Skills						
	Ctudente ere conchie					
	Students are capable					
	<ul> <li>to apply device</li> </ul>	s in basic circuits,				
	to realize the pl	hysical context and to so	olve complex probl	ems by oneself		
Personal Competence						
Social Competence	Students are able to p	repare and perform the	ir lab experiments	in team work as well as to prese	ent and discus	s the results in from
	of audience.					
Autonomy	Students are canable	to acquire knowledge ba	sod on literature in	a order to propare their experim	onto	
Workload in Hours	·			n order to prepare their experime	ents.	
Credit points	6	me 110, Study Time in L	ecture 70			
Course achievement	Compulsory Bonus	Form	Description			
Course achievement	Yes 10 %		•	erarbeiten in Kleingruppen Wis	sen zu einem	bestimmten Thema
		practical work		n dieses in Form eines Ve		
			Diskussion. [	Darüber hinaus betreut jede C	Gruppe eine Ü	Jbungsaufgabe, die
			inhaltlich zu d	dem jeweiligen Versuch gehört.		
Examination	Written exam					
Examination duration and	120 min					
scale	0 15					
Assignment for the	3 3			ecialisation Electrical Engineerin	g: Compulsory	
Following Curricula		: Core qualification: Com	. ,	loom.		
		Specialisation Electrical		•	. Commulac:::	
	3 3	. 5 . 5		cialisation Electrical Engineering		conv
	Computational Science	e and Engineering: Spec	iaiisatioii II. Mathel	matics & Engineering Science: El	lective Compu	oui y

Course L0720: Electronic Dev	vices
Тур	Lecture
Hrs/wk	3
СР	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	S.M. Sze: Semiconductor devices, Physics and Technology, John Wiley & Sons (1985)F. Thuselt: Physik der Halbleiterbauelemente, Springer (2011)  T. Thille, D. Schmitt-Landsiedel: Mikroelektronik, Halbleiterbauelemente und deren Anwendung in elektronischen Schaltungen, Springer (2004)  B.L. Anderson, R.L. Anderson: Fundamentals of Semiconductor Devices, McGraw-Hill (2005)  D.A. Neamen: Semiconductor Physics and Devices, McGraw-Hill (2011)  M. Shur: Introduction to Electronic Devices, John Wiley & Sons (1996)  S.M. Sze: Physics of semiconductor devices, John Wiley & Sons (2007)  H. Schaumburg: Halbleiter, B.G. Teubner (1991)  A. Möschwitzer: Grundlagen der Halbleiter-&Mikroelektronik, Bd1 Elektronische Halbleiterbauelemente, Carl Hanser (1992)  HG. Unger, W. Schultz, G. Weinhausen: Elektronische Bauelemente und Netzwerke I, Physikalische Grundlagen der Halbleiterbauelemente, Vieweg (1985)

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

Module M1235: Electrical Power Systems I: Introduction to Electrical Power Systems					
Courses					
Title		Тур	Hrs/wk	СР	
Electrical Power Systems I: Introduc	ction 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				
Recommended Previous	Fundamentals of Electrical Engineering				
Knowledge					
Educational Objectives	After taking part successfully, students have reached the fo	ollowing learning results			
Professional Competence					
Knowledge	Students are able to give an overview of conventional and	modern electric power systems.	They can explain ir	n detail and critically	
	evaluate technologies of electric power generation, transm	ission, storage, and distribution a	s well as integration	on of equipment into	
	electric power systems.				
Skills	With completion of this module the students are able to	o apply the acquired skills in an	polications of the	design, integration.	
	development of electric power systems and to assess the re				
Personal Competence					
Social Competence	The students can participate in specialized and interdisciplinary discussions, advance ideas and represent their own work results in				
	front of others.				
Autonomy	Students can independently tap knowledge of the emphasis of the lectures.				
Workload in Hours	Independent Study Time 110, Study Time in Lecture 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 semeste	r): Specialisation Electrical Engine	ering: Elective Cor	mpulsory	
Following Curricula	General Engineering Science (German program, 7 semester	r): Specialisation Green Technolog	jies, Focus Renewa	able Energy: Elective	
	Compulsory				
	Data Science: Core qualification: Elective Compulsory				
	Electrical Engineering: Core qualification: Elective Compuls				
	Energy and Environmental Engineering: Specialisation Ener		ory		
	Energy Systems: Specialisation Energy Systems: Elective C	• •	wine. Fleetive C	anula anu	
	General Engineering Science (English program, 7 semester		-	іриіѕогу	
	Green Technologies: Energy, Water, Climate: Specialisation Computational Science and Engineering: Specialisation II. N		-	Isory	
	Renewable Energies: Core qualification: Compulsory	actionidates & Engineering Science	c. Liective Compu	1501 y	
	Theoretical Mechanical Engineering: Technical Complement	tary Course: Elective Compulsory			
	Theoretical Mechanical Engineering: Specialisation Energy:				
		-,y			

ourse L1670: Electrical Power Systems I: Introduction to Electrical Power Systems					
Тур	Lecture				
Hrs/wk	3				
СР					
Workload in Hours	Independent Study Time 78, Study Time in Lecture 42				
Lecturer	Prof. Christian Becker				
Language	DE				
Cycle	WiSe				
Content	fundamentals and current development trends in electric power engineering				
	tasks and history of electric power systems				
	symmetric three-phase systems				
	fundamentals and modelling of eletric power systems				
	• lines				
	• transformers				
	synchronous machines				
	induction machines				
	loads and compensation				
	grid structures and substations				
	fundamentals of energy conversion				
	electro-mechanical energy conversion				
	thermodynamics				
	power station technology				
	<ul> <li>renewable energy conversion systems</li> </ul>				
	steady-state network calculation				
	network modelling				
	load flow calculation				
	• (n-1)-criterion				
	symmetric failure calculations, short-circuit power				
	control in networks and power stations				
	grid protection				
	grid planning				
	power economy fundamentals				
Literature	K. Heuck, KD. Dettmann, D. Schulz: "Elektrische Energieversorgung", Vieweg + Teubner, 9. Auflage, 2013				
	A. J. Schwab: "Elektroenergiesysteme", Springer, 5. Auflage, 2017				
	R. Flosdorff: "Elektrische Energieverteilung" Vieweg + Teubner, 9. Auflage, 2008				

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

Module M0783: Meas	urements: Method	s and Data Pro	cessing			
Courses						
Title				Тур	Hrs/wk	СР
EE Experimental Lab (L0781)				Practical Course	2	2
Measurements: Methods and Data				Lecture	2	3
Measurements: Methods and Data	Processing (L0780)			Recitation Section (small)	1	1
Module Responsible	Prof. Alexander Schlaefer					
Admission Requirements	None					
Recommended Previous	principles of mathematics					
Knowledge	principles of electrical eng	neering				
Educational Objectives	After taking part successfu	lly, students have rea	ched the following	ng learning results		
<b>Professional Competence</b>						
Knowledge	The students are able to e	xplain the purpose of	f metrology and	the acquisition and proces	sing of measureme	ents. They can detail
	aspects of probability theo	ry and errors, and exp	plain the process	ing of stochastic signals. S	tudents know meth	ods to digitalize and
	describe measured signals					
Skills	The students are able to e	aluate problems of m	netrology and to	apply methods for describi	ng and processing o	of measurements.
Personal Competence						
Social Competence	The students solve probler	ns in small groups.				
Autonomy	The students can reflect th	eir knowledge and dis	cuse and evalua	to their recults		
Autonomy	The students can reflect th	en knowledge and als	scuss una evalua	te their results.		
		10.01 1.71 1.1	. 70			
Workload in Hours		10, Study Time in Lec	ture 70			
Credit points			D			
Course achievement	Yes 10 % Exc	n ercises	Description			
Examination		ercises				
Examination duration and	90 min					
scale	0 15 1 1 5 1	10				
Assignment for the	3 3			ecialisation Electrical Engin	eering: Elective Co	mpulsory
Following Curricula			-			
	General Engineering Scien			_	eering: Elective Con	npulsory
	Technomathematics: Spec	alisation III. Engineer	ing Science: Elec	tive Compulsory		

Course L0781: EE Experimen	Course L0781: EE Experimental 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, Prof. Rolf-Rainer Grigat, Prof. Herbert Werner, Dozenten des SD E, Prof. Christian Becker, Prof. Heiko			
	Falk, Prof. Thorsten Kern, Prof. Alexander Kölpin			
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: Measurements: Methods and Data Processing		
Тур	Lecture	
Hrs/wk	2	
СР	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: Measurements: Methods and Data Processing		
Тур	Recitation Section (small)	
Hrs/wk	1	
СР	1	
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14	
Lecturer	Prof. Alexander Schlaefer	
Language	DE	
Cycle	WiSe	
Content	See interlocking course	
Literature	See interlocking course	

Module M0777: Semio	conductor Circuit Design			
Courses				
<b>Fitle</b> Semiconductor Circuit Design (L076 Semiconductor Circuit Design (L086		Typ Lecture Recitation Section (small)	Hrs/wk 3 1	<b>CP</b> 4 2
Module Responsible		Recitation Section (Smail)	1	2
Admission Requirements	None			
Recommended Previous	Fundamentals of electrical engineering			
Knowledge	r diladifferitats of electrical engineering			
3	Basics of physics, especially semiconductor physics			
<b>Educational Objectives</b>	After taking part successfully, students have reached	the following learning results		
<b>Professional Competence</b>				
Knowledge	Students are able to explain the functionality of Students are able to explain how analog circuit. Students are able to explain the functionality of Students know the fundamental digital logic colors. Students have knowledge about memory circuit. Students know the appropriate fields for the understanding the students know the students.	ts functions and where they are applied.  of fundamental operational amplifiers and  rcuits and can discuss their advantages a  lits and can explain their functionality and	d their specificat and disadvantag	
Skills	<ul> <li>Students can calculate the specifications of di</li> <li>Students are able to develop different logic ci</li> <li>Students can use MOS devices, operational an</li> </ul>	cuits and can design different types of lo	gic circuits.	ctronic circuits.
Personal Competence Social Competence Autonomy	<ul> <li>Students are able work efficiently in heteroger</li> <li>Students working together in small groups care</li> <li>Students are able to assess their level of known</li> </ul>	solve problems and answer professional	l questions.	
Workload in Hours  Credit points	Independent Study Time 124, Study Time in Lecture	30		
Course achievement				
Examination	Written exam			
Examination duration and	120 min			
scale				
Assignment for the	General Engineering Science (German program, 7 se	mester): Specialisation Electrical Enginee	ering: Compulsor	у
Following Curricula	General Engineering Science (German program,			
	Compulsory			
	Data Science: Core qualification: Elective Compulsor	/		
	Electrical Engineering: Core qualification: Compulsor			
	Engineering Science: Specialisation Electrical Engine	<i>y</i> , ,		
	Engineering Science: Specialisation Mechatronics: Co General Engineering Science (English program, 7 ser	•	ring: Compulsor	
	General Engineering Science (English program,			
	Compulsory	, semester). Specialisation Mechanica	. Linguisecinity,	i ocus inecliati offic
	General Engineering Science (English program, 7 ser	nester): Specialisation Mechatronics: Con	npulsory	
	Computational Science and Engineering: Specialisation			ulsory
	Mechanical Engineering: Specialisation Mechatronics			
	Mechatronics: Core qualification: Compulsory			
	Technomathematics: Specialisation III. Engineering S	cience: Elective Compulsory		

Course L0763: Semiconducto	or Circuit Design
Тур	Lecture
Hrs/wk	3
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/img/bo

Course L0864: Semiconducto	or Circuit Design
	Recitation Section (small)
Hrs/wk	1
СР	2
Workload in Hours	Independent Study Time 46, Study Time in Lecture 14
Lecturer	Prof. Matthias Kuhl, Weitere Mitarbeiter
Language	DE
Cycle	SoSe
Content	Basic circuits and characteristic curves of bipolar transistors Basic circuits and characteristic curves of MOS transistors for amplifiers Realization and dimensioning of operational amplifiers Realization of logic functions Basic circuits with MOS transistors for combinational and sequential logic Memory circuits Circuits for analog-to-digital and digital-to-analog converters Design of exemplary circuits  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

Module M0734: Electr	ical Engineering Project Labora	tory			
Courses					
<b>Title</b> Electrical Engineering Project Labor	ratory (L0640)	<b>Typ</b> Project-/problem-based Lea		lrs/wk	<b>CP</b> 6
Module Responsible	Prof. Christian Becker				
Admission Requirements	None				
Recommended Previous	Electrical Engineering I, Electrical Engineering	II			
Knowledge					
Educational Objectives	After taking part successfully, students have re	eached the following learning results			
Professional Competence	3,,				
-	Students are able to give a summary of the	e technical details of projects in the area	of electi	rical engine	ering and illustrate
	respective relationships. They are capable of	describing and communicating relevant pr	oblems a	nd questions	using appropriate
	technical language. They can explain the typic	al process of solving practical problems and	present	related resul	ts.
Skills	The students can transfer their fundamental				
	They identify and overcome typical problems of			ctrical engine	eering. Students are
	able to develop, compare, and choose concept	ual solutions for non-standardized problems	i.		
Personal Competence					
· ·	Students are able to cooperate in small, mixed	d-subject groups in order to independently	derive sol	lutions to aiv	en problems in the
,	context of electrical engineering. They are al			-	
	qualified audience. Students have the ab	lity to develop alternative approaches	to an e	electrical en	gineering problem
	independently or in groups and discuss advant	ages as well as drawbacks.			
Autonomy	Students are capable of independently solving				
	in as well as extent their knowledge using the meaningfully extend given problems and prag-				
	meaningrany exteria given problems and prag-	natically solve them by means of correspon	unig solu	cions and co	псерса.
Workload in Hours	Independent Study Time 68, Study Time in Lec	ture 112			
Credit points					
Course achievement	None				
Examination	Subject theoretical and practical work				
Examination duration and	based on task + presentation				
scale					
Assignment for the	General Engineering Science (German program	n, 7 semester): Specialisation Electrical Eng	neering:	Compulsory	
Following Curricula	Electrical Engineering: Core qualification: Com	•			
	Engineering Science: Specialisation Electrical I				
	General Engineering Science (English program Technomathematics: Specialisation III. Engineer		neering: C	ompulsory	
	recimonidationatics. Specialisation III. Enginee	and Science. Elective compaisory			

Course L0640: Electrical Engineering 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).			

		anny a con	nmunication
rogramming Concepts, Data Handling & Communication (L2689) rogramming Concepts, Data Handling & Communication (L2690)	Typ Lecture Recitation Section (small)	<b>Hrs/wk</b> 3 2	<b>CP</b> 3 3
Prof. Sibylle Fröschle			
None			
After taking part successfully, students have reached the fol	lowing learning results		
Independent Study Time 110, Study Time in Lecture 70			
6			
Compulsory Bonus Form Description	n		
No 10 % Attestation Testate f	inden semesterbegleitend statt.		
Written exam			
120 min			
General Engineering Science (German program, 7 seme	ester): Specialisation Mechanical	Engineering, F	ocus Biomechanics
Compulsory			
Compulsory General Engineering Science (German program, 7 semes Compulsory General Engineering Science (German program, 7 semes Engineering: Compulsory General Engineering Science (German program, 7 semes Engineering Sciences: Compulsory General Engineering Science (German program, 7 semes Engineering Sciences: Compulsory General Engineering Science (German program, 7 semester) Engineering: Compulsory General Engineering Science (German program, 7 semester) Engineering: Compulsory General Engineering Science (German program, 7 semester) Bioprocess Engineering: Core qualification: Compulsory Electrical Engineering: Core qualification: Compulsory Energy and Environmental Engineering: Core qualification: Core qualification: Core	ter): Specialisation Mechanical Exter): Specialisation Mechanical Interester): Specialisation Mechanical Exter): Specialisation Mechanical Exter): Specialisation Mechanical Enginery: Specialisation Mechanical Enginery: Specialisation Electrical Engineericompulsory Specialisation Process Engineerical	Engineering, Focal Engineering, Focal Engineering, I Engineering, Focus Theering, Focus Foring: Elective Compg: Elective Compg	us Energy Systems  cus Aircraft Systems  Focus Materials in  Focus Mechatronics  neoretical Mechanical  Product Developmen  mpulsory
	Prof. Sibylle Fröschle  None  After taking part successfully, students have reached the fold  After taking part successfully,	rogramming Concepts, Data Handling & Communication (L2690)  Prof. Sibylle Fröschle  None  After taking part successfully, students have reached the following learning results  Independent Study Time 110, Study Time in Lecture 70  6  Compulsory Bonus Form Description No 10 % Attestation Testate finden semesterbegleitend statt.  Written exam 120 min  General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering Science (German program, 7 semester): Specialisation Mechanical Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Compulsory 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 Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering Engineering Science (German program, 7 semester): Specialisation Mechanical Engineeri	rogramming Concepts, Data Handling & Communication (L2689) Lecture 3 rogramming Concepts, Data Handling & Communication (L2690) Recitation Section (small) 2  Prof. Sibylle Fröschle  None  After taking part successfully, students have reached the following learning results  After taking part successfully, students have reached the following learning results  Independent Study Time 110, Study Time in Lecture 70  6  Compulsory Bonus Form Description No 10 % Attestation Testate finden semesterbegleitend statt.  Written exam  120 min  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 Green Technologies, Focus Renew Compulsory  General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Compulsory  General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Planing Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Planing Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Planing Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Planingering, Compulsory  General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Planingering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Planingering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Planingering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Planingering, Compulsory  General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Planingering, Compulsory  General Engineering Science (German program, 7 semester): Specialisation Process Engineering: Elective Compulsory

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

Course L2690: Computer Science for Engineers - Programming Concepts, Data Handling & Communication		
Тур	Recitation Section (small)	
Hrs/wk	2	
СР	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	

## **Specialization Green Technologies**

Module M1711: Green	Tochnologies I			
Module M1/11: Green	i reciniologies i			
Courses				
Title		Тур	Hrs/wk	СР
Introduction to Green Technologies  Meteorology and Climate Systems		Seminar Lecture	2	2
Meteorology and Climate Systems		Recitation Section (small)	2	2
	Prof. Martin Kaltschmitt			
Admission Requirements	None			
Recommended Previous	none			
Knowledge				
Educational Objectives	After taking part successfully, students have reached t	he following learning results		
Professional Competence				
Knowledge	Upon completion of this module, students will be all problems, especially in Hamburg. Furthermore, they a can compare learned technologies in the field of clim and defend it in discussions.	re able to find and process suitable a	approaches to sol	utions. The students
	In addition, students can give an overview of the basic	s of meterology and climate.		
Skills	The students are able to apply the knowledge they have acquired on sustainable technologies in the area of the environmentally and climate-friendly water, energy and climate nexus in order to explain solution approaches for a supply-secure provision.			
	Furthermore, the students are able to explain the proc to renewable energy projects in the context of other m		imate and metero	ology and apply them
Personal Competence Social Competence	Students can  work together in a team of about 3-5 people, discuss tasks on the topics of environmental, resolutions, present their own work results to fellow students assess the performance of fellow students in coper	s and		
Autonomy	The students are able to independently access sour respective learning status in consultation with supenecessary to solve them.			
Workload in Hours	Independent Study Time 96, Study Time in Lecture 84			
Credit points	6			
Course achievement	Compulsory Bonus Form Design Yes 20 % Presentation	cription		
Examination	Written exam			
Examination duration and scale	60 min			
Assignment for the		•	gies: Compulsory	
Following Curricula	Green Technologies: Energy, Water, Climate: Core qua	lification: Compulsory		

Course L2727: Introduction t	o Green Technologies
Тур	Seminar
Hrs/wk	2
СР	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Prof. Martin Kaltschmitt
Language	DE
Cycle	WiSe
Content	<ul> <li>Preliminary discussion of the seminar</li> <li>Interesting presentations by people responsible for climate and environmental protection in Hamburg, keyword: Green Port of Hambur</li> <li>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</li> <li>Presentation of the task / the topic to be worked on with PPT presentation or poster presentation of the results</li> </ul>
Literature	Eigenständiges Literaturstudium in der Bibliothek und aus anderen Quellen.

	and Climate Systems - Introduction
Тур	Lecture
Hrs/wk	2
СР	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	NN
Language	DE
Cycle	
	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	

Course L2829: Meteorology	and Climate Systems - Introduction
Тур	Recitation Section (small)
Hrs/wk	2
СР	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	NN
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  Ulaborate the second second second feaths in the billion
	High and low pressure areas, air masses and fronts, instabilities  Fast feedbacks in climate
	Water vapour, temperature gradient, ice albedo, clouds
	Weather and climate modelling
	Discretisation and num. Solution, parametrisation, data assimilation, boundary conditions, ensemble predictions, chaos, parallel
	computers
	Carbon cycle and earth history
	Reservoirs of carbon, fossil fuels, earth ages, Urey reaction
	Weather extremes
	Rain, wind and heat - meteorological basics, statistical description & climate trends
	Ice and sea level
	Is the sea level rising? Role of ice in Earth's history, snowballs and greenhouses, Milankovitch cycles
	The view from space
Literature	
Literature	l .

Module M1497: Meas	urement Techno	ology for VT	/ BVT			
Courses						
Title				Тур	Hrs/wk	СР
Practical Course Measurement Technology (L2270)			Practical Course	2	2	
Measurement Technology (L2268)				Lecture	2	2
Physical Fundamentals of Measure	ment Technology (L2269)			Lecture	2	2
Module Responsible	Prof. Alexander Penn					
Admission Requirements	None					
Recommended Previous	_	ical skills, integra	al- and differential calc	ulus, basic physical conc	epts such as tempera	ture, mass, velocity,
Knowledge	etc					
Educational Objectives	After taking part succe	essfully, students	have reached the follo	wing learning results		
Professional Competence						
Knowledge	Physical basics: kine	matics and dyna	mics (theory of motion	on), rotation of rigid bo	dies, energy and mo	mentum, electricity,
J.			emperature and heat, i		. 37	
				inty, basics of sensor te		nciples, temperature
	measurement, pressu	re measurement,	level measurement, fic	w measurement. Usage o	or Matiab Scripts.	
	Practical course: Press	sure drop in piping	g, calorimetry, image d	ata acquisition, flow mea	surement, concentration	on measurement and
	mass transfer, capacit	ive measurement	s of solid concentration	ns, spectroscopy, error ca	lculation, chromatogra	phy
Skille	Literature research o	ategorisation of th	hematical tonics analy	rsis of an experimental te	act stand proparation	of test protocol first
Skills				surement technology, pre		·
	calculations.					
Personal Competence						
Social Competence	Arrangement and division of work in practical training and learning groups, assessment of own level of knowledge, work on the					
			Itation with persons	responsible for teaching	, presentation of the	preparation of the
	experiment, tolerance	of frustration				
Autonomy	Time management of	the workload, inc	dependent developmer	t of the thematic basics,	personal responsibility	for the provision of
	protective equipment	and work cloth	ing, practice of prese	entation in front of a gr	roup, active participat	ion in the lectures,
	formulation of enquirie	es/detailed questi	ons by using clicker.			
Workload in Hours	Independent Study Tir	no 06 Study Time	o in Locturo 94			
Credit points		ne 96, Study Time	e in Lecture 84			
Course achievement	Compulsory Bonus	Form	Description			
Course achievement	No 20 %	Excercises		zes währen der Vorlesung	g	
Examination	Written exam		<u></u>	<u> </u>		
Examination duration and	120 min					
scale						
Assignment for the	General Engineering S	science (German p	program, 7 semester): 9	Specialisation Process Eng	gineering: Compulsory	
Following Curricula			-	Specialisation Process Eng		
	General Engineering S	cience (German p	orogram, 7 semester): 9	Specialisation Bioprocess	Engineering: Compulso	ory
	General Engineering S	cience (German p	orogram, 7 semester): 9	Specialisation Green Tech	nologies: Compulsory	
	Bioprocess Engineerin	g: Core qualificati	ion: Compulsory			
			-	pecialisation Process Engi	ineering: Compulsory	
	_		mate: Core qualification	n: Compulsory		
	Orientation Studies: C					
	Process Engineering: (	Core qualification:	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
СР	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Prof. Alexander Penn
Language	DE
Cycle	WiSe
Content	Basic introduction to measurement technology for process engineers. Includes error calculation, measurement units, calibration, measurement data analysis, measurement techniques and sensors. Particular attention is paid to the measurement of temperature, pressure, flow and level. The lecture provides insights into the latest developments in sensor technology in measurement technology and process engineering.
Literature	Fraden, Jacob (2016): Handbook of Modern Sensors. Physics, Designs, and Applications. 5th ed. 2016. Cham, New York: Springer. Online verfügbar unter http://search.ebscohost.com/login.aspx?direct=true&scope=site&db=nlebk&AN=1081958.  Hering, Ekbert; Schönfelder, Gert (2018): Sensoren in Wissenschaft und Technik. Funktionsweise und Einsatzgebiete. 2. Aufl. 2018. Online verfügbar unter http://dx.doi.org/10.1007/978-3-658-12562-2.  Strohrmann, Günther (2004): Messtechnik im Chemiebetrieb. Einführung in das Messen verfahrenstechnischer Größen. 10., durchges. Aufl. München: Oldenbourg.  Tränkler, Hans-Rolf; Reindl, Leonhard M. (2014): Sensortechnik. Handbuch für Praxis und Wissenschaft. 2., völlig neu bearb. Aufl. Berlin: Springer Vieweg (VDI-Buch). Online verfügbar unter http://dx.doi.org/10.1007/978-3-642-29942-1.  Webster, John G.; Eren, Halit B. (2014): Measurement, Instrumentation, and Sensors Handbook, Second Edition. Electromagnetic, Optical, Radiation, Chemical, and Biomedical Measurement. 2nd ed. Hoboken: Taylor and Francis. Online verfügbar unter http://gbv.eblib.com/patron/FullRecord.aspx?p=1407945.

Course L2269: Physical Fundamentals of Measurement Technology		
Тур	Lecture	
Hrs/wk	2	
СР	2	
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28	
Lecturer	Prof. Christian Schroer	
Language	DE	
Cycle	WiSe	
Content		
Literature		

Module M1714: Conve	entional Energy Systems and Energy Econ	omics		
Courses				
Title		Тур	Hrs/wk	СР
Energy systems and markets (L274	14)	Lecture	2	2
Fossil Energy Sources (L2745)		Lecture	3	3
Fossil Energy Sources (L2746)		Recitation Section (large)	1	1
Module Responsible	Prof. Martin Kaltschmitt			
Admission Requirements	None			
Recommended Previous	none			
Knowledge				
<b>Educational Objectives</b>	After taking part successfully, students have reached the follo	wing learning results		
Professional Competence				
Knowledge				
Skills				
Personal Competence				
Social Competence	The students are able to analyze suitable technical alterna	tives and to assess them with	technical, econor	mical and ecological
	criteria under sustainability aspects.			
Autonomy	Students can independently exploit sources , acquire the p	articular knowledge about the s	subject area and	transform it to new
Autonomy	questions.	articular knowledge about the s	subject area and	transform to to new
	questions.			
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):	Specialisation Green Technologi	ies: Compulsory	
	Green Technologies: Energy, Water, Climate: Core qualification			
_				

Course L2744: Energy system	ourse L2744: Energy systems and markets		
Тур	Lecture		
Hrs/wk	2		
СР	2		
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28		
Lecturer	Prof. Martin Kaltschmitt		
Language	DE		
Cycle	SoSe		
Content			
Literature			

Course L2745: Fossil Energy	Course L2745: Fossil Energy Sources		
Тур	Lecture		
Hrs/wk	3		
СР	3		
Workload in Hours	Independent Study Time 48, Study Time in Lecture 42		
Lecturer	Prof. Martin Kaltschmitt		
Language	DE		
Cycle	SoSe		
Content			
Literature			

Course L2746: Fossil Energy	Course L2746: Fossil Energy Sources	
Тур	Recitation Section (large)	
Hrs/wk	1	
СР	1	
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14	
Lecturer	Prof. Martin Kaltschmitt	
Language	DE	
Cycle	SoSe	
Content		
Literature		

Module M1715: Renev	wable Energies			
Courses				
Title		Тур	Hrs/wk	СР
Renewable Energies I (L2740)		Lecture	2	2
Renewable Energies I (L2742)		Recitation Section (large)	1	1
Renewable Energies II (L2741)		Lecture	2	2
Renewable Energies II (L2743)		Recitation Section (large)	1	1
Module Responsible	Prof. Martin Kaltschmitt			
Admission Requirements	None			
Recommended Previous	none			
Knowledge				
Educational Objectives	After taking part successfully, students have r	eached the following learning results		
Professional Competence				
Knowledge				
61.71				
Skills				
Personal Competence				
Social Competence	The students are able to analyze suitable to			,
	criteria under sustainability aspects. This allov	vs them to make an effective contribuition to a	more sustainable	power supply.
Autonomy	Students can independently exploit sources	acquire the particular knowledge about the	subject area and	transform it to new
	questions.	,	,	
	questions			
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	90 min			
scale				
Assignment for the	General Engineering Science (German program	m, 7 semester): Specialisation Green Technolog	gies: Compulsory	
Following Curricula	Green Technologies: Energy, Water, Climate: 0	Core qualification: Compulsory		

Course L2740: Renewable En	ourse L2740: Renewable Energies I		
Тур	Lecture		
Hrs/wk	2		
СР	2		
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28		
Lecturer	Prof. Martin Kaltschmitt		
Language	DE		
Cycle	SoSe		
Content			
Literature	Kaltschmitt, M.; Streicher, W.; Wiese, A. (Hrsg.): Erneuerbare Energien - Systemtechnik, Wirtschaftlichkeit, Umweltaspekte;		
	Springer, Berlin, Heidelberg, 2020, 6. Auflage		

Course L2742: Renewable Er	nergies I
Тур	Recitation Section (large)
Hrs/wk	1
СР	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 Hydropower Heat pump  Deep geothermal energy
Literature	Kaltschmitt, M.; Streicher, W.; Wiese, A. (Hrsg.): Erneuerbare Energien - Systemtechnik, Wirtschaftlichkeit, Umweltaspekte; Springer, Berlin, Heidelberg, 2020, 6. Auflage

Course L2741: Renewable Energies 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
Content	
Literature	

Course L2743: Renewable Energies II	
Тур	Recitation Section (large)
Hrs/wk	1
СР	1
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14
Lecturer	Prof. Martin Kaltschmitt
Language	DE
Cycle	SoSe
Content	
Literature	

Module M0536: Funda	amentals of Fluid Mechanics			
Courses				
Title		Тур	Hrs/wk	СР
Fundamentals of Fluid Mechanics (	L0091)	Lecture	2	4
Fluid Mechanics for Process Engine	ering (L0092)	Recitation Section (large)	2	2
Module Responsible				
Admission Requirements	None			
Recommended Previous	Mathematics I+II+III			
Knowledge	Technical Mechanics I+II			
	Technical Thermodynamics I+II			
	Working with force balances			
	Simplification and solving of partial differential	equations		
	Integration			
Educational Objectives	After taking part successfully, students have reached	the following learning results		
<b>Professional Competence</b>				
Knowledge	Students are able to:			
	explain the difference between different types	of flow		
	give an overview for different applications of the ground of the gr		ss engineering	
	explain simplifications of the Continuity- and No.			ions
CL III				
SKIIIS	The students are able to			
	<ul> <li>describe and model incompressible flows math</li> </ul>	ematically		
	<ul> <li>reduce the governing equations of fluid mechanics</li> </ul>		ative solutions e	.g. by integration
	notice the dependency between theory and tec	• •		
	<ul> <li>use the learned basics for fluid dynamical appli</li> </ul>	cations in fields of process engineering		
<b>Personal Competence</b>				
Social Competence	The students			
	are capable to gather information from subject	t related, professional publications and	relate that inforn	nation to the contex
	of the lecture and			
	<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 Englis
	(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			
•				
	search further literature for each topic and to e	· -		
	<ul> <li>work on their exercises by their own and to eval</li> </ul>	duate their actual knowledge with the le	еспраск.	
Workload in Hours	Independent Study Time 124, Study Time in Lecture 5	56		
Credit points				
Course achievement		scription		
Evamination	Yes 5 % Midterm Written exam			
Examination duration and				
scale	3 Hours			
Assignment for the	General Engineering Science (German program, 7 ser	nester): Specialisation Process Engineer	ina: Compulsorv	
Following Curricula				ory
-	General Engineering Science (German program, 7 ser			
	General Engineering Science (German program, 7 ser	nester): Specialisation Energy and Envir	omental Enginee	ring: Compulsory
	Bioprocess Engineering: Core qualification: Compulso			
	Energy and Environmental Engineering: Core qualification			
	Green Technologies: Energy, Water, Climate: Core qu	• •		
	Logistics and Mobility: Specialisation Traffic Planning a			
	Technomathematics: Specialisation III. Engineering So Process Engineering: Core qualification: Compulsory	herice: Elective Compulsory		
	Engineering: Core qualification: Compulsory Engineering and Management - Major in Logistics and	Mobility: Specialisation Traffic Planning	and Systems: Fla	ective Compulsory
	and management - major in Logistics and		and Systems. Lit	cc.vc compaisory

Course L0091: Fundamentals	s of Fluid Mechanics
Тур	Lecture
Hrs/wk	2
СР	4
Workload in Hours	Independent Study Time 92, Study Time in Lecture 28
Lecturer	Prof. Michael Schlüter
Language	DE
Cycle	SoSe SoSe
Content	fluid properties hydrostatic overall balances - theory of streamline overall balances- conservation equations differential balances - Navier Stokes equations irrotational flows - Potenzialströmungen flow around bodies - theory of physical similarity turbulent flows
Literature	compressible flows
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> </ol>
	<ol> <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</li> </ol>
	<ol> <li>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> </ol>
	<ol> <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
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>

Module M0686: Sanit	ary Engineering I			
Courses				
<b>Title</b> Wastewater Disposal (L0276) Wastewater Disposal (L0278)		<b>Typ</b> Lecture Recitation Section (large)	Hrs/wk 2 1	<b>CP</b> 2 1
Drinking Water Supply (L0306) Drinking Water Supply (L0308)		Lecture Recitation Section (large)	2 1	1 2
Module Responsible	Prof. Ralf Otterpohl			
Admission Requirements	None			
Recommended Previous Knowledge	Basic knowledge on Chemistry and Biology Hydraulics of pipe systems and open channels Basic knowledge on water management: water Basic knowledge on Environmental Legislation:			
<b>Educational Objectives</b>	After taking part successfully, students have reached t	he following learning results		
Professional Competence Knowledge	The students can examplify their expert knowledge on urban water infrastructures. They can present the derivation and detailed explanation of important standards for the design of drinking water supply and wastewater disposal systems in Germany and they are capable of reproducing the relevant empiricals assumptions and scientific simplifications. The students are able to present and discuss sanitary engineering processes and the technologies used for drinking and wastewater treatment. They can also assess existing problems in the field of sanitary engineering by considering legal, risk and saftey aspects. Furthermore, they know how to draft the features and effectiveness of important technologies of the future such as high- and low-pressure membrane filtration systems and techniques for the removal of trace pollutants.			
Skills	The students are able to apply the relevant standards and guidelines for the design and operation of urban water infrastructures independently. Their expertise comprises expert skills to design drinking water supply and urban drainage systems as well as the associated treatment facilities. Besides the acquirement of technical skills the students are able to address and solve biochemical problems in the filed of drinking water and wastewater treatment. The students are also able to develop ideas of their own to improve the existing water related infrastructures, systems and concepts.			
Personal Competence Social Competence	Social skills are not targeted in this module.			
Autonomy	Students are able to form concepts on their own to optimize urban water infrastructure processes. Therefore they can acquire appropriate knowledge when being given some clues or information with regard to the approach to problems (preparation and follow-up of the exercises).			
Workload in Hours	Independent Study Time 96, Study Time in Lecture 84			
Credit points	6			
Course achievement				
	Written exam			
Examination duration and scale	120 min			
Assignment for the	General Engineering Science (German program, 7 sem	ester): Specialisation Civil Engineering:	Elective Compu	sory
Following Curricula	General Engineering Science (German program, 7 sem		ies: Compulsory	
	Civil- and Environmental Engineering: Core qualificatio	• •		
	Civil- and Environmental Engineering: Core qualificatio		Elective Comment	·on/
	General Engineering Science (English program, 7 seme Green Technologies: Energy, Water, Climate: Core qua		Elective Compuls	ьог у

Course L0276: Wastewater D	isposal
Тур	Lecture
Hrs/wk	2
СР	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Prof. Ralf Otterpohl
Language	DE
Cycle	SoSe 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, Membrane 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.).</li> <li>München: Oldenbourg Industrieverl.</li> </ul>
	Abwasser : Technik und Kontrolle. Neitzel, Volkmar, and Weinheim [u.a.]: Wiley-VCH, 1998.
	<ul> <li>Kommunale Kläranlagen: Bemessung, Erweiterung, Optimierung, Betrieb und Kosten, (2009). Günthert, F. Wolfgang: (3., völlig neu bearb. Aufl.). Renningen: expert-Verl.</li> </ul>
	• Water and wastewater technology Hammer, M. J. 1., & . (2012). (7. ed., internat. ed.). Boston [u.a.]: Pearson Education International.
	• Water and wastewater engineering : design principles and practice: Davis, M. L. 1. (2011) New York, NY: McGraw-Hill.
	Biological wastewater treatment: (2011). C. P. Leslie Grady, Jr. (3. ed.). London, Boca Raton, Fla. [u.a.]: IWA Publ.

Course L0278: Wastewater 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 Water Supply					
Тур	Lecture				
Hrs/wk	2				
СР	1				
Workload in Hours	dependent 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).				
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Course L0308: Drinking Water	ourse L0308: Drinking Water Supply		
Тур	Recitation Section (large)		
Hrs/wk	1		
СР	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		

Module M1712: Green	Technologies II			
Courses				
Title Practical Exercise Environmental Technology (L1387) Environmental Assessment (L0860) Environmental Assessment (L1054)		Typ Practical Course Lecture Recitation Section (small)	Hrs/wk 1 2	CP 1 2
Environmental Technologie (L0326)		Lecture	2	2
Module Responsible	Dr. Isabel Höfer			
Admission Requirements	None			
Recommended Previous Knowledge	Fundamentals of inorganic/organic chemistry and biology.			
<b>Educational Objectives</b>	After taking part successfully, students have reached the f	ollowing learning results		
Professional Competence				
	With the completion of this modul the students obtain profound knowledge of environmental technology. They are able to describe the behaviour of chemicals in the environment. Students can give an overview of scientific disciplines involved. They can explain terms and allocate them to related methods.  Additional students acquire in-depth knowledge of important cause-effect chains of potential environmental problems which might occur from production processes, projects or construction measures. They have knowledge about the methodological diversity and are competent in dealing with different methods and instruments to assess environmental impacts. Besides the students are able			
Skills	to estimate the complexity of these environmental processes as well as uncertainties and difficulties with their measurement.  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 opinions in front of and against the group.  The students are able to select a suitable method for the respective case from the variety of assessment methods. Thereby they can develop suitable solutions for managing and mitigating environmental problems in a business context. They are able to carry out Life Cycle Impact Assessments independently and can apply the software programs OpenLCA and the database Ecolonvent. After finishing the course the students have the competence to critically judge research results or other publications on environmental impacts.			
Personal Competence				
Social Competence	The students are able to discuss the various technical and scientific tasks, both subject-specific and multidisciplinary. They are able to develop different approaches to the task as a group as well as 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			
Autonomy	concept of sustainability. Their sensitivity and consciousness towards these subjects are raised and which helps to raise their awareness of their future social responsibilities in their role as engineers.  The students learn to research, process and present a scientific topic independently. They are able to carry out independent scientific work. They can solve an environmental problem in a business context and are able to judge results of other publications.			
Workload in Hours	Independent Study Time 96, Study Time in Lecture 84			
Credit points	6			
Course achievement	None			
Examination	Written exam			
Examination duration and scale	120 min			
Assignment for the Following Curricula	General Engineering Science (German program, 7 semeste Green Technologies: Energy, Water, Climate: Core qualifica	· ·	ies: Compulsory	

Course L1387: Practical Exer	cise Environmental Technology
Тур	Practical Course
Hrs/wk	
СР	1
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14
Lecturer	Prof. Martin Kaltschmitt, Dr. Isabel Höfer
Language	DE
Cycle	SoSe
	The practical course Environmental Engineering currently consists of 6 experiments, which deal with the different focal points of environmental engineering in the areas of air, water, soil, environment, biomass and noise. The following experiments are carried out for this purpose:  Determination of the calorific value of biomass, soil purification, waste water treatment, noise emissions, plastic waste, biowaste.  Translated with www.DeepL.com/Translator (free version)  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	

Course L0860: Environmenta	I Assessment			
Тур	Lecture			
Hrs/wk				
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)			

Course L1054: Environmental Assessment				
Тур	Recitation Section (small)			
Hrs/wk	1			
СР	1			
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14			
Lecturer	Prof. Martin Kaltschmitt, Dr. Anne Rödl			
Language	DE			
Cycle	WiSe			
Content	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.			
Literature	Power point Präsentationen			

Course L0326: Environmental Technologie		
Тур	Lecture	
Hrs/wk	2	
СР	2	
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28	
Lecturer	Prof. Martin Kaltschmitt, Dr. Isabel Höfer	
Language	DE	
Cycle	WiSe	
Content	1. Introductory seminar on environmental science: 2. Environmental impact and adverse effects 3. Wastewater technology 4. Air pollution control 5. Noise protection 6. Waste and recycling management 7. Soil and ground water protection 8. Renewable energies 9. Resource conservation and energy efficiency  Förster, U.: Umweltschutztechnik; 2012; Springer Berlin (Verlag) 8., Aufl. 2012; 978-3-642-22972-5 (ISBN)	

Module M0538: Heat	and Mass Transfer			
Courses				
Title		Тур	Hrs/wk	СР
Heat and Mass Transfer (L0101)		Lecture	2	2
Heat and Mass Transfer (L0102)		Recitation Section (small)	1	2
Heat and Mass Transfer (L1868)		Recitation Section (large)	1	2
Module Responsible	Prof. Irina Smirnova			
Admission Requirements	None			
Recommended Previous	Basic knowledge: Technical Thermodynamics			
Knowledge				
Educational Objectives	After taking part successfully, students have reached the	e following learning results		
Professional Competence				
Knowledge				
	The students are capable of explaining qualitative	and determining quantitative heat	transfer in proced	lural apparatus (e. g.
	heat exchanger, chemical reactors).			
	They are capable of distinguish and characterize of the second seco	different kinds of heat transfer mec	nanisms namely h	eat conduction, heat
	transfer and thermal radiation.			
	The students have the ability to explain the ph		detail and to des	scribe mass transfer
	qualitative and quantitative by using suitable mas			
	They are able to depict the analogy between heat-	- and mass transfer and to describe	complex linked pr	ocesses in detail.
Skills				
Skiiis	<ul> <li>The students are able to set reasonable system is</li> </ul>	boundaries for a given transport pr	oblem by using th	ne gained knowledge
	and to balance the corresponding energy and mas	ss flow, respectively.		
	<ul> <li>They are capable to solve specific heat transfer p</li> </ul>	problems (e.g. heated chemical rea	ctors, temperature	e alteration in fluids)
	and to calculate the corresponding heat flows.			
	Using dimensionless quantities, the students can expressions	execute scaling up of technical proce	esses or apparatus	5.
	They are able to distinguish between diffusion, co	nvective mass transition and mass	transfer. They car	use this knowledge
	for the description and design of apparatus (e.g. e	xtraction column, rectification colun	nn).	
	In this context, the students are capable to choose	e and design fundamental types of h	neat and mass exc	changer for a specific
	application considering their advantages and disac	dvantages, respectively.		
	In addition, they can calculate both, steady-state a	and non-steady-state processes in p	rocedural apparat	us.
	The students are capable to connect their knowledge.	owledge obtained in this course	with knowlegde	of other courses (In
	particular the courses thermodynamics, fluid me	echanics and chemical process eng	gineering) to solve	e concrete technical
	problems.			
Personal Competence				
Social Competence				
	The students are capable to work on subject-specific	cific challenges in teams and to pre	sent the results o	rally in a reasonable
	manner to tutors and other students.			
Autonomy				
Autonomy	The students are able to find and evaluate necess.	ary information from suitable source	2S	
	They are able to prove their level of knowledge	during the course with accompar	nying procedure o	continuously (clicker-
	system, exam-like assignments) and on this basis	they can control their learning proc	esses.	
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56			
Credit points				
Course achievement				
Examination				
	120 minutes; theoretical questions and calculations			
scale		ton). Consisting Dec	nin n. C !	
_	General Engineering Science (German program, 7 semes	· ·		
Following Curricula	General Engineering Science (German program, 7 semes			ory
	General Engineering Science (German program, 7 semes			ala a Can
	General Engineering Science (German program, 7 semes	ter): Specialisation Energy and Envi	romental Enginee	ring: Compulsory
	Bioprocess Engineering: Core qualification: Compulsory			
	Energy and Environmental Engineering: Core qualification	• •		
	General Engineering Science (English program, 7 semest			
	General Engineering Science (English program, 7 semest			ing: Compulsory
	General Engineering Science (English program, 7 semester): Specialisation Process Engineering: Compulsory			
	Green Technologies: Energy, Water, Climate: Core qualification: Compulsory			
	Technomathematics: Specialisation III. Engineering Scien	ice: Elective Compulsory		
	Process Engineering: Core qualification: Compulsory			

Course L0101: Heat and Mass Transfer			
Тур	Lecture		
Hrs/wk			
СР			
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28		
Lecturer	Prof. Irina Smirnova		
Language	DE		
Cycle	WiSe		
Content	1. Heat transfer  Introduction, one-dimensional heat conduction  Convective heat transfer  Multidimensional heat conduction  Non-steady heat conduction  Thermal radiation  Mass transfer  one-way diffusion, equimolar countercurrent diffusion  boundary layer theory, non-steady mass transfer  Heat and mass transfer single particle/ fixed bed  Mass transfer and chemical reactions		
Literature	H.D. Baehr und K. Stephan: Wärme- und Stoffübertragung, Springer     VDI-Wärmeatlas		

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

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

## **Focus Renewable Energy**

Module M1713: Green	Technologies III			
Courses				
Title		Тур	Hrs/wk	СР
Study Work Green Technologies (L2	2766)	Project Seminar	2	4
Scientific Work and Writing (L2765)		Seminar	2	2
Module Responsible	Dozenten des Studiengangs			
Admission Requirements	None			
Recommended Previous	keine			
Knowledge				
Educational Objectives	After taking part successfully, students have reached the	following learning results		
<b>Professional Competence</b>				
Knowledge	The students, based on a literature survey, learn to study in detail a subject theme from the disciplines of green technologies and deliver afterwards a summary presentation to a specialised audience. Environmental issues and their multidisciplinary linkages are preferred, when selecting the thematic area of these studies. Through their own written contribution the students communicate an overview over the subject and practice technical writing. With the discussion the students practice scientific debating on a specialised subject matter.			
Skills	The students can, when working on a technical topic not familiar to them:  conduct a literature survey  choose the relevant information for their presentation  prepare a written summary  present results in front of peers and staff  correctly cite and reference sources.			
Personal Competence Social Competence	The students practice a critical assessment of the literature in a predefined specialised theme and learn to give presentations of their own technical sub-topic tailored to their public and discuss with the audience. When attending technical presentations, the students can formulate questions to other speakers and participate in the ensuing discussion.			
Autonomy	The fulfilment of the tasks combines independent work w	- '	and write a ccientifi	c roport
Autonomy	The students can, guided by instructors, critically reflect of	on their learning and work Status	s, and write a scientin	с тероп.
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56			
Credit points	6			
Course achievement	None			
Examination	,			
Examination duration and	?			
scale				
Assignment for the Following Curricula	General Engineering Science (German program, 7 semest Compulsory General Engineering Science (German program, 7 semest Engineering: Elective Compulsory Green Technologies: Energy, Water, Climate: Specialisation Green Technologies: Energy, Water, Climate: Specialisation	ster): Specialisation Green Techron Energy Technology: Elective (	nologies, Focus Water	
	Green Technologies: Energy, Water, Climate: Specialisation Green Technologies: Energy, Water, Climate: Specialisation			

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

Course L2765: Scientific Wor	k and Writing
Тур	Seminar
Hrs/wk	2
СР	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Prof. Martin Kaltschmitt, Dr. Detlev Bieler, Florian Hagen
Language	DE
Cycle	WiSe
Content	The seminar offers an introduction into the diverse aspects of academic research and writing: Finding the topic, finding specialized information, knowledge organisation, writing, presenting and publishing. Suggestions for reflecting own processes of learning, informing and writing - in addition to practical recommendations and tips - facilitate the start and the creation of bachelor and master theses, works, which bring thoroughly self-fulfillment and make fun.  Topics of the seminar will be in particular
	<ul> <li>Scientific scholarship and academic research methods:</li> <li>Introduction, organization, attributes of science:         How is scientific knowledge created?         Work scheduling, finding topics, time management, specialities of academic research in engineering</li> <li>Finding specialized information: Full texts and library resources, databases http://www.tub.tuhh.de/en/subject-information/informing-points-to-survive/</li> <li>Reference management: http://www.tub.tuhh.de/en/publishing/reference-management/         Knowledge organisation and creating publications with Citavi</li> <li>Citing correctly and avoiding plagiarism</li> <li>Preparing and doing presentations</li> </ul>
Literature	<ol> <li>Semesterapparat "Wissenschaftliches Arbeiten" in der TU-Bibliothek: https://inyurl.com/Semesterapparat-Wiss-Arbeiten</li> <li>Weblog Wissenschaftliches Arbeiten der TU-Bibliothek: https://www.tub.tuhh.de/wissenschaftliches-arbeiten/</li> <li>Online-Tutorial VISION der TU-Bibliothek zum wissenschaftlichen Arbeiten: https://www.vision.tuhh.de (funktioniert nur mit installiertem Flash)</li> <li>Andreas Hirsch-Weber, Stefan Scherer: Wissenschaftliches Arbeiten und Abschlussarbeit in Natur- und Ingenieurwissenschaften: Grundlagen, Praxisbeispiele, Übungen. Stuttgart: Ulmer, 2016.</li> <li>Werner Sesink: Einführung in das wissenschaftliche Arbeiten: inklusive E-Learning, Web-Recherche, digitale Präsentation u.a. 9., aktualisierte Aufl. München: Oldenbourg, 2012.</li> <li>Judith Theuerkauf: Schreiben im Ingenieurstudium: effektiv und effizient zur Bachelor-, Master- und Doktorarbeit. Paderborn: Schöningh, 2012.</li> <li>Wolfsberger, Judith: Frei geschrieben: Mut, Freiheit &amp; Strategie für wissenschaftliche Abschlussarbeiten. Wien: Böhlau, 2010</li> <li>Biedermann, Wieland u.a.: Forschungsmethodik in den Ingenieurwissenschaften: Skript vom Lehrstuhl für Produktentwicklung, Prof. DrIng. Udo Lindemann, Technische Universität München (TUM), 2012. https://www.mw.tum.ude/fileadmin/w00btx/lpl/Documents/Forschungsmethodik_Skript.pdf</li> <li>Wissenschaftliches Arbeiten - HOOU Angebot der HCU Hamburg: https://blogs.hoou.de/wissarbeiten/</li> <li>Course Reserves Collection "Scholarly Research Methods" in the TUHH library: http://tinyurl.com/Semesterapparat-Wiss-Arbeiten</li> <li>Scholarly research methods via TUHH library Website: https://www.tub.tuhh.de/en/scholarly-research-methods/</li> <li>VISION - Online-Tutorial on research methods by the TUHH library: http://www.vision.tuhh.de (Flash has to be installed)</li> <li>Scientific papers and presentations / Martha Davis. 3. ed. Amsterdam: Elsevier / Academic Press, 2013. http://www.sciencedirect.com/science/book/9780</li></ol>

Module M1235: Electrical Power Systems I: Introduction to Electrical Power Systems				
Courses				
Title		Тур	Hrs/wk	СР
Electrical Power Systems I: Introduc	ction 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			
Recommended Previous	Fundamentals of Electrical Engineering			
Knowledge				
Educational Objectives	After taking part successfully, students have reached the fo	ollowing learning results		
Professional Competence				
Knowledge	Students are able to give an overview of conventional and	modern electric power systems.	They can explain ir	n detail and critically
	evaluate technologies of electric power generation, transm	ission, storage, and distribution a	s well as integration	on of equipment into
	electric power systems.			
Skills	With completion of this module the students are able to	o apply the acquired skills in an	polications of the	design, integration.
	development of electric power systems and to assess the re			
Personal Competence				
Social Competence	The students can participate in specialized and interdiscipli	nary discussions, advance ideas a	ind represent their	own work results in
	front of others.			
Autonomy	Students can independently tap knowledge of the emphasis	s of the lectures.		
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 - 150 minutes			
scale				
Assignment for the	General Engineering Science (German program, 7 semeste	r): Specialisation Electrical Engine	ering: Elective Cor	mpulsory
Following Curricula	General Engineering Science (German program, 7 semester	r): Specialisation Green Technolog	ies, Focus Renewa	able Energy: Elective
	Compulsory			
	Data Science: Core qualification: Elective Compulsory			
	Electrical Engineering: Core qualification: Elective Compuls			
	Energy and Environmental Engineering: Specialisation Ener		ory	
	Energy Systems: Specialisation Energy Systems: Elective C	• •	wine. Fleetive C	anula anu
	General Engineering Science (English program, 7 semester		-	іриіѕогу
	Green Technologies: Energy, Water, Climate: Specialisation Computational Science and Engineering: Specialisation II. N		-	Isory
	Renewable Energies: Core qualification: Compulsory	actionidates & Engineering Science	c. Liective Compu	1501 y
	Theoretical Mechanical Engineering: Technical Complement	tary Course: Elective Compulsory		
	Theoretical Mechanical Engineering: Specialisation Energy:			
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Hrs/wk 3 CP 4  Workload in Hours Lecture Prof. Christian Becker Language DE Cycle Wilse  Content  - fundamentals and current development trends in electric power engineering - tasks and history of electric power systems - symmetric three-phase systems - induction machines - induction machines - loads and compensation - grid structures and substations - fundamentals of energy conversion - electro-mechanical energy conversion - o thermodynamics - power station technology - renewable energy conversion systems - stady-state network calculation - o network modelling - load flow calculation - o 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: "Elektroenerglesysteme", Springer, 5. Auflage, 2017	Course L1670: Electrical Pow	rer Systems I: Introduction to Electrical Power Systems	
Workload in Hours  Lecturer  Language  Cycle  Content  Co	Тур	Lecture	
Workload in Hours   Independent Study Time 78, Study Time in Lecture 42	Hrs/wk	3	
Lecturer  Language DE  Cycle WiSe  Content  • fundamentals and current development trends in electric power engineering • tasks and history of electric power systems • symmetric three-phase systems • fundamentals and modelling of eletric power systems • lines • transformers • synchronous machines • induction machines • loads and compensation • grid structures and substations • fundamentals of energy conversion • electro-mechanical energy conversion • thermodynamics • power station technology • renewable energy conversion systems • steady-state network calculation • network modelling • load flow calculation • (n-1)-criterion • symmetric failure calculations, short-circuit power • control in networks and power stations • grid protection • grid planning • power economy fundamentals  Literature  K. Heuck, KD. Dettmann, D. Schulz: "Elektrische Energieversorgung", Vieweg + Teubner, 9. Auflage, 2013	СР	4	
Cycle   WiSe	Workload in Hours	Independent Study Time 78, Study Time in Lecture 42	
Content  • fundamentals and current development trends in electric power engineering • tasks and history of electric power systems • symmetric three-phase systems • fundamentals and modelling of eletric power systems • lines • transformers • synchronous machines • induction machines • loads and compensation • grid structures and substations • fundamentals of energy conversion • electro-mechanical energy conversion • thermodynamics • power station technology • renewable energy conversion systems • steady-state network calculation • network modelling • load flow calculation • (n-1)-criterion • symmetric failure calculations, short-circuit power • control in networks and power stations • grid protection • grid planning • power economy fundamentals  Literature  K. Heuck, KD. Dettmann, D. Schulz: "Elektrische Energieversorgung", Vieweg + Teubner, 9. Auflage, 2013	Lecturer	Prof. Christian Becker	
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tasks and history of electric power systems symmetric three-phase systems fundamentals and modelling of eletric power systems lines transformers synchronous machines synchronous machines loads and compensation grid structures and substations fundamentals of energy conversion electro-mechanical energy conversion electro-mechanical energy conversion renewable energy conversion systems steady-state network calculation network modelling load flow calculation (n-1)-criterion symmetric failure calculations, short-circuit power control in networks and power stations grid protection grid planning power economy fundamentals  Literature  K. Heuck, KD. Dettmann, D. Schulz: "Elektrische Energieversorgung", Vieweg + Teubner, 9. Auflage, 2013	Content	• fundamentals and current development trends in electric power engineering	
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R. Flosdorff: "Elektrische Energieverteilung" Vieweg + Teubner, 9. Auflage, 2008		R. Flosdorff: "Elektrische Energieverteilung" Vieweg + Teubner, 9. Auflage, 2008	

Typ Recitation Section (small)  Hrs/wk 2  CP 2  Workload in Hours Independent Study Time 32, Study Time in Letecturer Prof. Christian Becker  Language DE  Cycle WiSe  Content  • fundamentals and current developmen • tasks and history of electric power syst • symmetric three-phase systems • fundamentals and modelling of eletric • lines • transformers • synchronous machines • induction machines • loads and compensation • grid structures and substations • fundamentals of energy conversion • electro-mechanical energy conv • thermodynamics • power station technology • renewable energy conversion sy	trends in electric power engineering	
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A. J. Schwab: "Elektroenergiesysteme", Spring	er. 5. Auflage. 2017	
R. Flosdorff: "Elektrische Energieverteilung" v	- ,	

Module M0639: Gas a	nd Steam Powe	r Plants				
Courses						
Title			T	/p	Hrs/wk	СР
Gas and Steam Power Plants (L020	6)			cture	3	5
Gas and Steam Power Plants (L021	0)		Re	ecitation Section (large)	1	1
Module Responsible	Dr. Kristin Abel-Günth	er				
Admission Requirements	None					
Recommended Previous						
Knowledge	"Technical Ther"     "Heat Transfer"	modynamics I and II"				
	"Fluid Mechanic					
	• Hala Mechanic	.5				
<b>Educational Objectives</b>	After taking part succe	essfully, students have re	eached the following	learning results		
<b>Professional Competence</b>						
Knowledge	plant, describe the va operation characteris combination possibilit equipped with Carbon	rious types of power plan tics of the power plan ies of conventional foss Capture and Storage.	nt and the layout of t it. Additionally they sil-fuelled power plan	mand and the energy con the steam generator block can describe the exhau this with solar thermal an and design of turbomach	k. They are also a ust gas cleaning id geothermal po	ble to determine the apparatus and the
Skills	The students will be able, using theories and methods of the energy technology from fossil fuels and based on well-founded knowledge on the function and construction of gas and steam power plants, to identify basic associations in the production of heat and electricity, so as to develop conceptual solutions. Through analysis of the problem and exposure to the inherent interplay between heat and power generation the students are endowed with the capability and methodology to develop realistic optimal concepts for the generation of electricity and the production of heat. From the technical basics the students become the ability to follow better the deliberations on the electricity mix composition within the energy-political triangle (economy, secure supply and environmental protection).  Within the framework of the exercise the students learn the use of the specialised software suite EBSILON Professional TM. With this tool small practical tasks are solved with the PC, to highlight aspects of the design and development of power plant cycles.  The students are able to do simplified calculations on turbomachinery either as part of a plant, as single component or at stage					
Personal Competence	level.					
·	contact with a moder and gain insights into	n power plant in this reg the conflicts between ted	gion. The students wi		ience with a pow	er plant in operation
Autonomy	The students assisted by the tutors will be able to develop alone simple simulation models and run with these scenario analyses. In this manner the theoretical and practical knowledge from the lecture is consolidated and the potential effects from different process combinations and boundary conditions highlighted. The students are able independently to analyse the operational performance of steam power plants and calculate selected quantities and characteristic curves.					
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Workload in Hours		ne 124, Study Time in Le	ecture 50			
Credit points  Course achievement	6 Compulsory Bonus	Form	Description			
Course achievement	No 5 %	Attestation  Excercises	15-minütiges, bestanden/nicht	unbenotetes Testat bestanden (keine anteilig ben im Laufe der Vorlesu	gen Punkte)	Professional; nur ; bis zu 5 % Bonus je
			nach Anteil richt	iger Abgaben		
Examination	Written exam					
Examination duration and	Written examination of	of 120 min				
scale						
Assignment for the		cience (German progran	n, 7 semester): Speci	alisation Green Technolog	jies, Focus Renew	able Energy: Elective
Following Curricula				0 1		
	Energy and Environmental Engineering: Core qualification: Elective Compulsory Energy Systems: Technical Complementary Course Core Studies: Elective Compulsory General Engineering Science (English program, 7 semester): Specialisation Mechanical Engineering, Focus Energy Systems:					
	Elective Compulsory	TRANSPORT (1)	Sanajalia-ti 5	Customer Flantin C	laani	
	Green Technologies: E		Specialisation Energy	Systems: Elective Compu Technology: Elective Com ompulsory	-	
	cenamear Engineerii	.g. Specialisation Energy	Systems. Elective CC	paisory		

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

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

Module M0546: Therr	mal Separation Processes			
Courses				
Title		Тур	Hrs/wk	СР
Thermal Separation Processes (L01	118)	Lecture	2	2
Thermal Separation Processes (L01	119)	Recitation Section (small)	2	2
Thermal Separation Processes (L01	141)	Recitation Section (large)	1	1
Separation Processes (L1159)	To account	Practical Course	1	1
Module Responsible				
Admission Requirements				
Knowledge	Recommended requirements: Thermodynamics	111		
Educational Objectives	After taking part successfully, students have rea	ached the following learning results		
Professional Competence				
Knowledge	The students can distinguish and description	iba different tunes of consention process	aa ayah aa diatilla	tion systemation and
	adsorption  The students develop an understanding	for the course of concentration during a so	eparation process, separation systems	the estimation of the
Personal Competence Social Competence Autonomy	Using the gained knowledge the students close the associated energy and material The students can use different graphical theoretical stages required They can select and design a basic type disadvantages of the process The students are capable to obtain indeptables) They can calculate continuous and discore the students are able to prove their theo the students are able to discuss the theory colloquium. The students are capable of linking their gained technical problems. Other lectures such as them.  The students can work technical assignm The students are able to carry out practitiem. They are able to discuss their result.	balances all methods for the designing of a separal elemental separation process for a given pendently the needed material properties of attinuous processes retical knowledge in the experimental lab wore created background and the content of the knowledge with the content of other lecture modynamics, fluid mechanics and chemical ents in small groups and present the combination is small groups and organized that and to document them scientifically in a seeded information from suitable sources by	en case based on from appropriate so fork. experimental work es and use it togetiengineering.  Ined results in the total ending a functional divisor report.	define the amount of the advantages and curces (diagrams and curces) with the teachers in their for the solution of the utorial to the control of the curces are their quality.
Workload in Hours	Independent Study Time 96, Study Time in Lect	ure 84		
Credit points				
Course achievement				
Examination				
Examination duration and scale	120 minutes; theoretical questions and calculati	ions		
	General Engineering Science (German program,	7 semester): Specialisation Bioprocess Eng 7 semester): Specialisation Green Technol 7 semester): Specialisation Energy and Englusory Halification: Elective Compulsory 7 semester): Specialisation Bioprocess Engine 7 semester): Specialisation Energy and Env 7 semester): Specialisation Process Engine	gineering: Compulso ogies, Focus Renew viromental Enginee neering: Compulso iromental Engineer ering: Compulsory	ory vable Energy: Elective ring: Compulsory ry
	Green Technologies: Energy, Water, Climate: Sp Process Engineering: Core qualification: Compul		ve Compulsory	

Course L0118: Thermal Sepa	ration Processes
Тур	Lecture
Hrs/wk	2
СР	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Prof. Irina Smirnova
Language	DE
Cycle	WiSe
Content	<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>

Course L0119: Thermal Sepa	ration Processes
Тур	Recitation Section (small)
Hrs/wk	2
СР	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Prof. Irina Smirnova
Language	DE
Cycle	WiSe
Content	Introduction in the thermal process engineering and to the main features of separation processes  Simple equilibrium processes, several steps processes  Distillation of binary mixtures, enthalpy-concentration diagrams  Extractive and azeotrope distillation, water vapor distillation, stepwise distillation  Extraction: separation ternary systems, ternary diagram  Multiphase separation including complex mixtures  Designing of separation devices without discrete stages  Drying  Chromatographic separation processes  Membrane separation  Energy demand of separation processes  Advance overview of separation processes  Selection of separation processes  The students work on tasks in small groups and present their results in front of all students.
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
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 1984 Ullmann"s Enzyklopädie der Technischen Chemie</li> </ul>

Course L1159: Separation Processes		
Тур	Practical Course	
Hrs/wk	1	
СР	1	
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14	
Lecturer	Prof. Irina Smirnova	
Language	DE/EN	
Cycle	WiSe	
Content	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 devices without discrete stages  Drying  Chromatographic separation processes  Membrane separation  Energy demand of separation processes  Advance overview of separation processes  Selection of separation processes	
Literature	<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>	

Module M1726: System Integration Renewable Energies				
Courses				
Title		Тур	Hrs/wk	СР
System Integration Renewable Energies I (L2767)		Lecture	2	2
System Integration Renewable Energies I (L2768)		Recitation Section (small)	1	1
System Integration Renewable Ene		Lecture	2	2
System Integration Renewable Ene		Recitation Section (small)	1	1
-	Prof. Martin Kaltschmitt			
Admission Requirements				
Recommended Previous	Fundamentals of renewable energies and the energy sys	stem		
Knowledge				
Educational Objectives	After taking part successfully, students have reached th	e following learning results		
Professional Competence				
Knowledge	With the completion of the module the students are ab fields of renewable energies. Current problems concepresented and analyzed. In particular, the sectors electrical energies in the sectors electrical energies in the sectors of the sectors and analyzed.	erning the integration of renewable	energies in the	energy system are
Skills	sector coupling activities.  By completing this module, students can apply the basics learned to various sector coupling problems and, in this context, assess the potentials as well as the limits of sector coupling in the German energy system. In particular, the students should use the application and linking of already learned methods and knowledge here, so that a vision of the different technologies is achieved.			
Personal Competence				
Social Competence	The students will be able to discuss problems in the area	as of sector coupling and the integration	on of renewable	energies.
Autonomy	The students are able to acquire own sources based on the main topics of the lecture and to increase their knowledge. Furthermore, the students can search further technologies and interconnection possibilities for the energy system itself.			
Workload in Hours	Independent Study Time 96, Study Time in Lecture 84			
Credit points	6			
Course achievement	None	None		
Examination	Written exam			
Examination duration and	120 min			
scale				
Assignment for the	General Engineering Science (German program, 7 seme	ster): Specialisation Green Technologi	es, Focus Renew	able Energy: Elective
Following Curricula	Compulsory			
	Green Technologies: Energy, Water, Climate: Specialisat	tion Energy Systems: Elective Compuls	sory	

Course L2767: System Integration Renewable Energies I			
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	WiSe		
Content	<ol> <li>Introduction</li> <li>Fossil-dominated energy system</li> <li>Mega trends in energy transition</li> <li>Characteristics of renewable energy provision technologies - electricity</li> <li>Integration of renewables - electricity II</li> <li>Characteristics of renewable energy provision technologies - heat</li> <li>Integration of renewables - heat I</li> <li>Integration of renewables - heat II</li> <li>Characteristics of renewable energy provision technologies - mobility</li> <li>Integration of renewables - mobility</li> <li>Communications technology and control engineering</li> <li>Reduction in consumption</li> <li>Load management</li> <li>Interaction of renewable generation and controlled reduction in demand</li> </ol>		
Literature	<ul> <li>D. Thrän (editor): Smart Bioenergy. Technologies and concepts for a more flexible bioenergy provision in future energy systems. Springer, Cham, Heielberg, New York, Dordrecht, London, 2015</li> <li>R. von Miller (Hrsg.): Lexikon der Energietechnik und Kraftmaschinen Band 6 und 7. Deutsche Verlags-Anstalt Stuttgart 1965</li> <li>K. Naumann et. al.: Monitoring Biokraftstoffsektor. 3. Auflage, DBFZ Report Nr. 1, Leipzig, 2016</li> <li>M. Kaltschmitt, W. Streicher, A. Wiese (Hrsg.): Erneuerbare Energien. Systemtechnik, Wirtschaftlichkeit, Umweltaspekte. 4. Auflage, Springer</li> </ul>		

ourse L2768: System Integration Renewable Energies I	
Тур	Recitation Section (small)
Hrs/wk	1
СР	1
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14
Lecturer	Prof. Martin Kaltschmitt
Language	DE
Cycle	WiSe
Content	See interlocking course
Literature	See interlocking course

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

Course L2770: System Integration Renewable Energies II		
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	
Cycle	SoSe	
Content		
	1. Introduction	
	2. Power-to-Hydrogen	
	3. Power-to-Gas	
	4. Power-to-Liquid	
	5. Power-to-Heat	
	6. Hybrid Technologies	
	7. Combined Technology Concepts I	
	8. Combined Technology Concepts II	
	9. Link-up with renewable industrial production	
	10. Utilization of residual materials from renewable energy provision	
	11. Biomass as system stabilizer I	
	12. Biomass as system stabilizer II	
	System modelling - fundamentals     System modelling - approaches and results	
	14. System modelling - approaches and results  15. Planning tools	
	13. Flailling tools	
Literature		
	<ul> <li>D. Thrän (editor): Smart Bioenergy. Technologies and concepts for a more flexible bioenergy provision in future energy systems. Springer, Cham, Heielberg, New York, Dordrecht, London, 2015</li> <li>R. von Miller (Hrsg.): Lexikon der Energietechnik und Kraftmaschinen Band 6 und 7. Deutsche Verlags-Anstalt Stuttgart 1965</li> <li>K. Naumann et. al.: Monitoring Biokraftstoffsektor. 3. Auflage, DBFZ Report Nr. 1, Leipzig, 2016</li> <li>M. Kaltschmitt, W. Streicher, A. Wiese (Hrsg.): Erneuerbare Energien. Systemtechnik, Wirtschaftlichkeit, Umweltaspekte. 4. Auflage, Springer Berlin Heidelberg, 2006</li> <li>Bundesministerium für Wirtschaft und Energie: Die Energie der Zukunft.</li> </ul>	

		Typ Lecture Recitation Section (small)	<b>Hrs/wk</b> 3 2	<b>CP</b> 3 3
Prof. Sibylle Fröschle				
None				
After taking part successfully, students have re	eached the following	ng learning results		
Independent Study Time 110. Study Time in Le	ecture 70			
Compulsory Bonus Form	Description			
No 10 % Attestation	Testate finde	n semesterbegleitend statt.		
Written exam				
120 min				
	gram, 7 semester	r): Specialisation Mechanica	al Engineering, F	Focus Biomechanics
• •				
Compulsory General Engineering Science (German progr. Compulsory General Engineering Science (German progr. Engineering: Compulsory General Engineering Science (German progr. Engineering Science: (German progr. Engineering Science: (German progr. Engineering Science: (German progr. Compulsory General Engineering Science: (German progr. Engineering: Compulsory General Engineering Science: (German progr. Engineering: Compulsory General Engineering Science: (German progr. Engineering: Core (German progr. Eneral Engineering: Core qualification: Com. Electrical Engineering: Core qualification: Com. Energy and Environmental Engineering: Core of General Engineering Science: (English program.	ram, 7 semester): ram, 7 semester): gram, 7 semester gram, 7 semester m, 7 semester): Sp m, 7 semester): Sp mpulsory upulsory qualification: Comp n, 7 semester): Spe	Specialisation Mechanical  Specialisation Mechanical  Specialisation Mechanical  Specialisation Mechanical  Specialisation Mechanical Enginerialisation Electrical Enginerialisation  Specialisation Process Engineerialisation Process Engineerialisation Process Engineerialisation	Engineering, Footal Engineering, Footal Engineering, al Engineering, Focus Thineering, Focus Fering: Elective Compg: Elective	us Energy Systems  tus Aircraft System  Focus Materials in  Focus Mechatronics  neoretical Mechanical  Product Developmen  mpulsory
	rogramming Concepts, Data Handling & Communic Prof. Sibylle Fröschle  None  After taking part successfully, students have reference of the successfully, stu	After taking part successfully, students have reached the following and the following part successfully, students have reached the following part of the f	rogramming Concepts, Data Handling & Communication (L2689)  Prof. Sibylle Fröschle  None  After taking part successfully, students have reached the following learning results  Independent Study Time 110, Study Time in Lecture 70  6  Compulsory Bonus Form Description  No 10 % Attestation Testate finden semesterbegleitend statt.  Written exam  120 min  General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering Science (German program, 7 semester): Specialisation Mechanical Compulsory  General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering Science (German program, 7 semester): Specialisation Mechanical Compulsory  General Engineering Science (German program, 7 semester): Specialisation Mechanical Compulsory  General Engineering Science (German program, 7 semester): Specialisation Mechanical Compulsory  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: Compulsory  General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering Engineering Science (German program, 7 semester): Specialisation Mechanical Engineerings Compulsory  General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering: Compulsory  General Engineering Science (German program, 7 semester): Specialisation Electrical Engineering: Core qualification: Compulsory  General Engineering Science (German program, 7 semester): Specialisation Electrical Engineering: Core qualification: Compulsory  General Engineering Science (German program, 7 semester): Specialisation Electrical Engineering: Core qualification	rogramming Concepts, Data Handling & Communication (L2689) Lecture 3 rogramming Concepts, Data Handling & Communication (L2690) Recitation Section (small) 2  Prof. Sibylle Fröschle  None  After taking part successfully, students have reached the following learning results  Independent Study Time 110, Study Time in Lecture 70  6  Compulsory Bonus Form Description No 10 % Attestation Testate finden semesterbegleitend statt.  Written exam  120 min  General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Green Technologies, Focus Renew Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering. Focus Renew Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Planjineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Planjineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Planjineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Planjineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Planjineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Planjineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Planjineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Planjineering: Compulsory Gene

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

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

Module M1719: Clima	te change impact & mitigation			
Courses				
Title		Тур	Hrs/wk	СР
Metereology of climate change (L2	749)	Lecture	2	2
Technical measures to mitigate clir	nate change (L2747)	Lecture	2	2
Technical measures to mitigate clir	nate change (L2748)	Recitation Section (small)	2	2
Module Responsible	Prof. Martin Kaltschmitt			
Admission Requirements	None			
Recommended Previous				
Knowledge				
Educational Objectives	After taking part successfully, students have re	ached the following learning results		
Professional Competence				
Knowledge				
Skills				
Personal Competence				
Social Competence				
Autonomy				
Workload in Hours	Independent Study Time 96, Study Time in Lect	ture 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 Technolog	ies, Focus Renew	able Energy: Elective
Following Curricula	Compulsory			
	Green Technologies: Energy, Water, Climate: S	pecialisation Energy Systems: Elective Compul	sory	

Course L2749: Metereology	ourse L2749: Metereology of climate change		
Тур	Lecture		
Hrs/wk	2		
СР	2		
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28		
Lecturer	NN		
Language	DE		
Cycle	SoSe		
Content			
Literature			

Course L2747: Technical measures to mitigate climate change	
Тур	Lecture
Hrs/wk	2
СР	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Prof. Martin Kaltschmitt
Language	DE
Cycle	SoSe
Content	
Literature	

Course L2748: Technical mea	ourse L2748: Technical measures to mitigate climate change		
Тур	Recitation Section (small)		
Hrs/wk	2		
СР	2		
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28		
Lecturer	Prof. Martin Kaltschmitt		
Language	DE		
Cycle	SoSe		
Content			
Literature			

Module M0544: Phase	e Equilibria Thermodynamics			
Courses				
Title Phase Equilibria Thermodynamics (		Typ Lecture	Hrs/wk	<b>CP</b> 2
Phase Equilibria Thermodynamics ( Phase Equilibria Thermodynamics (		Recitation Section (small) Recitation Section (large)	1 1	2
Module Responsible	Prof. Irina Smirnova		=	_
-	None			
-	Mathematics, Physical Chemistry, Thermodynamics	s I and II		
Knowledge				
Educational Objectives	After taking part successfully, students have reach	ed the following learning results		
Professional Competence				
Knowledge	<ul> <li>Starting from the very basics of thermodylequilibria.</li> <li>They learn how state variables are influent these properties.</li> <li>Moreover, the students learn how phase edifferent phases (vapor, liquid, solid) coexist</li> <li>For different phase equilibria, several examples and interpreting the editorial properties.</li> </ul>	eed by the mixing of compounds and lear quilibria can be described mathematically the in equilibrium. Furthermore the fundamer mples relevant for different kinds of proc	n concepts to qu and which phen stals of reaction e	antitatively describe omena may occur if quilibria are taught.
Skills	<ul> <li>Applying their knowledge, the students are able to identify the correct equation for the determination of the equilibrium 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 they 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 well as 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 many separation and reaction processes in chemical engineering.</li> </ul>			
Personal Competence Social Competence Autonomy	The students are able to work in small groups, to other students  The students are able to find necessary info During the semester the students are ab knowledge the students can adept their lear	rmation self-reliantly in literature sources a le to check their learning progress cont	and to judge their	quality.
Workload in Hours	Independent Study Time 124, Study Time in Lectur	re 56		
Credit points	6			
Course achievement	None			
Examination	Written exam			
	120 minutes; theoretical questions and calculation	S		
scale				
_	General Engineering Science (German program, 7			
Following Curricula	General Engineering Science (German program, 7			-
	General Engineering Science (German program, 7 Compulsory	semester). Specialisation Green Technolog	ies, i ocus Kellew	able Lifergy, Elective
	Bioprocess Engineering: Core qualification: Compu	Isory		
	Green Technologies: Energy, Water, Climate: Spec		Compulsory	
	Green Technologies: Energy, Water, Climate: Spec	ialisation Energy Systems: Elective Compu	sory	
	Process Engineering: Core qualification: Compulsor	У		

Course L0114: Phase Equilib	ria Thermodynamics
Тур	Lecture
Hrs/wk	2
СР	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Prof. Irina Smirnova
Language	DE
Cycle	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. Osmotic pressure
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 rd ed. Prentice Hall, 1997.J.P. O´Connell, J.M. Haile: Thermodynamics. Cambridge University Press, 2005.</li> </ul>

Course L0140: Phase Equilibria Thermodynamics				
Тур	Recitation Section (small)			
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	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 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.  • Jürgen Gmehling, Bärbel Kolbe: Thermodynamik. VCH 1992 • I.M. Prausnitz, R.N. Lichtenthaler, E.G. de Azevedo: Molecular Thermodynamics of Fluid-Phase Equilibria, 3rd ed. Prentice			
	<ul> <li>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
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: 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>

## Focus Water and Environmental Engineering

Module M1627: Water	r and Environment			
Courses				
Title		Тур	Hrs/wk	СР
Project on Water, Environment, Tra	ffic (L2462)	Project-/problem-based Learning	2	3
Water in the Environment (L2461)		Lecture	2	3
Module Responsible	Prof. Mathias Ernst			
Admission Requirements	None			
Recommended Previous	Basic knowledge of chemistry			
Knowledge				
<b>Educational Objectives</b>	After taking part successfully, students have i	reached the following learning results		
<b>Professional Competence</b>				
Knowledge	Students can define generic material interact	ions between the environmental media. The can d	lemonstrate th	neir knowledge about
	natural as well as anthropogenic materials. They are capable of explaining the natural condition of waters and othe			of waters and other
	environmental media.			
Skills	Students are able to research environment-	specific aspects of civil engineering independent	t. They can p	resent their findings
	using accredited academic media (e.g. posters) and can give a short summary including scientific references.			
Personal Competence				
Social Competence	Students can fulfil a complex environment-rel	ated assignment in the field of civil engineering by	working in a	team.
Autonomy				
	Independent Study Time 124, Study Time in L	ecture 56		
Credit points	6			
Course achievement	None			
Examination	Subject theoretical and practical work			
Examination duration and	Written-theoretical part and project work			
scale				
Assignment for the	General Engineering Science (German progra	ım, 7 semester): Specialisation Green Technologie	s, Focus Wate	r and Environmental
Following Curricula	Engineering: Elective Compulsory			
	Civil- and Environmental Engineering: Core qu	alification: Compulsory		
	Green Technologies: Energy, Water, Climate:	Specialisation Water: Elective Compulsory		

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

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

Module M1722: New 1	Frends in Water and Environmen	ntal Research		
Courses				
Title		Тур	Hrs/wk	СР
Introduction to Microplastics in Env	ironment (L2755)	Integrated Lecture	2	2
Research Methods for Water and E	nvironmental Research (L2756)	Lecture	1	2
Research Trends in Water and Envi	ronmental Research (L2757)	Seminar	2	2
Module Responsible	Prof. Nima Shokri			
Admission Requirements	None			
Recommended Previous				
Knowledge				
Educational Objectives	After taking part successfully, students have reached the following learning results			
Professional Competence				
Knowledge				
Skills				
Personal Competence				
Social Competence				
Autonomy				
Workload in Hours	Independent Study Time 110, Study Time in Le	ecture 70		
Credit points	6			
Course achievement	None			
Examination	Written elaboration			
Examination duration and	Report (about 5-10 pages) and Presentation (a	bout 15 min)		
scale				
Assignment for the	General Engineering Science (German program, 7 semester): Specialisation Green Technologies, Focus Water and Environmental			
Following Curricula	Engineering: Elective Compulsory			
	Civil- and Environmental Engineering: Specialis	sation Water and Environment: Elective Com	pulsory	
	Green Technologies: Energy, Water, Climate: S	Specialisation Water: Elective Compulsory		

Course L2755: Introduction t	ourse L2755: Introduction to Microplastics in Environment		
Тур	Integrated Lecture		
Hrs/wk	2		
СР	2		
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28		
Lecturer	Prof. Nima Shokri		
Language	EN		
Cycle	WiSe		
Content			
Literature			

Course L2756: Research Met	Course L2756: Research Methods for Water and Environmental Research		
Тур	Lecture		
Hrs/wk	1		
СР	2		
Workload in Hours	Independent Study Time 46, Study Time in Lecture 14		
Lecturer	Prof. Nima Shokri		
Language	EN		
Cycle	WiSe		
Content			
Literature			

Course L2757: Research Tree	urse L2757: Research Trends in Water and Environmental Research		
Тур	Seminar		
Hrs/wk	2		
СР	2		
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28		
Lecturer	Prof. Nima Shokri, Dr. Alexandru Tatomir		
Language	EN		
Cycle	WiSe		
Content			
Literature			

Module M1713: Green	n Technologies III			
Courses				
Title		Тур	Hrs/wk	СР
Study Work Green Technologies (L2766)		Project Seminar	2	4
Scientific Work and Writing (L2765)	)	Seminar	2	2
Module Responsible	Dozenten des Studiengangs			
Admission Requirements	None			
Recommended Previous	keine			
Knowledge				
Educational Objectives	After taking part successfully, students have reached the fol	lowing learning results		
Professional Competence				
Knowledge	The students, based on a literature survey, learn to study in deliver afterwards a summary presentation to a specialised preferred, when selecting the thematic area of these studies overview over the subject and practice technical writing. specialised subject matter.	audience. Environmental issue s. Through their own written c	es and their multidisci ontribution the studer	plinary linkages are its communicate an
Skills	The students can, when working on a technical topic not fam  conduct a literature survey choose the relevant information for their presentation prepare a written summary present results in front of peers and staff correctly cite and reference sources.			
Personal Competence Social Competence	The students practice a critical assessment of the literature their own technical sub-topic tailored to their public and distudents can formulate questions to other speakers and part.  The fulfilment of the tasks combines independent work with	scuss with the audience. Whe ticipate in the ensuing discuss	en attending technica	•
Autonomy	The students can, guided by instructors, critically reflect on t	their learning and work status	, and write a scientific	report.
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56			
Credit points	6			
Course achievement	None			
Examination	Study work			
Examination duration and	?			
scale				
Assignment for the	General Engineering Science (German program, 7 semester)	: Specialisation Green Techno	ologies, Focus Renewa	ble Energy: Elective
Following Curricula	Compulsory General Engineering Science (German program, 7 semester Engineering: Elective Compulsory Green Technologies: Energy, Water, Climate: Specialisation of Green Technologies: Energy, Water, Climate: Specialisation of Green Technologies: Energy, Water, Climate: Specialisation of	Energy Technology: Elective C Water: Elective Compulsory	Compulsory	and Environmental
	Green Technologies: Energy, Water, Climate: Specialisation	Bioresource Technology: Elect	rive Compulsory	

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

Course L2765: Scientific Wor	k and Writing
Тур	Seminar
Hrs/wk	2
СР	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Prof. Martin Kaltschmitt, Dr. Detlev Bieler, Florian Hagen
Language	DE
Cycle	WiSe
Content	The seminar offers an introduction into the diverse aspects of academic research and writing: Finding the topic, finding specialized information, knowledge organisation, writing, presenting and publishing. Suggestions for reflecting own processes of learning, informing and writing - in addition to practical recommendations and tips - facilitate the start and the creation of bachelor and master theses, works, which bring thoroughly self-fulfillment and make fun.  Topics of the seminar will be in particular  Scientific scholarship and academic research methods: Introduction, organization, attributes of science: How is scientific knowledge created? Work scheduling, finding topics, time management, specialities of academic research in engineering Finding specialized information: Full texts and library resources, databases http://www.tub.tuhh.de/en/subject-information/informing-points-to-survive/ Reference management: http://www.tub.tuhh.de/en/publishing/reference-management/
Literature	Knowledge organisation and creating publications with Citavi     Citing correctly and avoiding plagiarism     Preparing and doing presentations
Eliciatule	<ol> <li>Semesterapparat "Wissenschaftliches Arbeiten" in der TU-Bibliothek: https://inyurl.com/Semesterapparat-Wiss-Arbeiten</li> <li>Weblog Wissenschaftliches Arbeiten der TU-Bibliothek: https://www.tub.tubh.de/wissenschaftliches-arbeiten/</li> <li>Online-Tutorial VISION der TU-Bibliothek zum wissenschaftlichen Arbeiten: https://www.vision.tubh.de (funktioniert nur mit installiertem Flash)</li> <li>Andreas Hirsch-Weber, Stefan Scherer: Wissenschaftliches Arbeiten und Abschlussarbeit in Natur- und Ingenieurwissenschaften: Grundlagen, Praxisbeispiele, Übungen. Stuttgart: Ulmer, 2016.</li> <li>Werner Sesink: Einführung in das wissenschaftliche Arbeiten: inklusive E-Learning, Web-Recherche, digitale Präsentation u.a. 9., aktualisierte Aufl. München: Oldenbourg, 2012.</li> <li>Judith Theuerkauf: Schreiben im Ingenieurstudium: effektiv und effizient zur Bachelor-, Master- und Doktorarbeit. Paderborn: Schöningh, 2012.</li> <li>Wolfsberger; Judith: Frei geschrieben: Mut, Freiheit &amp; Strategie für wissenschaftliche Abschlussarbeiten. Wien: Böhlau, 2010</li> <li>Biedermann, Wieland u.a.: Forschungsmethodik in den Ingenieurwissenschaften: Skript vom Lehrstuhl für Produktentwicklung, Prof. DrIng. Udo Lindemann, Technische Universität München (TUM), 2012. https://www.mw.tum.de/fileadmin/w00btx/lpi/Documents/Forschungsmethodik_Skript.pdf</li> <li>Wissenschaftliches Arbeiten - HOOU Angebot der HCU Hamburg: https://blogs.hoou.de/wissarbeiten/</li> <li>Course Reserves Collection "Scholarly Research Methods" in the TUHH library: http://tinyurl.com/Semesterapparat-Wiss-Arbeiten</li> <li>Scholarly research methods via TUHH library Website: https://www.tub.tuhh.de/en/scholarly-research-methods/</li> <li>VISION - Online-Tutorial on research methods by the TUHH library: http://www.vision.tuhh.de (Flash has to be installed)</li> <li>Scientific papers and presentations / Martha Davis. 3. ed. Amsterdam: Elsevier / Academic Press, 2013. http://wwww.sciencedirect.com/science/book/9780</li></ol>

Module M0869: Hydra	ulic Engineering					
Courses						
Title				Тур	Hrs/wk	СР
Hydraulics (L0957)				Lecture	1	1
Hydraulics (L0958)				Project-/problem-based Learning	1	1
Hydraulic Engineering (L0959)				Lecture	2	2
Hydraulic Engineering (L0960)				Project-/problem-based Learning	1	2
Module Responsible	Prof. Peter Fröhle					
Admission Requirements	None					
Recommended Previous	Hydraulic Engineering I					
Knowledge						
Educational Objectives	After taking part successful	lly, students have re	eached the following	ng learning results		
Professional Competence						
Knowledge	Students are able to define	e the basic terms o	of hydraulic engine	ering and hydraulics. They are	able to expla	ain the application of
	basic hydrodynamic formu	lations (conservation	on laws) to practica	al hydraulic engineering probler	ns. Besides tl	his, the students can
	illustrate important tasks o	of hydraulic enginee	ering and give an o	verview over river engineering,	, flood protec	tion, hydraulic power
	engineering and waterways	s engineering.				
Skills	The students are able to a	nnly hydraulic engi	neering methods a	nd approaches to basic practical	al problems a	nd design respective
Simo			-			
	hydraulic engineering systems. Besides this, they are able to use and apply established approaches of hydraulics and determine water surfaces of channel flows, influences of constructions (weirs, etc.) on channel flows as well as flow conditions of pipe system.					
	Furthermore, they are able to run, explain and document basic hydraulic experiments.					
	rundiennore, they are able	to run, explain una	document basic ii	yaraane experiments.		
Personal Competence						
Social Competence	The students are able to deploy their gained knowledge in applied problems. Additionally, they will be able to work in team with					
	engineers of other disciplines in a goal-orientated, structured manner. They can explain their results by use of peer learning					
	approaches.					
Autonomy	The students will be able to	o independently ext	end their knowledg	ge and apply it to new problems	. Furthermore	e, they are capable of
	organising their individual	work flow to contrib	ute to the conduct	of experiments and to present of	discipline-spe	cific knowledge.
Workload in Hours	Independent Study Time 13	10, Study Time in Le	ecture 70			
Credit points	6					
Course achievement	Compulsory Bonus Form		Description			
		ject theoretical	_		sentation zu	u einem Versuchs
		ctical work	Hydromechar	ik oder Hydraulik		
Examination	Written exam					
Examination duration and			The examination	includes tasks with respect to	the general (	understanding of the
scale	lecture contents and calcul	ations tasks.				
Assignment for the	General Engineering Science	ce (German progran	n, 7 semester): Spe	ecialisation Civil Engineering: Ele	ective Compu	Isory
Following Curricula	General Engineering Science	ce (German program	m, 7 semester): Sp	ecialisation Green Technologies	, Focus Wate	r and Environmental
	Engineering: Elective Comp	oulsory				
	Civil- and Environmental Er	ngineering: Core qua	alification: Compul	sory		
	General Engineering Science	ce (English program	, 7 semester): Spe	cialisation Civil Engineering: Ele	ctive Compuls	sory
	Green Technologies: Energ	y, Water, Climate: S	Specialisation Wate	r: Elective Compulsory		

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

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

Course L0959: Hydraulic Engineering	
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/SoSe
Content	Fundamentals of hydraulic engineering
	<ul> <li>Introduction and hydrological cycle</li> <li>River engineering <ul> <li>Regime theory of natural rivers</li> <li>Sediment transport</li> <li>Regulation of rivers</li> <li>Bank protection / protection of river bed</li> <li>Tidal rivers</li> </ul> </li> <li>Flood protection <ul> <li>Dikes</li> <li>Flood contraol basins</li> </ul> </li> <li>Hydraulic power</li> <li>Inland waterways engineering <ul> <li>waterways</li> <li>Locks and ship lifts</li> <li>Fish passages</li> </ul> </li> <li>Nature-oriented hydraulic engineering</li> </ul>
Literature	Strobl, T. & Zunic, F: Wasserbau, Springer 2006
	Patt, H. & Gonsowski, P: Wasserbau, Springer 2011

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

Module M1632: Appli	ed Water Management			
Courses				
Title		Тур	Hrs/wk	СР
Groundwater Hydrology and Model	ing (L2471)	Project-/problem-based Learning	2	2
Groundwater Hydrology and Model	_	Lecture	2	2
Nature-oriented Hydraulic Enginee	ring (L2472)	Project-/problem-based Learning	2	2
Module Responsible	Prof. Peter Fröhle			
Admission Requirements	None			
Recommended Previous Knowledge	Basic knowledge of analysis and differential equation     hydromechanical and hydraulic engineering princip			
<b>Educational Objectives</b>	After taking part successfully, students have reached the	following learning results		
<b>Professional Competence</b>				
Knowledge	Students are able to define the basic tasks and terms of nature-oriented hydraulic engineering und groundwater hydrology. They cam describe the basics concepts, the basic approaches and methods of nature-oriented hydraulic engineering, groundwater hydrology and groundwater modelling and are able to apply these to practical problems.			
Skills	The students are able to apply the methods and approaches of nature-oriented hydraulic engineering and of groundwater hydrology to practical problems. They can demonstrate to transfer and apply these to simple hydraulic engineering systems. In addition, they are able to apply the approaches commonly used in groundwater hydrology. They can exemplarily explain and reason how to apply them as a basis for geo-hydrological questions. In addition, students can apply basic groundwater modelling methods to simple problems of groundwater movement and groundwater recharge.			
Personal Competence				
Social Competence	Students are able to help each other solving case studies. The students are able to deploy their gained knowledge in applied problems of the practical nature-based hydraulic engineering. Additionally, they will be able to demonstrate to work cooperatively in teams consisting of engineers from different subject areas.			
Autonomy	The students will be able to independently extend their knowledge and apply it to new problems.			
Workload in Hours	Independent Study Time 96, Study Time in Lecture 84			
Credit points	6			
Course achievement	None			
Examination	Subject theoretical and practical work			
Examination duration and scale	Written-theoretical part and modeling			
Assignment for the	General Engineering Science (German program, 7 semes	ter): Specialisation Green Technologies	, Focus Wate	er and Environmental
Following Curricula				
-	Civil- and Environmental Engineering: Specialisation Civil I	Engineering: Elective Compulsory		
	Civil- and Environmental Engineering: Specialisation Traffi	c and Mobility: Elective Compulsory		
	Civil- and Environmental Engineering: Specialisation Wate	r and Environment: Elective Compulsor	у	
	Green Technologies: Energy, Water, Climate: Specialisatio	n Water: Elective Compulsory		

Course L2471: Groundwater Hydrology and Modeling	
Тур	Project-/problem-based Learning
Hrs/wk	2
СР	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Prof. Nima Shokri
Language	DE
Cycle	SoSe
Content	See interlocking course
Literature	See interlocking course

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

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

Module M0670: Partic	cle Technology and Solids Process	s Engineering		
Courses				
Title Particle Technology I (L0434) Particle Technology I (L0435) Particle Technology I (L0440)		<b>Typ</b> Lecture Recitation Section (small) Practical Course	<b>Hrs/wk</b> 2 1 2	CP 3 1 2
Module Responsible	Prof. Stefan Heinrich			
Admission Requirements	None			
Recommended Previous Knowledge				
<b>Educational Objectives</b>	After taking part successfully, students have rea	ched the following learning results		
<b>Professional Competence</b>				
Knowledge	After successful completion of the module stude	nts are able to		
	name and explain processes and unit-ope     characterize particles, particle distribution			
Skills	Students are able to  choose and design apparatuses and proce asses solids with respect to their behavior document their work scientifically.		desired solids prop	perties of the product
Personal Competence Social Competence Autonomy	The students are able to discuss scientific topi technical-scientific issues in a group. Students are able to analyze and solve questions		personal and to o	develop solutions for
Workload in Hours	Independent Study Time 110, Study Time in Lect	ture 70		
Credit points	6			
Course achievement	Compulsory         Bonus         Form           Yes         None         Written elaboration	Description sechs Berichte (pro Versuch ein Bericht)	à 5-10 Seiten	
Examination	Written exam			
Examination duration and	90 minutes			
scale Assignment for the	General Engineering Science (German program,	7 competer). Considiration Drasses Facines	ring. Camanulaan.	
Following Curricula	General Engineering Science (German program, General Engineering Science (German program, General Engineering Science (German program, Engineering: Elective Compulsory Bioprocess Engineering: Core qualification: Compulsory Energy and Environmental Engineering: Core qualification: Compulsory General Engineering Science (English program, 7 General Engineering Science (English program, 7 General Engineering Science (English program, 7	7 semester): Specialisation Energy and Envi 7 semester): Specialisation Green Technologoulsory alification: Elective Compulsory 7 semester): Specialisation Bioprocess Engin 9 semester): Specialisation Energy and Envir	romental Enginee ogies, Focus Wate eering: Compulso omental Engineer	ring: Compulsory r and Environmental
	Green Technologies: Energy, Water, Climate: Spo Process Engineering: Core qualification: Compuls	ecialisation Water: Elective Compulsory	J p	

Course L0434: Particle Technology I		
Тур	Lecture	
Hrs/wk	2	
СР	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 Technology I	
Тур	Recitation Section (small)
Hrs/wk	1
СР	1
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14
Lecturer	Prof. Stefan Heinrich
Language	DE
Cycle	SoSe
Content	See interlocking course
Literature	See interlocking course

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

Module M1630: Sanita	ary Engineering II			
Courses				
Title		Тур	Hrs/wk	СР
Management of Wastewater Infrasti	ructure (L2467)	Seminar	2	3
Drinking Water Treatment (L2466)		Seminar	2	3
	Prof. Mathias Ernst			
	None			
	Basic knowledge in the field of drinking water sup	ply and waste water disposal.		
Knowledge				
	After taking part successfully, students have reac	hed the following learning results		
Professional Competence				
Skills  Personal Competence  Social Competence	The students can examplify their expert knowledge on drinking water, waste water treatment and the associated infrastructure systems. They are capable of reproducing the relevant empiricals assumptions and scientific simplifications in detail. The students can model some processes mathematically. They can also assess existing problems in the field of sanitary engineering, such as removal of nitrate, and place them in a socio-political context. Furthermore, they know how to draft the features and effectiveness of important technologies of the future such as high- and low-pressure membrane filtration systems and techniques.  The students are able to apply the relevant standards and guidelines for the design and operation of urban water infrastructures independently. Their expertise comprises expert skills to design drinking water supply and urban drainage systems as well as the associated treatment facilities. Besides the acquirement of technical skills the students are able to address and solve biochemical problems in the filed of drinking water and wastewater treatment. The students are also able to develop ideas of their own to improve the existing water related infrastructures, systems and concepts.  The students are able to develop a specific topic in a team and to work out milestones according to a given plan.  Students are in a position to work on a subject and to organize their work flow independently. They can also present on this			
	subject.			
	Independent Study Time 124, Study Time in Lectu	ure 56		
Credit points	6			
Course achievement	None			
Examination	Subject theoretical and practical work			
Examination duration and	Written-theoretical part and modelling			
scale				
·	General Engineering Science (German program,	7 semester): Specialisation Green Tech	nnologies, Focus Wate	r and Environmental
Following Curricula	Engineering: Elective Compulsory	an Water and Foreign		
	Civil and Environmental Engineering: Specialisati	·	-	
	Civil and Environmental Engineering: Specialisati		-	
	Civil- and Environmental Engineering: Specialisati Green Technologies: Energy, Water, Climate: Specialisati	·	JISOT Y	
	Green recimologies. Energy, water, climate. Sper	ciansación water. Liective Compuisory		

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

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

## **Specialization Computer Science**

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

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

Module M0561: Discre	ete Algebraic Structures			
Courses				
Title		Тур	Hrs/wk	СР
Discrete Algebraic Structures (L016	4)	Lecture	2	3
Discrete Algebraic Structures (L016	5)	Recitation Section (small)	2	3
Module Responsible	Prof. Karl-Heinz Zimmermann			
Admission Requirements	None			
Recommended Previous	Mathematics from High School.			
Knowledge				
Educational Objectives	After taking part successfully, students have reach	ed the following learning results		
Professional Competence				
Knowledge	The students know the important basics of discret	te algebraic structures including elemer	tary combinatorial	structures, monoids,
	groups, rings, fields, finite fields, and vector spaces	s. They also know specific structures like	sub sum-, and que	otient structures and
	homomorphisms.			
CI:III-	Charles to a select to formation and another basis of	in and a discharge about the second		
SKIIIS	Students are able to formalize and analyze basic d	iscrete 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 fro	m specific standard books and to asso	ciate the acquired	knowledge to other
	classes.			
	Independent Study Time 124, Study Time in Lectur	e 56		
Credit points				
Course achievement				
Examination	Written exam			
Examination duration and	120 min			
scale				
	General Engineering Science (German program, 7	semester): Specialisation Computer Scie	nce: Compulsory	
Following Curricula	Computer Science: Core qualification: Compulsory			
	Data Science: Core qualification: Compulsory			
	Computational Science and Engineering: Core qual			
	Orientation Studies: Core qualification: Elective Cor	mpulsory		

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

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

	outer Engineering			
Courses				
litle .	Тур	)	Hrs/wk	СР
omputer Engineering (L0321)	Lect		3	4
omputer Engineering (L0324)	1	itation Section (small)	1	2
Module Responsible				
Admission Requirements				
Recommended Previous Knowledge	Basic knowledge in electrical engineering			
Educational Objectives	After taking part successfully, students have reached the following le	arning results		
Professional Competence	Arter taking part successionly, stauches have reached the following le	arriing results		
•	This module deals with the foundations of the functionality of com	outing systems. It covers	the layers from	the assembly-lev
J	programming down to gates. The module includes the following topic		,	•
	Introduction			
	Combinational logic: Gates, Boolean algebra, Boolean function	s. hardware synthesis. com	binational netw	orks
	Sequential logic: Flip-flops, automata, systematic hardware de			
	Technological foundations			
	Computer arithmetic: Integer addition, subtraction, multiplication.	on and division		
	Basics of computer architecture: Programming models, MIPS si	ngle-cycle architecture, pip	pelining	
	Memories: Memory hierarchies, SRAM, DRAM, caches			
	Input/output: I/O from the perspective of the CPU, principles of	passing data, point-to-poir	nt connections,	busses
Skills	The students perceive computer systems from the architect's perspe	ctive, i.e., they identify the	internal struct	ure and the physic
	composition of computer systems. The students can analyze, how high	hly specific and individual	computers can	be built based or
	collection of few and simple components. They are able to distingui	sh between and to explair	the different a	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 interdepender	icies between a	physical comput
	system and the software executed on it. In particular, they shall und	erstand the consequences	that the execu	tion of software h
	on the hardware-centric abstraction layers from the assembly langua	age down to gates. This wa	y, they will be	enabled to evalua
	the impact that these low abstraction levels have on an entire system	n's performance and to pro	pose feasible o	otions.
Personal Competence				
•	Students are able to solve similar problems alone or in a group and to	present the results accord	dingly.	
Autonomy	Students are able to acquire new knowledge from specific literature a	and to associate this knowle	edge with other	classes.
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56			
Credit points	6			
Course achievement				
F	Yes 10 % Excercises Written exam			
	90 minutes, contents of course and labs			
scale				
Assignment for the		isation Computer Science:	Compulsory	
-	General Engineering Science (German program, 7 semester): Special	•		
	General Engineering Science (German program, 7 semester): Special		ompulsory	
	General Engineering Science (German program, 7 Scinescer). Special	isation Process Engineering		
	General Engineering Science (German program, 7 semester): S		g: Compulsory	ocus Mechatronio
			g: Compulsory	ocus Mechatronic
	General Engineering Science (German program, 7 semester): S Compulsory General Engineering Science (German program, 7 semester): Spe	pecialisation Mechanical	g: Compulsory Engineering, F	
	General Engineering Science (German program, 7 semester): S Compulsory General Engineering Science (German program, 7 semester): Spe Engineering: Compulsory	pecialisation Mechanical ecialisation Mechanical En	g: Compulsory Engineering, F gineering, Focu	us Aircraft Syster
	General Engineering Science (German program, 7 semester): S Compulsory General Engineering Science (German program, 7 semester): Spe Engineering: Compulsory General Engineering Science (German program, 7 semester): Special	pecialisation Mechanical ecialisation Mechanical En	g: Compulsory Engineering, F gineering, Focu	us Aircraft Syster
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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	gineering
Тур	Lecture
Hrs/wk	3
СР	4
Workload in Hours	Independent Study Time 78, Study Time in Lecture 42
Lecturer	Prof. Heiko Falk
Language	DE/EN
Cycle	WiSe
Content	Introduction Combinational Logic Sequential Logic Technological Foundations Representations of Numbers, Computer Arithmetics Foundations of Computer Architecture Memories Input/Output
Literature	<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	Recitation Section (small)
Hrs/wk	1
СР	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 M0852: Grapl	h Theory and Optimization			
Courses				
itle		Тур	Hrs/wk	СР
Graph Theory and Optimization (L1		Lecture	2	3
Graph Theory and Optimization (L1		Recitation Section (small)	2	3
Module Responsible	Prof. Anusch Taraz			
Admission Requirements	None			
Recommended Previous	Discrete Algebraic Structures			
Knowledge	Mathematics I			
Educational Objections	After the Life was the second of the second or the second	and the fellowing bounds are action		
Educational Objectives	After taking part successfully, students hav	e reached the following learning results		
Professional Competence				
Knowledge	Students can name the basic concept	ots in Graph Theory and Optimization. They are	able to explain the	em using appropriat
	examples.			
	Students can discuss logical connect	tions between these concepts. They are capabl	e of illustrating th	ese connections wit
	the help of examples.			
	They know proof strategies and can it	reproduce them.		
Skills				
	'	raph Theory and Optimization with the help of	f the concepts st	udied in this course
		g them by applying established methods.		
		rify further logical connections between the conc		
	results.	can develop and execute a suitable approach,	and are able to c	ritically evaluate th
	resurts.			
Personal Competence				
Social Competence		n teams. They are capable to use mathematics as	a common langu	age.
	In doing so, they can communicate r	new concepts according to the needs of their co	operating partners	. Moreover, they can
	design examples to check and deepe	en the understanding of their peers.		
Autonomy	Students are capable of checking th	eir understanding of complex concepts on their	own. They can sp	ecify open question
	precisely and know where to get help	o in solving them.		
	Students have developed sufficient	persistence to be able to work for longer period	ds in a goal-orien	ted manner on hard
	problems.			
Workload in Hours	Independent Study Time 124, Study Time in	n Lecture 56		
Credit points	6			
Course achievement	None			
Examination				
Examination duration and	120 min			
scale				
Assignment for the	General Engineering Science (German prog	ram, 7 semester): Specialisation Computer Scien	ce: Compulsory	
Following Curricula				
	Data Science: Core qualification: Compulso	ry		
	Logistics and Mobility: Specialisation Engine	eering Science: Elective Compulsory		
	Logistics and Mobility: Specialisation Traffic	Planning and Systems: Elective Compulsory		
	Logistics and Mobility: Specialisation Inform	nation Technology: Elective Compulsory		
	Technomathematics: Specialisation I. Mathe	ematics: Elective Compulsory		
		gistics and Mobility: Specialisation Traffic Plannin		
	Engineering and Management - Major in Log	gistics and Mobility: Specialisation Information Te	chnology: Elective	Compulsory

Course L1046: Graph Theory	and Optimization
Тур	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	Graphs, search algorithms for graphs, trees planar graphs shortest paths minimum spanning trees maximum flow and minimum cut theorems of Menger, König-Egervary, Hall NP-complete problems backtracking and heuristics linear programming duality integer linear programming
Literature	<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	ourse L1047: Graph Theory and Optimization	
Тур	Recitation Section (small)	
Hrs/wk	2	
СР	3	
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28	
Lecturer	Prof. Anusch Taraz	
Language	DE/EN	
Cycle	SoSe	
Content	See interlocking course	
Literature	See interlocking course	

Module M0727: Stoch	astics			
Courses				
Title		Тур	Hrs/wk	СР
Stochastics (L0777)		Lecture	2	4
Stochastics (L0778)		Recitation Section (small)	2	2
Module Responsible	Prof. Matthias Schulte			
Admission Requirements	None			
Recommended Previous	Calculus			
Knowledge	<ul> <li>Discrete algebraic structures (combinatorics)</li> </ul>			
	Propositional logic			
	, ,			
Educational Objectives	After taking part successfully, students have reached	d the following learning results		
Professional Competence				
Knowledge	<ul> <li>Students can name the basic concepts in Stoc</li> </ul>	hastics. They are able to explain them u	sing appropriate e	examples.
	Students can discuss logical connections between			
	the help of examples.	3, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1,	, and a second	
	They know proof strategies and can reproduce	e them.		
2				
Skills	Students can model problems from stochast	ics with the help of the concepts studi	ed in this course	. Moreover, they are
	capable of solving them by applying establish	ed methods.		
	Students are able to discover and verify further	er logical connections between the conce	epts studied in the	course.
	<ul> <li>For a given problem, the students can deve</li> </ul>	lop and execute a suitable approach, a	and are able to c	ritically evaluate the
	results.			
Personal Competence				
Social Competence				
	Students are able to work together (e.g. on the students are able to work together to the students).	neir regular home work) in heterogeneou	isly composed tea	ims (i.e., teams from
	different study programs and background kno			
	In doing so, they can communicate new concerns		perating partners	. Moreover, they can
	design examples to check and deepen the un	derstanding of their peers.		
Autonomy				
	Students are capable of checking their under		own. They can sp	ecify open questions
	precisely and know where to get help in solvir			
	<ul> <li>Students can put their knowledge in relation t</li> <li>Students have developed sufficient persister</li> </ul>		de in a goal-orien	ted manner on hard
	problems.	ice to be usic to work for longer period	as iii u goui onen	tea manner on nara
	Independent Study Time 124, Study Time in Lecture	56		
Credit points				
Course achievement				
Examination				
Examination duration and	120 min			
scale	General Engineering Science (Cormon program 7 co	amostor). Specialization Computer Science	co: Compulsory	
Assignment for the Following Curricula	General Engineering Science (German program, 7 se Computer Science: Core qualification: Compulsory	eniester): Specialisation Computer Scienc	.e. Compulsory	
Following Curricula	Data Science: Core qualification: Compulsory			
	Computational Science and Engineering: Core qualifi	ication: Compulsory		
	Logistics and Mobility: Specialisation Engineering Sci			
	Logistics and Mobility: Specialisation Information Tec			
	Theoretical Mechanical Engineering: Core qualification			
	Engineering and Management - Major in Logistics an	• •	chnology: Elective	Compulsory
<u> </u>	<u> </u>			<u> </u>

Course L0777: Stochastics	
Тур	Lecture
Hrs/wk	2
СР	4
Workload in Hours	Independent Study Time 92, Study Time in Lecture 28
Lecturer	Prof. Matthias Schulte
Language	DE/EN
Cycle	SoSe
Content	<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	
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

Courses			-	
itle		Тур	Hrs/wk	СР
utomata Theory and Formal Langu	uages (L0332)	Lecture	2	4
utomata Theory and Formal Langu	uages (L0507)	Recitation Section (small)	2	2
Module Responsible	Prof. Tobias Knopp			
Admission Requirements	None			
Recommended Previous	Participating students should be able to			
Knowledge	- specify algorithms for simple data structures (s	such as, e.g., arrays) to solve computational p	roblems	
	- apply propositional logic and predicate logic for	r specifying and understanding mathematical	proofs	
	- apply the knowledge and skills taught in the mo	odule Discrete Algebraic Structures		
<b>Educational Objectives</b>	After taking part successfully, students have rea	ched the following learning results		
<b>Professional Competence</b>				
	problems are hard to represent with proposition syntax, semantics, and decision problems for the solving the predicate logic SAT decision problems kinds of temporal logic, and identify their apparatomata and can identify relationships to log deterministic and nondeterministic finite autority formalism for which nondeterminism is more expressivity, and, in additional problems w.r.t. other formalisms. They understate for specifying systems and their properties. Studies or grammars.	his representation formalism. Students can also describe syntax, semanti dication areas. The participants of the courgic and formal grammars. The spectrum that mata and pushdown automata to Turing mexpressive than determinism. They are also dition, students can transform decision problem that some formalisms easily induce algorithm.	explain unification cs, and decision se can define votat students can nachines. Studer able to demons ems w.r.t. one for others whereas of	on and resolution problems for various kinds of fir explain ranges fructs can name the trate which decisionalism into decisions are best suit
Skills	Students can apply propositional logic as well as problems in order to derive propositional logic, which formalism is best suited for a particular decision problems to specific formulas. Students grammars from automata and vice versa. They emptiness problem in case of infinite words.	predicate logic, or temporal logic formulas t application problem, and they can demonst s can also transform nondeterministic autom	o represent then rate the applicat ata into determi	n. They can evaluation of algorithms nistic ones, or der
Personal Competence				
Social Competence				
Autonomy				
	Independent Study Time 124, Study Time in Lect	ture 56		
Credit points	6			
Course achievement	None			
Examination	Written exam			
Examination duration and	90 min			
scale				
Assignment for the	General Engineering Science (German program,	7 semester): Specialisation Computer Science	e: Compulsorv	
Following Curricula	Computer Science: Core qualification: Compulsor			
-	Data Science: Core qualification: Compulsory			
	Engineering Science: Specialisation Mechatronics	s: Elective Compulsory		
	General Engineering Science (English program, 7		ctive Compulsory	
	Computational Science and Engineering: Core qu	ualification: Compulsory		
	Orientation Studies: Core qualification: Elective (	· ·		
	Orientation Stadies, core quanteation Elective	compaisory		

Course L0332: Automata The	eory and Formal Languages
Тур	Lecture
Hrs/wk	2
СР	4
	Independent Study Time 92, Study Time in Lecture 28
	Prof. Tobias Knopp
Language	
Cycle	3036
Content	1. Propositional logic, Boolean algebra, propositional resolution, SAT-2KNF
	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 expressive
	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, pumping lemma for context-free grammars, transformation of formalisms (from pushdown automata to context-free grammars and
	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, verification
	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)
114.	
Literature	Logik für Informatiker Uwe Schöning, Spektrum, 5. Aufl.
	2. Logik für Informatiker Martin Kreuzer, Stefan Kühling, Pearson Studium, 2006
	3. Grundkurs Theoretische Informatik, Gottfried Vossen, Kurt-Ulrich Witt, Vieweg-Verlag, 2010.
	4. Principles of Model Checking, Christel Baier, Joost-Pieter Katoen, The MIT Press, 2007
	I.

Course L0507: Automata The	eory and Formal Languages
Тур	Recitation Section (small)
Hrs/wk	2
СР	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Prof. Tobias Knopp
Language	EN
Cycle	SoSe
Content	See interlocking course
Literature	See interlocking course

Module M0803: Embe	dded Systems			
Courses				
Title		Тур	Hrs/wk	СР
Embedded Systems (L0805)		Lecture	3	4
Embedded Systems (L0806)		Recitation Section (small)	1	2
Module Responsible	Prof. Heiko Falk			
Admission Requirements	None			
Recommended Previous	Computer Engineering			
Knowledge				
Educational Objectives	After taking part successfully, students have reached th	e following learning results		
Professional Competence				
Knowledge	Embedded systems can be defined as information proceed foundations of such systems. In particular, it deals with their specification languages (models of computation, specification of real-time applications, translations between	an introduction into these systems (r hierarchical automata, specification	otions, common	characteristics) and
	Another part covers the hardware of embedded syste hardware, embedded processors, memories, energy di introduction into real-time operating systems, middlev systems using hardware/software co-design (hardware/efficient realizations, compilers for embedded processor	ssipation, reconfigurable logic and ac ware and real-time scheduling. Finally (software partitioning, high-level trans	tuators. The cou t, the implement	rse also features an
Skills	After having attended the course, students shall be at relevant parts of technological competences to use in a able to compare different models of computations and which areas of embedded system design specific risks e	order to obtain a functional embedded feasible techniques for system-level o	systems. In part	cicular, they shall be
Personal Competence				
Social Competence	Students are able to solve similar problems alone or in a	a group and to present the results acco	rdingly.	
Autonomy	Students are able to acquire new knowledge from specif	fic literature and to associate this know	ledge with other	· classes.
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56			
Credit points	6			
Course achievement	Compulsory Bonus Form Descri	iption		
	Yes 10 % Subject theoretical and			
	practical work			
Examination	Written exam			
Examination duration and scale	90 minutes, contents of course and labs			
Assignment for the	General Engineering Science (German program, 7 seme	ster): Specialisation Computer Science	· Compulsory	
Following Curricula	Computer Science: Specialisation Computer and Softwar			
	Computer Science: Specialisation I. Computer and Softw			
	Electrical Engineering: Core qualification: Elective Comp			
	Engineering Science: Specialisation Mechatronics: Electi	ve Compulsory		
	Aircraft Systems Engineering: Core qualification: Elective	e Compulsory		
	General Engineering Science (English program, 7 semes	ter): Specialisation Mechatronics: Elec	tive Compulsory	
	Computational Science and Engineering: Core qualificat	ion: Compulsory		
	Mechatronics: Specialisation System Design: Elective Co	ompulsory		
	Mechatronics: Specialisation Intelligent Systems and Ro	botics: Elective Compulsory		
	Mechatronics: Core qualification: Elective Compulsory			
	Microelectronics and Microsystems: Specialisation Embe	eaded Systems: Elective Compulsory		

Course L0805: Embedded Sy	stems
Тур	Lecture
Hrs/wk	3
СР	4
Workload in Hours	Independent Study Time 78, Study Time in Lecture 42
Lecturer	Prof. Heiko Falk
Language	EN
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 nd Edition, Springer, 2012., Springer, 2012.</li> </ul>

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

Module M0731: Funct	ional Programming			
Courses				
Title		Тур	Hrs/wk	СР
Functional Programming (L0624)		Lecture	2	2
Functional Programming (L0625)		Recitation Section (large)	2	2
Functional Programming (L0626)		Recitation Section (small)	2	2
Module Responsible	Prof. Sibylle Schupp			
Admission Requirements	None			
Recommended Previous	Discrete mathematics at high-school level			
Knowledge				
<b>Educational Objectives</b>	After taking part successfully, students have reached th	ne following learning results		
Professional Competence				
Knowledge	Students apply the principles, constructs, and simple d to read Haskell programs and to explain Haskell synta: errors in programs. They apply the fundamental data unit tests of functions and simple proof techniques for p	as well as Haskell's read-eval-print lo structures, data types, and type cons	op. They interpr tructors. They e	ret warnings and find employ strategies for
Skills	Students break a natural-language description down in in a structured way. They assess different langua implementations level, and justify their choice. They a and implement unit tests and can assess the quality of	age constructs, make conscious sel nalyze given programs and rewrite th	ections both a em in a controll	t specification and ed way. They design
Personal Competence				
Social Competence	Students practice peer programming with varying peoprograms orally. They communicate in English.	ers. They explain problems and solution	ons to their pee	r. They defend their
Autonomy	In programming labs, students learn under supervisi exercises, they develop solutions individually and indep		the mechanics	of programming. In
Workload in Hours	Independent Study Time 96, Study Time in Lecture 84			
Credit points	6			
Course achievement		ription		
F	Yes 15 % Excercises			
Examination				
Examination duration and scale	90 min			
Assignment for the	General Engineering Science (German program, 7 seme	estar): Specialisation Computer Science	· Elective Comp	ulcony
Following Curricula	Computer Science: Core qualification: Compulsory	ister). Specialisation computer Science	. Liective Comp	uisory
i onowing curricula	Data Science: Core qualification: Elective Compulsory			
	Engineering Science: Specialisation Mechatronics: Elect	ive Compulsory		
	General Engineering Science (English program, 7 seme		Flective Compu	Ilsory
	General Engineering Science (English program, 7 seme			-
	Computational Science and Engineering: Specialisation			
	Technomathematics: Specialisation II. Informatics: Elec-	·	,	

Course L0624: Functional Pro	ogramming
Тур	Lecture
Hrs/wk	2
СР	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Prof. Sibylle Schupp
Language	EN
Cycle	WiSe
Content	<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 Pro	ogramming
Тур	Recitation Section (large)
Hrs/wk	2
СР	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Prof. Sibylle Schupp
Language	EN
Cycle	WiSe
Content	<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 Pro	
	Recitation Section (small)
Hrs/wk	
СР	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Prof. 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.

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Computational Science and Engineering: Core qualification: Compulsory

 ${\it Mechanical\ Engineering: Specialisation\ Theoretical\ Mechanical\ Engineering:\ Compulsory}$ 

Mechanical Engineering: Specialisation Energy Systems: Elective Compulsory

Mechanical Engineering: Specialisation Mechatronics: Elective Compulsory

Theoretical Mechanical Engineering: Technical Complementary Course Core Studies: Elective Compulsory

Process Engineering: Specialisation Process Engineering: Elective Compulsory

Course L0417: Numerical Mathematics I		
Тур	Lecture	
Hrs/wk	2	
СР	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 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

Module M1578: Semi	nars Computer Science			
Courses				
Title Introductory Seminar Computer Science I (L2362) Introductory Seminar Computer Science II (L2361)		<b>Typ</b> Seminar Seminar	<b>Hrs/wk</b> 2 2	<b>CP</b> 3 3
	Prof. Karl-Heinz Zimmermann	Settilital	2	3
Admission Requirements	None			
Recommended Previous		s at the Rachelor's level		
Knowledge	basic knowledge of computer science and Mathematic	s at the bachelor's level.		
	After taking part successfully, students have reached t	he following learning results		
Professional Competence				
-	The students are able to			
	<ul> <li>explicate a specific topic in the field of Compute</li> <li>describe complex issues,</li> </ul>	r Science,		
	<ul> <li>present different views and evaluate in a critical</li> </ul>	way		
	present unrefer views and evaluate in a critical	way.		
Skills	The students are able to			
	familiarize in a specific topic of Computer Science	e in limited time,		
	<ul> <li>realize a literature survey on the specific topic a</li> </ul>			
	elaborate a presentation and give a lecture to a	selected audience,		
	<ul> <li>sum up the presentation in 10-15 lines,</li> </ul>			
	<ul> <li>answer questions in the final discussion.</li> </ul>			
Personal Competence				
	The students are able to			
	elaborate and introduce a topic for a certain aud	lience,		
	<ul> <li>discuss the topic, content and structure of the presentation</li> </ul>	resentation with the instructor,		
	<ul> <li>discuss certain aspects with the audience, and</li> </ul>			
	as the lecturer listen and respond to questions fi	rom the audience.		
Autonomy	The students are able to			
	<ul> <li>define the task in question in an autonomous wa</li> </ul>	ay,		
	develop the necessary knowledge,			
	<ul> <li>use appropriate work equipment, and</li> </ul>			
	guided by an instructor critically check the work	ing status.		
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56	5		
Credit points	6	<u> </u>		
Course achievement	None			
Examination	Presentation			
Examination duration and	x			
scale				
Assignment for the	General Engineering Science (German program, 7 semi	ester): Specialisation Computer So	cience: Elective Compu	ulsory
Following Curricula	Computer Science: Core qualification: Compulsory			
	General Engineering Science (English program, 7 seme Computational Science and Engineering: Core qualifica		ence: Elective Compu	isory

Course L2362: Introductory Seminar Computer Science I	
Тур	Seminar
Hrs/wk	2
СР	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Prof. Karl-Heinz Zimmermann
Language	DE/EN
Cycle	WiSe/SoSe
Content	
Literature	

Course L2361: Introductory	Course L2361: Introductory Seminar Computer Science II	
Тур	Seminar	
Hrs/wk	2	
СР	3	
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28	
Lecturer	Prof. Karl-Heinz Zimmermann	
Language	DE/EN	
Cycle	WiSe/SoSe	
Content		
Literature		

Module M0834: Comp	uternetworks and Internet Security			
Courses				
Title		Тур	Hrs/wk	СР
Computer Networks and Internet Security (L1098)		Lecture	3	5
Computer Networks and Internet Se	ecurity (L1099)	Recitation Section (small)	1	1
Module Responsible	Prof. Andreas Timm-Giel			
Admission Requirements	None			
<b>Recommended Previous</b>	Basics of Computer Science			
Knowledge				
<b>Educational Objectives</b>	After taking part successfully, students have reached	d the following learning results		
Professional Competence				
Knowledge	Students are able to explain important and commo	n Internet protocols in detail and clas	sify them, in order t	o be able to analyse
	and develop networked systems in further studies a	nd job.		
61.71				
Skills	Students are able to analyse common Internet proto	cols and evaluate the use of them in	different domains.	
Personal Competence				
Social Competence				
Autonomy	Students can select relevant parts out of high amou	nt of professional knowledge and can	independently learn	and understand it.
Workload in Hours	Independent Study Time 124, Study Time in Lecture	56		
Credit points	6			
Course achievement	None			
Examination	Written exam			
Examination duration and	120 min			
scale				
Assignment for the	General Engineering Science (German program, 7 se	emester): Specialisation Computer Sci	ence: Elective Comp	ulsory
Following Curricula	Computer Science: Core qualification: Compulsory			
	Data Science: Core qualification: Elective Compulsor	у		
	Electrical Engineering: Core qualification: Elective Co	ompulsory		
	Engineering Science: Specialisation Mechatronics: El	ective Compulsory		
	General Engineering Science (English program, 7 ser	mester): Specialisation Computer Scie	nce: Elective Compu	Isory
	General Engineering Science (English program, 7 ser	mester): Specialisation Mechatronics:	Elective Compulsory	
	Computational Science and Engineering: Core qualifi	ication: Compulsory		
	Technomathematics: Specialisation II. Informatics: E	lective Compulsory		

Course L1098: Computer Networks 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, Prof. Dieter Gollmann, DrIng. Koojana Kuladinithi	
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	
Literature	Internet security: Firewalls	
	<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 Networks and Internet Security	
Тур	Recitation Section (small)
Hrs/wk	1
СР	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

Module M0791: Comp	uter Architecture			
Courses				
Title		Тур	Hrs/wk	СР
Computer Architecture (L0793)		Lecture	2	3
Computer Architecture (L0794)		Project-/problem-based Learning	2	2
Computer Architecture (L1864)		Recitation Section (small)	1	1
Module Responsible	Prof. Heiko Falk			
Admission Requirements	None			
Recommended Previous	Module "Computer Engineering"			
Knowledge				
Educational Objectives	After taking part successfully, students have reached the follow	ving learning results		
Professional Competence				
Knowledge	This module presents advanced concepts from the discipline various programming models is given, both for general-pu processors). Next, foundational aspects of the micro-architectu so-called pipelining and the methods used for the acceleratio know concepts for dynamic scheduling, branch prediction, hierarchies.	rpose computers and for special re of processors are covered. Here not instruction execution used in	al-purpose ma e, the focus pa this context.	achines (e.g., signal articularly lies on the The students get to
Skills	The students are able to describe the organization of processo models. The students examine various structures of pipelined analyze them w.r.t. criteria like, e.g., performance or energy e know parallel computer architectures and are able to distinguis	processor architectures and are ab fficiency. They evaluate different s	ole to explain to	their concepts and to memory hierarchies,
Personal Competence				
Social Competence	Students are able to solve similar problems alone or in a group	and to present the results accord	ingly.	
Autonomy	Students are able to acquire new knowledge from specific liter	ature and to associate this knowle	dge with othe	r classes.
Workload in Hours	Independent Study Time 110, Study Time in Lecture 70			
Credit points	6			
Course achievement	Compulsory         Bonus         Form         Description           No         15 %         Subject theoretical and practical work			
Examination	Written exam			
Examination duration and	90 minutes, contents of course and 4 attestations from the PBI	. "Computer architecture"		
scale				
Assignment for the	General Engineering Science (German program, 7 semester): S	•	lective Comp	ulsory
Following Curricula	Computer Science: Specialisation Computer and Software Engi			
	Computer Science: Specialisation I. Computer and Software En			
	Aircraft Systems Engineering: Core qualification: Elective Comp	•		
	Aircraft Systems Engineering: Specialisation Avionic Systems: I			
	General Engineering Science (English program, 7 semester): Sp	·		isory
	Computational Science and Engineering: Specialisation I. Comp		/	
	Microelectronics and Microsystems: Specialisation Embedded S	ystems: Elective Compulsory		

Course L0793: Computer Arc	hitecture
Тур	Lecture
Hrs/wk	2
СР	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> <li>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.</li> </ul>
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
СР	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Prof. Heiko Falk
Language	DE/EN
Cycle	WiSe
Content	See interlocking course
Literature	See interlocking course

Course L1864: Computer Architecture		
Тур	Recitation Section (small)	
Hrs/wk	1	
СР	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	

Module M0562: Comp	utability and Complexity The	ory			
Courses					
Title		Тур		Hrs/wk	СР
Computability and Complexity Theory (L0166) Lecture 2			3		
Computability and Complexity Theo		y (L0167) Recitation Section (small) 2 3			
Module Responsible	Prof. Karl-Heinz Zimmermann				
Admission Requirements	None				
Recommended Previous	Discrete Algebraic Structures, Automata Th	eory, Logic, and Formal Language	Theory.		
Knowledge					
Educational Objectives	After taking part successfully, students hav	re reached the following learning re	sults		
Professional Competence					
Knowledge	The students known the important made				
	computability, Gödel numbering of computations, the theorems of Kleene, Rice, and Rice-Shapiro, the concept of decidable and				
	undecidable sets, the word problems for semi-Thue systems, Thue systems, semi-groups, and Post correspondence systems,				
	Hilbert's 10-th problem, and the basic concepts of complexity theory.				
Skills	Students are able to investigate the compu	tability of sets and functions and to	analyze the con	nplexity of comp	outable functions.
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Personal Competence					
Social Competence	Students are able to solve specific problem	s alone or in a group and to presen	t the results acco	ordingly.	
Autonomy	Students are able to acquire new knowledg	e from newer literature and to asso	ciate the acquire	ed knowledae wi	ith other classes
Workload in Hours	Independent Study Time 124, Study Time in	n Lecture 56			
Credit points	6				
Course achievement	None				
Examination	Written exam				
Examination duration and	60 min				
scale	<u> </u>				
Assignment for the	General Engineering Science (German prog	ram, 7 semester): Specialisation Co	omputer Science	: Elective Compu	ulsory
Following Curricula	Computer Science: Core qualification: Comp	pulsory			
	Data Science: Core qualification: Elective C	ompulsory			
	General Engineering Science (English progr	•	•		Isory
	Computational Science and Engineering: Sp	pecialisation I. Computer Science: E	lective Compulso	ory	
	Technomathematics: Specialisation II. Infor	matics: Elective Compulsory			

Course L0166: Computability	ourse L0166: Computability and Complexity Theory		
Тур	Lecture		
Hrs/wk	2		
СР	3		
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28		
Lecturer	Prof. Karl-Heinz Zimmermann		
Language	DE/EN		
Cycle	SoSe		
Content			
Literature			

Course L0167: Computability	and Complexity Theory
Тур	Recitation Section (small)
Hrs/wk	2
СР	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Prof. Karl-Heinz Zimmermann
Language	DE/EN
Cycle	SoSe
Content	
Literature	

Title Operating Systems (L1153)			
Operating Systems (L1153) Operating Systems (L1154)  Module Responsible Prof. Volker Turau  Admission Requirements None  Recommended Previous Knowledge  **Object-oriented programming, algorithms, and data structures  **Procedural programming*  **Experience in using tools related to operating systems such as editors, linkers, compilers  **Experience in using C-libraries  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 systems, descriptory process states and their transitions, and paraphrase the architectural variants of operating systems. They give exame existing operating systems and explain their architectures. The participants of the course write concurrent programs using the conditional variables and semaphores. Students can describe the variants of realizing a file system. Students explain at least different scheduling algorithms.  **Skills**  Skills**  Students are able to use the POSIX libraries for concurrent programming in a correct and efficient way. They are able to jude efficiency of a scheduling algorithm for a given scheduling task in a given environment.			
Module Responsible Prof. Volker Turau  Admission Requirements None  Recommended Previous Knowledge  Object-oriented programming, algorithms, and data structures Procedural programming Experience in using tools related to operating systems such as editors, linkers, compilers Experience in using C-libraries  Frofessional Competence Knowledge  Knowledge  Knowledge  Students explain the main abstractions process, virtual memory, deadlock, lifelock, and file of operations systems, descriptory process states and their transitions, and paraphrase the architectural variants of operating systems. They give exam existing operating systems and explain their architectures. The participants of the course write concurrent programs using the conditional variables and semaphores. Students can describe the variants of realizing a file system. Students explain at least different scheduling algorithms.  Skills Students are able to use the POSIX libraries for concurrent programming in a correct and efficient way. They are able to jude efficiency of a scheduling algorithm for a given scheduling task in a given environment.			
Module Responsible Admission Requirements Recommended Previous Knowledge  Object-oriented programming, algorithms, and data structures Procedural programming Experience in using tools related to operating systems such as editors, linkers, compilers Educational Objectives Professional Competence  Knowledge  Students explain the main abstractions process, virtual memory, deadlock, lifelock, and file of operations systems, described the architectural variants of operating systems. They give exame existing operating systems and explain their architectures. The participants of the course write concurrent programs using the conditional variables and semaphores. Students can describe the variants of realizing a file system. Students explain at least different scheduling algorithms.  Skills Students are able to use the POSIX libraries for concurrent programming in a correct and efficient way. They are able to jude efficiency of a scheduling algorithm for a given scheduling task in a given environment.			
Admission Requirements  Recommended Previous Knowledge  Object-oriented programming, algorithms, and data structures Procedural programming Experience in using tools related to operating systems such as editors, linkers, compilers Educational Objectives 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 systems, described process states and their transitions, and paraphrase the architectural variants of operating systems. They give exame existing operating systems and explain their architectures. The participants of the course write concurrent programs using the conditional variables and semaphores. Students can describe the variants of realizing a file system. Students explain at least different scheduling algorithms.  Skills Students are able to use the POSIX libraries for concurrent programming in a correct and efficient way. They are able to jude efficiency of a scheduling algorithm for a given scheduling task in a given environment.			
Recommended Previous Knowledge  Object-oriented programming, algorithms, and data structures Procedural programming Experience in using tools related to operating systems such as editors, linkers, compilers 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 systems, described process states and their transitions, and paraphrase the architectural variants of operating systems. They give exame existing operating systems and explain their architectures. The participants of the course write concurrent programs using the conditional variables and semaphores. Students can describe the variants of realizing a file system. Students explain at least different scheduling algorithms.  Skills Students are able to use the POSIX libraries for concurrent programming in a correct and efficient way. They are able to jude efficiency of a scheduling algorithm for a given scheduling task in a given environment.			
Object-oriented programming, algorithms, and data structures     Procedural programming     Experience in using tools related to operating systems such as editors, linkers, compilers     Experience in using C-libraries  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 systems, described process states and their transitions, and paraphrase the architectural variants of operating systems. They give exame existing operating systems and explain their architectures. The participants of the course write concurrent programs using the conditional variables and semaphores. Students can describe the variants of realizing a file system. Students explain at least different scheduling algorithms.  Skills  Students are able to use the POSIX libraries for concurrent programming in a correct and efficient way. They are able to jude efficiency of a scheduling algorithm for a given scheduling task in a given environment.			
Procedural programming Experience in using tools related to operating systems such as editors, linkers, compilers Experience in using C-libraries  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 systems, descriptoress states and their transitions, and paraphrase the architectural variants of operating systems. They give exame existing operating systems and explain their architectures. The participants of the course write concurrent programs using the conditional variables and semaphores. Students can describe the variants of realizing a file system. Students explain at least different scheduling algorithms.  Skills  Students are able to use the POSIX libraries for concurrent programming in a correct and efficient way. They are able to jude efficiency of a scheduling algorithm for a given scheduling task in a given environment.	Object-oriented programming, algorithms, and data structures.		
Experience in using tools related to operating systems such as editors, linkers, compilers     Experience in using C-libraries  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 systems, descriptoress states and their transitions, and paraphrase the architectural variants of operating systems. They give exame existing operating systems and explain their architectures. The participants of the course write concurrent programs using the conditional variables and semaphores. Students can describe the variants of realizing a file system. Students explain at least different scheduling algorithms.  Skills  Students are able to use the POSIX libraries for concurrent programming in a correct and efficient way. They are able to jude efficiency of a scheduling algorithm for a given scheduling task in a given environment.			
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	dge the		
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 program, 7 semester): Specialisation Computer Science: Elective Compulsory			
Following Curricula Computer Science: Specialisation I. Computer and Software Engineering: Elective Compulsory			
General Engineering Science (English program, 7 semester): Specialisation Computer Science: Elective Compulsory			
Computational Science and Engineering: Specialisation I. Computer Science: Elective Compulsory			
Technomathematics: Specialisation II. Informatics: Elective Compulsory			

Course L1153: Operating Sys	stems
Тур	Lecture
Hrs/wk	2
СР	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	Operating Systems, William Stallings, Pearson International Edition     Moderne Betriebssysteme, Andrew Tanenbaum, Pearson Studium

Course L1154: Operating Systems		
Тур	Recitation Section (small)	
Hrs/wk	2	
СР	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	vare Engineering			
Courses				
Title		Тур	Hrs/wk	СР
Software Engineering (L0627)		Lecture	2	3
Software Engineering (L0628)		Recitation Section (small)	2	3
Module Responsible	Prof. Sibylle Schupp			
Admission Requirements	None			
Recommended Previous Knowledge	Automata theory and formal languages     Procedural programming or Functional programming or Functional programming or Functional programming or Functional Programming Chicago Programming Chicago Programming Chicago	-		
	<ul> <li>Object-oriented programming, algorithms, and da</li> </ul>	ta structures		
Educational Objectives	After taking part successfully, students have reached the	e following learning results		
Professional Competence				
	Students explain the phases of the software life cy engineering, and paraphrase the principles of structured of existing large-scale systems. They write test cases different notations, and critique both. They explain simaintenance, and project planning.	software development. They give ex- for different test strategies and de mple design patterns and the major	amples of softwa evise specification activities in rec	re-engineering tasks ons or models using quirements analysis,
Skills	For a given task in the software life cycle, students id choose the proper approach for quality assurance. They errors at different levels. They apply and modify no specifications.	design tests for realistic systems, as	sess the quality	of the tests, and find
Personal Competence				
Social Competence	Students practice peer programming. They explain probl	ems and solutions to their peer. They	communicate in	English.
Autonomy	Using on-line quizzes and accompanying material for s adjust it appropriately. Working on exercise problems, t	•	level of knowled	ge continuously and
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56			
Credit points	6			
Course achievement	Compulsory     Bonus     Form     Description       Yes     15 %     Excercises	ption		
Examination	Written exam			
Examination duration and	90 min			
scale				
Assignment for the	General Engineering Science (German program, 7 semes	ter): Specialisation Computer Science	e: Elective Comp	ulsory
Following Curricula	Computer Science: Core qualification: Compulsory			
	General Engineering Science (English program, 7 semest			Isory
	Computational Science and Engineering: Specialisation I	·	ory	
	Technomathematics: Specialisation II. Informatics: Electi	ve Compulsory		

Course 10627, Coffus as Fund	
Course L0627: Software Engi	
Тур	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	
	<ul> <li>Software Life Cycle Models (Waterfall, V-Model, Evolutionary Models, IncrementalModels, Iterative Models, Agile Processes)</li> <li>Requirements (Elicitation Techniques, UML Use Case Diagrams, Functional and Non-Functional Requirements)</li> <li>Specification (Finite State Machines, Extended FSMs, Petri Nets, Behavioral UML Diagrams, Data Modeling)</li> <li>Design (Design Concepts, Modules, (Agile) Design Principles)</li> <li>Object-Oriented Analysis and Design (Object Identification, UML Interaction Diagrams, UML Class Diagrams, Architectural Patterns)</li> <li>Testing (Blackbox Testing, Whitebox Testing, Control-Flow Testing, Data-Flow Testing, Testing in the Large)</li> <li>Maintenance and Evolution (Regression Testing, Reverse Engineering, Reengineering)</li> <li>Project Management (Blackbox Estimation Techniques, Whitebox Estimation Techniques, Project Plans, Gantt Charts, PERT Charts)</li> </ul>
Literature	Kassem A. Saleh, Software Engineering, J. Ross Publishing 2009.

Course L0628: Software Eng	Course L0628: Software Engineering	
Тур	Recitation Section (small)	
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	See interlocking course	
Literature	See interlocking course	

Module M1269: Lab C	yber-Physical Systems
Courses	
Title	Typ Hrs/wk CP
Lab Cyber-Physical Systems (L1740	Project-/problem-based Learning 4 6
Module Responsible	Prof. Heiko Falk
Admission Requirements	None
Recommended Previous	Module "Embedded Systems"
Knowledge	
<b>Educational Objectives</b>	After taking part successfully, students have reached the following learning results
<b>Professional Competence</b>	
Knowledge	Cyber-Physical Systems (CPS) are tightly integrated with their surrounding environment, via sensors, A/D and D/A converters, and
	actors. Due to their particular application areas, highly specialized sensors, processors and actors are common. Accordingly, there
	is a large variety of different specification approaches for CPS - in contrast to classical software engineering approaches.
	Based on practical experiments using robot kits and computers, the basics of specification and modelling of CPS are taught. The
	lab introduces into the area (basic notions, characteristical properties) and their specification techniques (models of computation,
	hierarchical automata, data flow models, petri nets, imperative approaches). Since CPS frequently perform control tasks, the lab's
	experiments will base on simple control applications. The experiments will use state-of-the-art industrial specification tools
	(MATLAB/Simulink, LabVIEW, NXC) in order to model cyber-physical models that interact with the environment via sensors and
	actors.
Skills	After successful attendance of the lab, students are able to develop simple CPS. They understand the interdependencies between a
	CPS and its surrounding processes which stem from the fact that a CPS interacts with the environment via sensors, A/D converters,
	digital processors, D/A converters and actors. The lab enables students to compare modelling approaches, to evaluate their advantages and limitations, and to decide which technique to use for a concrete task. They will be able to apply these techniques
	to practical problems. They obtain first experiences in hardware-related software development, in industry-relevant specification
	tools and in the area of simple control applications.
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	6
Course achievement	None
Examination	Written elaboration
Examination duration and	Execution and documentation of all lab experiments
scale	
Assignment for the	
Following Curricula	Computer Science: Specialisation II. Mathematics and Engineering Science: Elective Compulsory
	Computer Science: Specialisation Computer and Software Engineering: Elective Compulsory
	General Engineering Science (English program, 7 semester): Specialisation Computer Science: Elective Compulsory
	Computational Science and Engineering: Specialisation II. Mathematics & Engineering Science: Elective Compulsory  Machatronics: Specialisation Intelligent Systems and Robotics: Elective Compulsory
	Mechatronics: Specialisation Intelligent Systems and Robotics: Elective Compulsory  Mechatronics: Specialisation System Design: Elective Compulsory
	Mechatronics: Specialisation System Design: Elective Compulsory  Mechatronics: Technical Complementary Course: Elective Compulsory
	received street received compensating course. Elective comparisory

Course L1740: Lab Cyber-Phy	ysical Systems
Тур	Project-/problem-based Learning
Hrs/wk	4
СР	6
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56
Lecturer	Prof. Heiko Falk
Language	DE/EN
Cycle	SoSe
Content	<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 narameters
- 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.

specialisation.						
Module M0598: Mech	anical Enginee	ring: Design				
Courses						
Title				Тур	Hrs/wk	СР
Embodiment Design and 3D-CAD (I	L0268)			Lecture	2	1
Mechanical Design Project I (L0695				Project-/problem-based Learning	3	2
Mechanical Design Project II (L0592	2)			Project-/problem-based Learning	3	2
Team Project Design Methodology				Project-/problem-based Learning	2	1
Module Responsible	Prof. Dieter Krause					
Admission Requirements						
Recommended Previous						
Knowledge	<ul> <li>Fundamentals</li> </ul>	of Mechanical Engineerin	ng Design			
3	<ul> <li>Mechanics</li> </ul>					
	<ul> <li>Fundamentals</li> </ul>	of Materials Science				
	Production Eng	gineering				
Educational Objections	A Character Library and a second		and the fall and	and the section of the		
Educational Objectives	After taking part succ	essiully, students have r	eached the following	ng learning results		
Professional Competence	After persion the me	dula atudanta ara ahla ta				
Knowieage	After passing the mo	dule, students are able to	):			
	<ul> <li>explain design</li> </ul>	guidelines for machinery	parts e.g. conside	ering load situation, materials an	d manufacturi	ng requirements,
	describe basic	s of 3D CAD,				
	<ul> <li>explain basics</li> </ul>	methods of engineering	designing.			
Skills	After passing the mo	dule, students are able to	):			
	<ul> <li>independently</li> </ul>	create sketches, technica	al drawings and do	ocumentations e.g. using 3D CAD	).	
		nents based on design gu	-		,	
		culate) used components		,		
				s systamtically and solution-orie	nted	
		y techniques in teams.	cerning design task.	s systematically and solution one	iccu,	
	- apply creativit	y teeriniques in teams.				
Personal Competence						
Social Competence	After passing the mo	After passing the module, students are able to:				
			!!!!!-!			
	<ul> <li>develop and evaluate solutions in groups including making and documenting decisions,</li> </ul>					
	moderate the use of scientific methods,					
		present and discuss solutions and technical drawings within groups,				
	• reflect the owr	results in the work grou	ps of the course.			
Autonomy	Students are able					
	to estimate their level of knowledge using activating methods within the lectures (e.g. with clickers),					
	<ul> <li>To solve engin</li> </ul>	eering design tasks syste	ematically.			
		ime 40, Study Time in Led	cture 140			
Credit points						
Course achievement		Form	Description	Konstruktion and ath a -111		
	Yes None	Written elaboration		Konstruktionsmethodik		
	Yes None	Written elaboration	Konstruktions			
	Yes None	Written elaboration	Konstruktions	. ,		
_	Yes None	Written elaboration	3D-CAD-Prak	tikum		
	Written exam					
Examination duration and	180					
scale						
Assignment for the				ecialisation Mechanical Engineer		•
Following Curricula				ecialisation Biomedical Engineer		-
				ecialisation Biomedical Engineer		
	General Engineering	Science (German prograr	m, 7 semester): Sp	ecialisation Energy and Envirom	ental Engineer	ring: Compulsory
	Digital Mechanical Engineering: Core qualification: Compulsory					
	Energy and Environmental Engineering: Core qualification: Compulsory					
	Engineering Science:	Core qualification: Comp	oulsory			
	I					

General Engineering Science (English program, 7 semester): Specialisation Biomedical Engineering: Compulsory Green Technologies: Energy, Water, Climate: Specialisation Energy Technology: Elective Compulsory Mechanical Engineering: Core qualification: Compulsory Mechatronics: Core qualification: Compulsory Naval Architecture: Core qualification: Compulsory

Course L0268: Embodiment I	Design and 3D-CAD
Тур	Lecture
Hrs/wk	2
СР	1
Workload in Hours	Independent Study Time 2, Study Time in Lecture 28
Lecturer	Prof. Dieter Krause
Language	DE
Cycle	WiSe
Content	Basics of 3D CAD technology  Practical course to apply a 3D CAD system  Introduction to the system  Sketching and creation of components  Creation of assemblies  Deriving technical drawings
Literature	<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 LOCOTe Marchanisa I D	and the Post of the
Course L0695: Mechanical Do	
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	Create a technical documentation of an existing mechanical model  Consolidation of the following aspects of technical drawings:  Presentation of technical objects and standardized parts (bearings, seals, shaft-hub joints, detachable connections, springs, axes and shafts)  Sectional views  Dimensioning  Tolerances and surface specifications  Creating a tally sheet
Literature	<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 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	Dubbel, Taschenbuch für Maschinenbau, Beitz, W., Küttner, KH, Springer-Verlag.  Maschinenelemente, Band I - III, Niemann, G., Springer-Verlag.  Maschinen- und Konstruktionselemente, Steinhilper, W., Röper, R., Springer-Verlag.  Einführung in die DIN-Normen, Klein, M., Teubner-Verlag.  Konstruktionslehre, Pahl, G., Beitz, W., Springer-Verlag.	

Course L0267: Team Project	Design Methodology
Тур	Project-/problem-based Learning
Hrs/wk	2
СР	1
Workload in Hours	Independent Study Time 2, Study Time in Lecture 28
Lecturer	Prof. Dieter Krause
Language	DE
Cycle	SoSe
Content	Introduction to engineering designing methodology  Team Project Design Methodology  Creating requirement lists  Problem formulation  Creating functional structures  Finding solutions  Evaluation of the found concepts  Documentation of the taken methodological steps and the concepts using presentation slides
Literature	<ul> <li>Dubbel, Taschenbuch für den Maschinenbau; Grote, KH., Feldhusen, J.(Hrsg.); Springer-Verlag, aktuelle Auflage.</li> <li>Maschinenelemente, Band I-Ill; 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 M0933: Fund	amentals of Materials Science			
Courses				
Title Fundamentals of Materials Science Fundamentals of Materials Science Physical and Chemical Basics of Ma	II (Advanced Ceramic Materials, Polymers and Composites) (L0506)	Typ Lecture Lecture Lecture	Hrs/wk 2 2 2	CP 2 2 2
Module Responsible			_	
Admission Requirements	None			
-	Highschool-level physics, chemistry und mathematics			
Knowledge				
Educational Objectives	After taking part successfully, students have reached the follow	ring learning results		
<b>Professional Competence</b>				
	The students have acquired a fundamental knowledge on r comprehensively. Fundamental knowledge here means specific phase transformations, corrosion and mechanical properties. Till for materials and can identify relevant approaches for chaphenomena back to the underlying physical and chemical laws	ally the issues of atomine students know about aracterizing specific pro of nature.	c structure, microstructu the key aspects of chara perties. They are able	re, phase diagrams acterization methoc to trace material
Skilis	The students are able to trace materials phenomena back to phenomena here refers to mechanical properties such as stre resistance, and to phase transformations such as solidification between processing conditions and the materials microstructum aterial's behavior.	ngth, ductility, and stiff n, precipitation, or me	ness, chemical propertic lting. The students can	es such as corrosion explain the relation
Personal Competence				
Social Competence	-			
Autonomy	-			
Workload in Hours	Independent Study Time 96, Study Time in Lecture 84			
Credit points	6			
Course achievement	None			
Examination	Written exam			
Examination duration and	180 min			
scale				
Assignment for the	General Engineering Science (German program, 7 semester): S	pecialisation Mechanica	l Engineering: Compulso	ry
Following Curricula	General Engineering Science (German program, 7 semester): S			ry
	General Engineering Science (German program, 7 semester): S			
	General Engineering Science (German program, 7 semester): S Data Science: Specialisation Materials Science: Compulsory	pecialisation Energy and	a Environnental Engineer	ing: Compulsory
	Digital Mechanical Engineering: Core qualification: Compulsory			
	Energy and Environmental Engineering: Core qualification: Comparisory	nnulsorv		
	Green Technologies: Energy, Water, Climate: Specialisation Ene	. ,	re Compulsory	
	Logistics and Mobility: Specialisation Engineering Science: Elect			
	Logistics and Mobility: Specialisation Production Management a		Compulsory	
	Mechanical Engineering: Core qualification: Compulsory		F 3	
	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 Compulsory		ction Management and	Processes: Electiv

Course L1085: Fundamentals	s of Materials Science I
Тур	Lecture
Hrs/wk	2
СР	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Prof. Jörg Weißmüller
Language	DE
Cycle	WiSe
Content	
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	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	Prof. Stefan 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	Für den Elektromagnetismus:  Bergmann-Schäfer: "Lehrbuch der Experimentalphysik", Band 2: "Elektromagnetismus", de Gruyter  Für die Atomphysik:  Haken, Wolf: "Atom- und Quantenphysik", Springer  Für die Materialphysik und Elastizität:  Hornbogen, Warlimont: "Metallkunde", Springer

Module M0597: Adva	nced Mechanical Engineering Design	1		
Courses				
Title Advanced Mechanical Engineering Design II (L0264) Advanced Mechanical Engineering Design II (L0265) Advanced Mechanical Engineering Design I (L0262) Advanced Mechanical Engineering Design I (L0263)		Typ Lecture Recitation Section (large) Lecture Recitation Section (large)	Hrs/wk 2 2 2 2	CP 2 1 2
Module Responsible				
Admission Requirements				
Recommended Previous Knowledge	Fundamentals of Mechanical Engineering Desir     Mechanics     Fundamentals of Materials Science     Production Engineering	gn		
<b>Educational Objectives</b>	After taking part successfully, students have reached	the following learning results		
Professional Competence Knowledge	After passing the module, students are able to:  • explain complex working principles and function			
Skills	<ul> <li>explain requirements, selection criteria, application scenarios and practical examples of complex machine elements,</li> <li>indicate the background of dimensioning calculations.</li> <li>After passing the module, students are able to:         <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> <li>recognize the content of technical drawings and schematic sketches,</li> <li>evaluate complex designs, technically.</li> </ul> </li> </ul>			
Personal Competence Social Competence Autonomy	Students are able to discuss technical information in the lecture supported by activating methods.			
Workload in Hours	Independent Study Time 68, Study Time in Lecture 1	12		
Credit points				
Course achievement				
Examination				
Examination duration and scale				
_	General Engineering Science (German program, 7 sei General Engineering Science (German program, 7 Compulsory Energy and Environmental Engineering: Core qualific Energy Systems: Technical Complementary Course C Engineering Science: Specialisation Mechanical Engir General Engineering Science (English program, 7 sen General Engineering Science (English program, 7 Compulsory Mechanical Engineering: Core qualification: Compulsory	ation: Elective Compulsory Core Studies: Elective Compulsory neering: Compulsory neeter): Specialisation Mechanical Engine semester): Specialisation Mechanical E	Engineering, Foo	eus Energy Systems:

Course L0264: Advanced Med	chanical Engineering Design II
Тур	Lecture
Hrs/wk	2
СР	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Prof. Dieter Krause, Prof. Otto von Estorff
Language	DE
Cycle	SoSe SoSe
Content	Advanced Mechanical Engineering Design I & II
	Lecture
	Fundamentals of the following machine elements:
	<ul> <li>Linear rolling bearings</li> </ul>
	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:
	<ul> <li>Linear rolling bearings</li> </ul>
	Axes & shafts
	Clutches & brakes
	Belt & chain drives
	Gear drives
	Epicyclic gears
	Crank gears
	Sliding bearings
	Calculations of hydrostatic systems (fluidics)
Literature	
	Dubbel, Taschenbuch für den Maschinenbau; Grote, KH., Feldhusen, J.(Hrsg.); Springer-Verlag, aktuelle Auflage.  Maschinger aber ande Board H. W. Nigerson, G., Godinger Verlag, although Auflage.
	<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> </ul>
	<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> </ul>
	Konstruktionslehre, Pahl, G.; Beitz, W., Springer-Verlag, aktuelle Auflage.
	Maschinenelemente 1-2; Schlecht, B., Pearson Verlag, aktuelle Auflage.
	Maschinenelemente - Gestaltung, Berechnung, Anwendung; Haberhauer, H., Bodenstein, F., Springer-Verlag, aktuelle
	Auflage.
	Roloff/Matek Maschinenelemente; Wittel, H., Muhs, D., Jannasch, D., Voßiek, J., Springer Vieweg, aktuelle Auflage.
	Sowie weitere Bücher zu speziellen Themen

Course L0265: Advanced Mechanical Engineering Design II	
Тур	Recitation Section (large)
Hrs/wk	2
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

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

Course L0263: Advanced Mechanical Engineering Design I	
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	WiSe
Content	See interlocking course
Literature	See interlocking course

Module M0680: Fluid	Dynamics			
Courses				
Title		Тур	Hrs/wk	СР
Fluid Mechanics (L0454)		Lecture	3	4
Fluid Mechanics (L0455)		Recitation Section (large)	2	2
Module Responsible	Prof. Thomas Rung			
Admission Requirements	None			
Recommended Previous	Sound knowledge of engineering mathematics, enginee	ring mechanics and thermodynamics.		
Knowledge				
<b>Educational Objectives</b>	After taking part successfully, students have reached th	e following learning results		
<b>Professional Competence</b>				
Knowledge	Students will have the required sound knowledge to	explain the general principles of flui	d engineering a	nd physics of fluids.
	Students can scientifically outline the rationale of flow	physics using mathematical models a	nd are familiar v	with methods for the
	performance analysis and the prediciton of fluid enginee	ering devices.		
61.71				
Skills	Students are able to apply fluid-engineering principles			*
	enables the student to carry out all necessary theoret	ical calculations for the fluid dynamic	design of engir	neering devices on a
	scientific level.			
Personal Competence				
Social Competence	The students are able to discuss problems and jointly de	evelop 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	180 min			
scale				
Assignment for the	General Engineering Science (German program, 7 seme	ster): Specialisation Mechanical Engine	eering: Compulso	ory
Following Curricula	General Engineering Science (German program, 7 seme	ster): Specialisation Biomedical Engine	eering: Compulso	ory
	General Engineering Science (German program, 7 seme	ster): Specialisation Naval Architecture	e: Compulsory	
	Mechanical Engineering: Core qualification: Compulsory			
	Naval Architecture: Core qualification: Compulsory			
	Technomathematics: Specialisation III. Engineering Scie	nce: Elective Compulsory		
•				· ·

Course L0454: Fluid Mechani	ics
Тур	Lecture
Hrs/wk	3
CP	4
Workload in Hours	Independent Study Time 78, Study Time in Lecture 42
Lecturer	Prof. Thomas Rung
Language	DE/EN
Cycle	SoSe
Content	continuum physics definition of fluids, difference to solids/structures and material properties of fluids dimensional analysis and similitude fluid forces and fluid statics transport and conservation of mass, momentum & energy fluid kinematics technically relevant flow models for incompressible fluids
	<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

Module M0960: Mecha	anics IV (Oscillations, Analytical Mecha	nics, Multibody Systems	s, Numerical	Mechanics)
Courses				
<b>Title</b> Mechanics IV (Oscillations, Analytic	al Mechanics, Numerical Mechanics) (L1137)	<b>Typ</b> Lecture	Hrs/wk	<b>CP</b> 3
=	al Mechanics, Numerical Mechanics) (L1138)	Recitation Section (small)	2	2
-	al Mechanics, Numerical Mechanics) (L1139)	Recitation Section (large)	1	1
Module Responsible				
Admission Requirements	None			
Recommended Previous	Mathematics I-III and Mechanics I-III			
Knowledge				
-	After taking part successfully, students have reached the	following learning results		
Professional Competence				
Knowledge	The students can			
	<ul> <li>describe the axiomatic procedure used in mechan</li> </ul>	ical contexts:		
	<ul> <li>explain important steps in model design;</li> </ul>			
	present technical knowledge.			
Skills	The students can			
	<ul> <li>explain the important elements of mathematical</li> </ul>	mechanical analysis and model for	mation, and appl	y it to the context of
	their own problems;	•		
	<ul> <li>apply basic methods to engineering problems;</li> </ul>			
	<ul> <li>estimate the reach and boundaries of the methods</li> </ul>	and extend them to be applicable t	o wider problem s	sets.
Personal Competence				
	The students can work in groups and support each other	to overcome difficulties.		
Autonomy	Students are capable of determining their own strengths	and weaknesses and to organize the	eir time and learn	ing based on those.
Workload in Hours	Independent Study Time 96, Study Time in Lecture 84			
Credit points	6			
Course achievement	None			
Examination	Written exam			
Examination duration and				
scale	220			
Assignment for the	General Engineering Science (German program, 7 semes	ter): Specialisation Mechanical Engir	neerina: Compulso	orv
Following Curricula	General Engineering Science (German program, 7 semes			-
3		- ·		,
	Energy Systems: Technical Complementary Course Core	•	. ,	
	Mechanical Engineering: Core qualification: Compulsory	. ,		
	Mechatronics: Core qualification: Compulsory			
	Naval Architecture: Core qualification: Compulsory			
	Technomathematics: Specialisation III. Engineering Scien	ce: Elective Compulsory		
	Theoretical Mechanical Engineering: Technical Compleme	, ,	Compulsory	
ronowing curricula	General Engineering Science (German program, 7 semes Energy Systems: Technical Complementary Course Core Mechanical Engineering: Core qualification: Compulsory Mechatronics: Core qualification: Compulsory Naval Architecture: Core qualification: Compulsory Technomathematics: Specialisation III. Engineering Scien	ter): Specialisation Naval Architectur Studies: Elective Compulsory ce: Elective Compulsory	e: Compulsory	n y

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	Elements of vibration theory Vibration of Multi-degree of freedom systems Analytical Mechanics Multibody Systems Numerical methods for time integration Introduction to Matlab
Literature	K. Magnus, H.H. Müller-Slany: Grundlagen der Technischen Mechanik. 7. Auflage, Teubner (2009).  D. Gross, W. Hauger, J. Schröder, W. Wall: Technische Mechanik 1-4. 11. Auflage, Springer (2011).  W. Schiehlen, P. Eberhard: Technische Dynamik, Springer (2012).

Course 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	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	SoSe	
Content	See interlocking course	
Literature	See interlocking course	

Module M0956: Meas	urement Technology for Mechanical	l Engineers		
Courses				
<b>Fitle</b> Practical Course: Measurement and Measurement Technology for Mech	-	<b>Typ</b> Practical Course Lecture	Hrs/wk 2 2	<b>CP</b> 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 electrica	I engineering		
<b>Educational Objectives</b>	After taking part successfully, students have reache	d the following learning results		
Professional Competence  Knowledge	Students are able to name the most important fun Calibration, Static and Dynamic Properties of Senso		ogy (Quantities an	d Units, Uncertainty
	They can outline the most important measuring m Temperature, mechanical quantities, Flow, Time, Fr		s to be maesured	Electrical Quantities
	They can describe important methods of chemical A	nalysis (Gas Sensors, Spectroscopy, Ga	s Chromatography	)
Skills	Students can select suitable measuring methods to	given problems and can use refering m	easurement device	es in practice.
	The students are able to orally explain issues in the place the issues into the right context and application		logy and solution a	pproaches as well a
Personal Competence Social Competence	Students can arrive at work results in groups and do	ocument them in a common report.		
Autonomy	Students are able to familiarize themselves with new	w measurement technologies.		
Workload in Hours	Independent Study Time 110, Study Time in Lecture	2 70		
Credit points	6			
Course achievement	Yes None Subject theoretical and practical work	Description		
Examination	Subject theoretical and practical work			
Examination duration and scale	105 minutes			
Assignment for the Following Curricula	General Engineering Science (German program, 7 st. General Engineering Science (German program, 7 st. General Engineering Science (German program, 7 st. Digital Mechanical Engineering: Core qualification: Cenergy and Environmental Engineering: Core qualification: Cenergy and Environmental Engineering: Core qualification Mechanical Engineering Science: Specialisation Mechanical Engineering Science: Specialisation Biomedical Engineering Science: Specialisation Biomedical Engineerial Engineering Science (English program, 7 st. General Engineering Science (English program, 7 st. Logistics and Mobility: Specialisation Production Man Mechanical Engineering: Core qualification: Compulsory Engineering and Management - Major in Logistics Compulsory	emester): Specialisation Biomedical Engemester): Specialisation Energy and Engompulsory compulsory	gineering: Compulsiviromental Engineer iromental Engineer ineering: Compulso ineering: Compulso compulsory ineering: Compulso ineering: Elective Copulsory	ory ring: Compulsory ring: Compulsory ory ory ompulsory

Course L1116: Measurement	Technology for Mechanical Engineering
Тур	
Hrs/wk	
СР	
	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	
СР	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**

Students with the emphasis Biomechanics get in addition to their core engineering skills, a basic understanding of the medical field focusing on fracture healing and implants. This enables them to understand operational planning as well as research and development in this highly interdisciplinary area.

Module M1277: MED I	: Introduction to Anatomy			
Courses				
Title		Тур	Hrs/wk	СР
Introduction to Anatomy (L0384)		Lecture	2	3
Module Responsible	Prof. Udo Schumacher			
Admission Requirements	None			
Recommended Previous	None			
Knowledge				
<b>Educational Objectives</b>	After taking part successfully, students have reached	the following learning results		
Professional Competence				
Knowledge	The students can describe basal structures and function	ons of internal organs and the mus	culoskeletal system.	
	The students can describe the basic macroscopy and i	microscopy of those systems.		
Skills	The students can recognize the relationship between	given anatomical facts and the dev	relanment of some com	nmon diseases: they
S.M.S	can explain the relevance of structures and their funct			on discuses, and
Personal Competence				
Social Competence	The students can participate in current discussions in	biomedical research and medicine	on a professional level	
Autonomy	The students are able to access anatomical knowledge	ge by themselves, can participate	in conversations on th	ne topic and acquire
	the relevant knowledge themselves.			
Weekleed to Herre	Indiana data Chala Tiras C2 Chala Tiras in Lashur 20			
	Independent Study Time 62, Study Time in Lecture 28			
Credit points  Course achievement				
Examination  Examination duration and				
scale	90 minutes			
	General Engineering Science (German program, 7 sem	nector): Specialisation Riomedical F	Engineering: Compulso	rv
_	General Engineering Science (German program, 7	•		-
	Compulsory		g,,	
	Data Science: Specialisation Medicine: Compulsory			
	Electrical Engineering: Specialisation Medical Technology	ogy: Elective Compulsory		
	Engineering Science: Specialisation Biomedical Engine	ering: Compulsory		
	General Engineering Science (English program, 7 sem	ester): Specialisation Biomedical E	ngineering: Compulsor	y
	Mechanical Engineering: Specialisation Biomechanics:	Compulsory		
	Biomedical Engineering: Specialisation Medical Technology	ology and Control Theory: Elective	Compulsory	
	Biomedical Engineering: Specialisation Management a	nd Business Administration: Electiv	ve Compulsory	
	Biomedical Engineering: Specialisation Artificial Organ	-		
	Biomedical Engineering: Specialisation Implants and E		ry	
	Technomathematics: Specialisation III. Engineering Sc	ence: Elective Compulsory		

Course L0384: Introduction t	o Anatomy			
Тур	Lecture			
Hrs/wk	2			
СР				
		ndependent Study Time 62, Study Time in Lecture 28		
	Prof. Tobias Lange			
Language				
Cycle				
Content	General Anatomy			
	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:	th week: Cardiovascular System		
	6 <sup>th</sup> week:	th week: Respiratory System		
	7 <sup>th</sup> week:	th week: Genito-urinary System		
	8 <sup>th</sup> week:	th week: Immune system		
	9 <sup>th</sup> week:	th week: Digestive System I		
	10 <sup>th</sup> week:	0 <sup>th</sup> week: Digestive System II		
	11 <sup>th</sup> week:	1 <sup>th</sup> week: Endocrine System		
	12 <sup>th</sup> week:	Nervous System		
	13 <sup>th</sup> week:	Exam		
Literature	Adolf Faller/Michae	l Schünke, Der Körper des Menschen, 17. Auflage, Thieme Verlag Stuttgart, 2016		

Courses					
itle		Тур	Hrs/wk CP		
ntroduction to Radiology and Radio		Lecture	2 3		
Module Responsible					
Admission Requirements Recommended Previous					
Knowledge	THORE .				
<b>Educational Objectives</b>	After taking part successfully, students have	e reached the following learning results			
<b>Professional Competence</b>					
Knowledge	<b>Therapy</b> The students can distinguish different types	of currently used equipment with respect	to its use in radiation therapy.		
	The students can explain treatment plans us	sed in radiation therapy in interdisciplinary	contexts (e.g. surgery, internal medicine).		
	The students can describe the patients	s' passage from their initial admittance	e through to follow-up care.		
	Diagnostics				
	The students can illustrate the technical bawell as sectional imaging techniques (CT, M		cluding angiography and mammography,		
	The students can explain the diagnostic as techniques.	well as therapeutic use of imaging technic	ques, as well as the technical basis for tho		
	The students can choose the right treatmen	it method depending on the patient's clinic	al history and needs.		
	The student can explain the influence of tec	chnical errors on the imaging techniques.			
	The student can draw the right conclusions based on the images' diagnostic findings or the error protocol.				
Skills	<b>Therapy</b> The students can distinguish curative and po	alliative situations and motivate why they	came to that conclusion.		
	The students can develop adequate therapy concepts and relate it to the radiation biological aspects.				
	The students can use the therapeutic princip	ple (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 individua groups, self-help groups, social services, psy		e.g. follow-up treatment, sports, social h		
	Diagnostics				
	The students can suggest solutions for repa	airs of imaging instrumentation after having	n done error analyses		
	The students can classify results of imagir				
	anatomy, pathology and pathophysiology.				
Personal Competence	The students can access the special social s	situation of tumor nationts and interact with	h thom in a professional way		
Social Competence	The students can assess the special social s The students are aware of the special, o measures and can meet them appropriately	often fear-dominated behavior of sick per	·		
Autonomy	The students can apply their new knowledge The students can introduce younger student				
The students are able to access anatomical knowledge by themselves, can participate competently in conv		te competently in conversations on the to			
***	and acquire the relevant knowledge themse				
Workload in Hours  Credit points		Lecture 28			
Course achievement					
	Written exam				
Examination duration and	90 minutes				
scale					
Assignment for the					
Following Curricula		rogram, / semester): Specialisation Med	chanical Engineering, Focus Biomechanii		
	Compulsory  Data Science: Specialisation Medicine: Computer Comput	pulsory			
	Electrical Engineering: Specialisation Medica				
	Engineering Science: Specialisation Riemed	ical Engineering: Compulsory			
	Liigineering Science. Specialisation biomed.	. 5 . 5 . 1 ,			
	General Engineering Science (English progra	am, 7 semester): Specialisation Biomedical	l Engineering: Compulsory		
	General Engineering Science (English progra Mechanical Engineering: Specialisation Biom	am, 7 semester): Specialisation Biomedical nechanics: Compulsory			
	General Engineering Science (English progra Mechanical Engineering: Specialisation Biom Biomedical Engineering: Specialisation Medi	am, 7 semester): Specialisation Biomedical nechanics: Compulsory ical Technology and Control Theory: Electiv	ve Compulsory		
	General Engineering Science (English progra Mechanical Engineering: Specialisation Biom	am, 7 semester): Specialisation Biomedical nechanics: Compulsory ical Technology and Control Theory: Electiv agement and Business Administration: Elec	ve Compulsory ctive Compulsory		

Technomathematics: Specialisation iii. Engineering Science: Elective Compulsory

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

Module M0662: Nume	erical Mathematics I
Courses	
Courses	Typ Hrs/wk CP
Title Numerical Mathematics I (L0417)	Typ         Hrs/wk         CP           Lecture         2         3
Numerical Mathematics I (L0418)	Recitation Section (small) 2 3
Module Responsible	Prof. Sabine Le Borne
Admission Requirements	None
Recommended Previous	a Makhamakil, I. I. Il fay Faninaning Chudanka (anyanan ay anglish) ay Anglusia C. Lingay Algabya I. I. Il fay Tash namakhamakinin
Knowledge	<ul> <li>Mathematik I + II for Engineering Students (german or english) or Analysis &amp; Linear Algebra I + II for Technomathematicia</li> <li>basic MATLAB/Python knowledge</li> </ul>
	basic MATEAU/Fycilon knowledge
Educational Objectives	After taking part successfully, students have reached the following learning results
Professional Competence	
Knowledge	Students are able to
	name numerical methods for interpolation, integration, least squares problems, eigenvalue problems, nonlinear root finding.
	problems and to explain their core ideas,
	repeat convergence statements for the numerical methods,
	explain aspects for the practical execution of numerical methods with respect to computational and storage complexitx.
Skills	Students are able to
	implement, apply and compare numerical methods using MATLAB/Python,
	<ul> <li>justify the convergence behaviour of numerical methods with respect to the problem and solution algorithm,</li> </ul>
	select and execute a suitable solution approach for a given problem.
Personal Competence	
Social Competence	Students are able to
	work together in heterogeneously composed teams (i.e., teams from different study programs and background knowledge
	explain theoretical foundations and support each other with practical aspects regarding the implementation of algorithms.
Autonomy	Students are capable
Autonomy	Students are capable
	• to assess whether the supporting theoretical and practical excercises are better solved individually or in a team,
	to assess their individual progess and, if necessary, to ask questions and seek help.
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56
Credit points	
Credit points	
Course achievement	
Course achievement	
Course achievement	None Written exam
Course achievement Examination	None Written exam
Course achievement Examination Examination duration and scale	None Written exam
Course achievement Examination Examination duration and scale Assignment for the	None Written exam 90 minutes
Course achievement Examination Examination duration and scale Assignment for the	None Written exam 90 minutes  General Engineering Science (German program, 7 semester): Specialisation Computer Science: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Materials Engineering Sciences: Compulsory
Course achievement Examination Examination duration and scale Assignment for the	None  Written exam  90 minutes  General Engineering Science (German program, 7 semester): Specialisation Computer Science: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Materials Engineering Sciences: Compulsory General Engineering Science (German program, 7 semester): Specialisation Biomedical Engineering: Compulsory
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Course achievement Examination Examination duration and scale Assignment for the	Written exam  90 minutes  General Engineering Science (German program, 7 semester): Specialisation Computer Science: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Materials Engineering Sciences: Compulsory General Engineering Science (German program, 7 semester): Specialisation Biomedical Engineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Biomechanic Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Theoretical Mechanic Engineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Aircraft System Engineering: Elective Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Mechatronics: Elective Compulsory
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Computational Science and Engineering: Core qualification: Compulsory

 ${\it Mechanical\ Engineering: Specialisation\ Theoretical\ Mechanical\ Engineering:\ Compulsory}$ 

Mechanical Engineering: Specialisation Energy Systems: Elective Compulsory

Mechanical Engineering: Specialisation Mechatronics: Elective Compulsory

Theoretical Mechanical Engineering: Technical Complementary Course Core Studies: Elective Compulsory

Process Engineering: Specialisation Process Engineering: Elective Compulsory

Course L0417: Numerical Ma	Course L0417: Numerical Mathematics I			
Тур	Lecture			
Hrs/wk	2			
СР	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 für Ingenieure und Naturwissenschaftler, Springer</li> </ul>			

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

Module M1279: MED	I: Introduction to Biochemistr	y and Molecular Biology		
Courses				
<b>Title</b> Introduction to Biochemistry and M	olecular Biology (L0386)	<b>Typ</b> Lecture	Hrs/wk	<b>CP</b>
Module Responsible	Prof. Hans-Jürgen Kreienkamp			
Admission Requirements	None			
Recommended Previous	None			
Knowledge				
<b>Educational Objectives</b>	After taking part successfully, students have	e reached the following learning results		
Professional Competence				
Knowledge	The students can			
	<ul> <li>describe basic biomolecules;</li> </ul>			
	<ul> <li>explain how genetic information is co</li> </ul>	ded in the DNA:		
	explain the connection between DNA			
		,		
Skills	The students can			
	<ul> <li>recognize the importance of molecula</li> </ul>	r parameters for the course of a disease;		
	describe selected molecular-diagnost	ic procedures;		
	explain the relevance of these proced	ures for some diseases		
Personal Competence	The short sale are a sale in the discussion of		1	
Social Competence	The students can participate in discussions i	n research and medicine on a technical leve	l.	
Autonomy	The students can develop understanding of	topics from the course, using technical litera	ature, by themselves.	
Workload in Hours	Independent Study Time 62, Study Time in L	ecture 28		
Credit points	3			
Course achievement	None			
Examination	Written exam			
Examination duration and	60 minutes			
scale				
Assignment for the	General Engineering Science (German progr	am, 7 semester): Specialisation Biomedical I	Engineering: Compulsory	/
Following Curricula	General Engineering Science (German pr	ogram, 7 semester): Specialisation Mech	anical Engineering, Fo	cus Biomechanics
	Compulsory			
	Data Science: Specialisation Medicine: Comp	pulsory		
	Electrical Engineering: Specialisation Medica	**		
	Engineering Science: Specialisation Biomedi			
	General Engineering Science (English progra	•		
	General Engineering Science (English pro	ogram, 7 semester): Specialisation Mecha	anical Engineering, Fo	cus Biomechanics
	Compulsory			
	Mechanical Engineering: Specialisation Biom	• •		
	Biomedical Engineering: Specialisation Mana	-		
	Biomedical Engineering: Specialisation Artifi			
	Biomedical Engineering: Specialisation Medi			
	Biomedical Engineering: Specialisation Impla	·	ory	
	Technomathematics: Specialisation III. Engir	neering Science: Elective Compulsory		

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

Module M1333: BIO I:	Implants and Fracture Healing					
Courses						
Title	Typ Hrs/wk CP					
Implants and Fracture Healing (L03	76) Lecture 2 3					
Module Responsible	Prof. Michael Morlock					
Admission Requirements	None					
Recommended Previous	It is recommended to participate in "Introduction into Anatomie" before attending "Implants and Fracture Healing".					
Knowledge						
Educational Objectives	After taking part successfully, students have reached the following learning results					
Professional Competence						
Knowledge	The students can describe the different ways how bones heal, and the requirements for their existence.					
	The students can name different treatments for the spine and hollow bones under given fracture morphologies.					
Skills	The students can determine the forces acting within the human body under quasi-static situations under specific assumptions.					
Skins	The state is the second configuration and second and second and second and second assembly assembly assembly as a second as					
Personal Competence						
Social Competence	The students can, in groups, solve basic numerical modeling tasks for the calculation of internal forces.					
Autonomy	The students can, in groups, solve basic numerical modeling tasks for the calculation of internal forces.					
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28					
Credit points	3					
Course achievement	None					
Examination	Written exam					
Examination duration and	90 min					
scale						
Assignment for the	General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Biomechanics					
Following Curricula						
	General Engineering Science (German program, 7 semester): Specialisation Biomedical Engineering: Compulsory					
	Engineering Science: Specialisation Biomedical Engineering: Compulsory					
	General Engineering Science (English program, 7 semester): Specialisation Biomedical Engineering: Compulsory					
	General Engineering Science (English program, 7 semester): Specialisation Mechanical Engineering, Focus Biomechanics:					
	Compulsory					
	Mechanical Engineering: Specialisation Biomechanics: Compulsory					
	Biomedical Engineering: Specialisation Implants and Endoprostheses: Elective Compulsory Biomedical Engineering: Specialisation Artificial Organs and Regenerative Medicine: Elective Compulsory					
	Biomedical Engineering: Specialisation Management and Business Administration: Elective Compulsory					
	Biomedical Engineering: Specialisation Medical Technology and Control Theory: Elective Compulsory					
	Orientation Studies: Core qualification: Elective Compulsory					
	Technomathematics: Specialisation III. Engineering Science: Elective Compulsory					
	the second second					

Course L0376: Implants and	Fracture Healing						
Тур	Lecture						
Hrs/wk							
CP							
Workload in Hours  Lecturer	Independent Study Time 62, Study Time in Lecture 28  Prof. Michael Morlock						
Language							
Cycle							
Content	ics to be covered include:						
	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						
	Pelvis (anatomy, biomechanics, fracture treatment)						
	racture Healing						
	Basics and biology of fracture repair						
	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						

Module M1280: MED I	I: Introduction to Physiology					
Courses						
Title	Typ Hrs/wk CP					
Introduction to Physiology (L0385)	Lecture 2 3					
Module Responsible	Dr. Roger Zimmermann					
Admission Requirements	None					
Recommended Previous	None					
Knowledge						
Educational Objectives	After taking part successfully, students have reached the following learning results					
<b>Professional Competence</b>						
Knowledge	The students can					
	describe the basics of the energy metabolism;					
	<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, development					
	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, by					
	themselves.					
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28					
Credit points	3					
Course achievement	None					
Examination	Written exam					
Examination duration and	60 minutes					
scale						
Assignment for the	General Engineering Science (German program, 7 semester): Specialisation Biomedical Engineering: Compulsory					
Following Curricula	General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Biomechanics					
	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 Mechanical Engineering, Focus Biomechanics Compulsory					
	General Engineering Science (English program, 7 semester): Specialisation Biomedical Engineering: 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 t	Course L0385: Introduction to Physiology				
Тур	ture				
Hrs/wk	2				
СР					
Workload in Hours	pendent Study Time 62, Study Time in Lecture 28				
Lecturer	Gerhard Engler				
Language					
Cycle	Se				
Content					
Literature	schenatlas der Physiologie, Silbernagl Despopoulos, ISBN 978-3-135-67707-1, Thieme				
	Repetitorium Physiologie, Speckmann, ISBN 978-3-437-42321-5, Elsevier				

Module M1332: BIO I:	Experimental Methods in Biomechanics				
Courses					
<b>Title</b> Experimental Methods in Biomecha	Typ         Hrs/wk         CP           anics (L0377)         Lecture         2         3				
Module Responsible	Prof. Michael Morlock				
Admission Requirements	None				
Recommended Previous Knowledge	It is recommended to participate in "Implantate und Frakturheilung" before attending "Experimentelle Methoden".				
	After taking part successfully, students have reached the following learning results				
Professional Competence					
Knowledge	The students can describe the different ways how bones heal, and the requirements for their existence.  The students can name different treatments 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 a given task.				
Skills	The students can describe the basic handling of several experimental techniques used in biomechanics.				
Personal Competence					
Social Competence	The students can, in groups, solve basic experimental tasks.				
Autonomy	The students can, in groups, solve basic experimental tasks.				
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 Following Curricula	General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Biomechanics 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 Mechanical Engineering, Focus Biomechanics Compulsory General Engineering Science (English program, 7 semester): Specialisation Biomedical Engineering: Compulsory General Engineering Science (English program, 7 semester): Specialisation Biomedical Engineering: 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	ourse L0377: Experimental Methods in Biomechanics		
Тур	Lecture		
Hrs/wk	2		
СР	3		
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28		
Lecturer	Prof. Michael Morlock		
Language	DE		
Cycle	SoSe		
Content			
Literature	Wird in der Veranstaltung bekannt gegeben		

Module M0934: Adva	nced Materials			
Courses				
Title		Тур	Hrs/wk	СР
Advanced Materials Characterization (L1087)		Lecture	2	2
Advanced Materials Design (L1091)	)	Lecture	2	2
Advanced Materials Design (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 reached the	following learning results		
Professional Competence				
Knowledge	The students will be able to explain the properties of ad	vanced materials along with their a	applications in tecl	hnology, in particular
	metallic, ceramic, polymeric, semiconductor, modern cor	nposite materials (biomaterials) an	d nanomaterials.	
Civilia	The shadest will be able to calculate as for such	in a consider to the trade in the		
SKIIIS	The students will be able to select material configurat			
	materials considering architectural principles from the			
	modern materials science, which enables them to select	optimum materials combinations of	epending on the te	echnical applications.
Personal Competence				
Social Competence	The students are able to present solutions to specialists a	and to develop ideas further.		
Autonomy	The students are able to			
	<ul> <li>assess their own strengths and weaknesses.</li> </ul>			
	define tasks independently.			
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 se	emester): Specialisation Mechanic	al Engineering, F	ocus Biomechanics:
Following Curricula	Compulsory			
	General Engineering Science (German program, 7 s	semester): Specialisation Mechan	ical Engineering,	Focus Materials in
	Engineering Sciences: Compulsory			
	Data Science: Specialisation Materials Science: Compulso	ory		
	General Engineering Science (English program, 7 semest	er): Specialisation Mechanical Engi	neering: Elective C	Compulsory
	Mechanical Engineering: Core qualification: Elective Com	pulsory		

Course L1087: Advanced Mat	terials Characterization					
Тур	cture					
Hrs/wk	2					
СР	2					
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28					
Lecturer	f. Patrick Huber					
Language						
Cycle	oSe					
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 Design					
Тур	cure				
Hrs/wk					
СР					
Workload in Hours	ndent Study Time 32, Study Time in Lecture 28				
Lecturer	odo Fiedler, Prof. Stefan Müller, Prof. Patrick Huber, Prof. Gerold Schneider, Prof. Jörg Weißmüller				
Language	EN				
Cycle	SoSe				
Content					
Literature	Vorlesungsunterlagen				

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

Courses						
itle	rearramming Consents Data Us	andling Communication (13690)	Typ	Hrs/wk	<b>CP</b> 3	
omputer Science for Engineers - P computer Science for Engineers - P			Lecture  Recitation Section (small)	3 2	3	
		mamig a communication (E2000)	necitation section (small)	-		
Module Responsible						
Admission Requirements	None					
Recommended Previous Knowledge						
	After telding part guessefull		allawing languing gasulta			
	Arter taking part successium	y, students have reached the f	ollowing learning results			
Professional Competence						
Knowledge Skills						
SKIIIS						
<b>Personal Competence</b>						
Social Competence						
Autonomy						
Workload in Hours	Independent Study Time 11	0, Study Time in Lecture 70				
Credit points	6					
Course achievement	Compulsory Bonus Form	Descript	ion			
	No 10 % Attes	station Testate	finden semesterbegleitend stati			
Examination	Written exam					
$ \  \   \textbf{Examination duration and} \\$	120 min					
scale						
Assignment for the	General Engineering Scien	ce (German program, 7 ser	nester): Specialisation Mechani	cal Engineering, I	Focus Biomechanic	
Following Curricula	Compulsory					
	General Engineering Science (German program, 7 semester): Specialisation Biomedical Engineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Green Technologies, Focus Renewable Energy: Electiv Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Energy Systems					
	Compulsory		ester): Specialisation Mechanica			
	Engineering: Compulsory General Engineering Scien	mester): Specialisation Mechai	nical Engineering,	Focus Materials		
	Engineering Sciences: Compulsory  General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Mechatronics:					
	Compulsory					
	General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Theoretical Mechanical Engineering: Compulsory					
	General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Product Development and Production: Elective Compulsory					
	General Engineering Science (German program, 7 semester): Specialisation Electrical Engineering: Elective Compulsory Bioprocess Engineering: Core qualification: Compulsory					
	Electrical Engineering: Core	qualification: Compulsory				
	Energy and Environmental Engineering: Core qualification: Compulsory					
	General Engineering Science (English program, 7 semester): Specialisation Process Engineering: Elective Compulsory					
	General Engineering Science (English program, 7 semester): Specialisation Energy and Environmental Engineering: Elective Compulsory					
	Green Technologies: Energy, Water, Climate: Specialisation Energy Systems: Elective Compulsory Logistics and Mobility: Core qualification: Compulsory					
		alisation Information Technolo	gy: Compulsory			
	Mechatronics: Core qualifica		S			
	Process Engineering: Core q	• •				

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

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

## **Focus Energy Systems**

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

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

Module M0684: Heat	Transfer			
Courses				
Title Heat Transfer (L0458) Heat Transfer (L0459)		Typ Lecture Recitation Section (large)	<b>Hrs/wk</b> 3 2	<b>CP</b> 4 2
	Dr. Andreas Moschallski	Recitation Section (large)	2	2
Admission Requirements				
Recommended Previous	Technical Thermodynamics I, II and Fluid Dynamics			
Knowledge	Teetimeen mennedynamics i, ii and riala synamics			
Educational Objectives	After taking part successfully, students have reached the follow	ing learning results		
Professional Competence				
Knowledge	The students are able to			
	- describe the different physical mechanism of Heat Transfer,			
	- explain the technical terms,			
	- to analyse comlex heat transfer processes in a critical way.			
Skills	The students are able to			
	- understand the physics of Heat Transfer,  - calculate and evaluate complex Heat Transfer processes,			
	- solve excersises self-consistent and in small groups.			
	3p.			
Personal Competence	The shudants are able to discuss in small arrays and daysles on			
Social Competence	The students are able to discuss in small groups and develop an	і арргоасіі.		
Autonomy	The students are able to develop a complex problem self-consis	stent and analyse the results in	a critical way. A	qualified exchange
	with other students is given.			
Workload in Hours	Independent Study Time 110, Study Time in Lecture 70			
Credit points	6			
Course achievement				
Examination				
Examination duration and	120 min			
scale Assignment for the	General Engineering Science (German program, 7 semester)	· Specialisation Machanical Fr	aginopring Factor	s Enorgy Systems
Following Curricula	Compulsory	: Specialisation Mechanical Er	igineering, Focu	s energy systems:
r onowing curricula	General Engineering Science (German program, 7 semester): Sp	pecialisation Biomedical Engine	erina: Compulsor	·v
	General Engineering Science (German program, 7 semester): S	_		-
	Engineering: Compulsory			
	Energy Systems: Technical Complementary Course Core Studies			
	General Engineering Science (English program, 7 semester): Compulsory	: Specialisation Mechanical Er	ngineering, Focu	s Energy Systems:
	General Engineering Science (English program, 7 semester): Sp	ecialisation Biomedical Enginee	ring: Compulsory	/
	Mechanical Engineering: Specialisation Energy Systems: Compu	•		
	Mechanical Engineering: Specialisation Theoretical Mechanical E	Engineering: Elective Compulsor	ry	

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	ourse L0459: Heat Transfer	
Тур	Recitation Section (large)	
Hrs/wk	2	
СР	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				
Fundamentals of Reciprocating Eng Internal Combustion Engines I (L00		Typ Lecture Recitation Section (large) Lecture	Hrs/wk 1 1 2	CP 1 1 2
Internal Combustion Engines I (L06		Recitation Section (large)	1	2
Module Responsible	·			
Admission Requirements	None			
Recommended Previous	Thermodynamics, Mechanics, Machine Elements			
Knowledge Educational Objectives	After taking part successfully, students have reached the follo	wing learning results		
Professional Competence	After taking part successiumy, students have reached the folio	wing learning results		
·	As a result of the part module "Fundamentals of Reciprocating Machinery", the students are able to reflect fundamentals regarding power and working machinery and describe the qualitative and quantitative correlations of operating methods and efficiencies of multiple types of engines, compressors and pumps. They are able to utilize technical terms and parameters as well as aspects regarding the development of power density and efficiency, furthermore to give an overview of charging systems, fuels and emissions. The students are able to select specific types of machinery and assess design related and operational problems.			
Skills	As a result of the part module "Internal Combustion Engines I", the students are able reflect and utilize the state-of-the-art regarding efficiency limits. In addition, they are able to utilize their knowledge of design, mechanical and thermodynamic characteristics and the approach of similarity. They are able to explain, assess and develop engines as well as charging systems. Detailed knowledge is present regarding computer-aided process design.  The students are skilled to employ basic and detail knowledge regarding reciprocating machinery, their selection and operation.			
	They are further able to assess, analyse and solve technical and operational problems and to perform mechanical and thermodynamic design.			
Personal Competence Social Competence	The students are able to communicate and cooperate in application.	a professional environment in	the field of ma	achinery design and
Autonomy	The widespread scope of gained knowledge enables the students to handle situations in their future profession independently and confidently.			
Workload in Hours	Independent Study Time 110, Study Time in Lecture 70			
Credit points	6			
Course achievement				
Examination	Written exam			
Examination duration and	120 min			
scale Assignment for the Following Curricula	Compulsory Energy and Environmental Engineering: Core qualification: Ele Energy Systems: Technical Complementary Course Core Studi General Engineering Science (English program, 7 semeste Compulsory Green Technologies: Energy, Water, Climate: Specialisation En	ective Compulsory les: Elective Compulsory r): Specialisation Mechanical E	ngineering, Foc	
	Mechanical Engineering: Specialisation Energy Systems: Com	Juisui y		

Course L0633: Fundamentals 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	Verbrennungsmotoren  Historischer Rückblick  Einteilung der Verbrennungsmotoren  Arbeitsverfahren  Vergleichsprozesse  Arbeit, Mitteldrücke, Leistungen  Arbeitsprozess des wirklichen Motors  Wirkungsgrade  Gemischbildung und Verbrennung  Motorkennfeld und Betriebskennlinien  Abgasentgiftung  Gaswechsel  Aufladung  Kühl- und Schmiersystem  Kräfte im Triebwerk  Kolbenverdichter  Thermodynamik des Kolbenverdichters  Einteilung und Verwendung  Kolbenpumpen  Prinzip der Kolbenpumpen	
Literature	Einteilung und Verwendung      A. Urlaub: Verbrennungsmotoren      W. Kalide: Kraft- und Arbeitsmaschinen	

Course L0634: Fundamentals	ourse L0634: Fundamentals of Reciprocating Engines and Turbomachinery - Part Reciprocating Engines		
Тур	Recitation Section (large)		
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	See interlocking course		
Literature	See interlocking course		

Course L0059: Internal Combustion Engines I		
Тур	Lecture	
Hrs/wk	2	
СР	2	
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28	
Lecturer	Prof. Wolfgang Thiemann	
Language	DE	
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	Vorlesungsskript  Übungsaufgaben mit Lösungsweg  Literaturliste	

Course L0639: Internal Combustion Engines I	
Тур	Recitation Section (large)
Hrs/wk	1
СР	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

Module M0655: Comp	utational Fluid Dynamics I			
Courses				
Title Computational Fluid Dynamics I (LC Computational Fluid Dynamics I (LC		<b>Typ</b> Lecture Recitation Section (large)	Hrs/wk 2 2	<b>CP</b> 3 3
Module Responsible	Prof. Thomas Rung			
Admission Requirements	None			
Recommended Previous				
Knowledge	Mathematical Methods for Engineers     Fundamentals of Differential/integral calculus and	d series expansions		
Educational Objectives	After taking part successfully, students have reached th	e following learning results		
Professional Competence				
Knowledge	The students are able to list the basic numerics of partial	al differential equations.		
Skills	The students are able develop appropriate numerical integration in space and time for the governing partial differential equations. They can code computational algorithms in a structured way.			lifferential equations.
Personal Competence Social Competence	The students can arrive at work results in groups and do	ocument them.		
Autonomy	The students can independently analyse approaches to	solving specific problems.		
Wardshard in Harris	Index and set Charle Time 124 Charle Time in Lock and E.			
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56			
Credit points				
Course achievement				
Examination	Written exam			
Examination duration and	2h			
scale				
Assignment for the	General Engineering Science (German program, 7 seme	ester): Specialisation Mechanical Engir	neering, Focus Th	neoretical Mechanical
Following Curricula	Engineering: Elective Compulsory			
	General Engineering Science (German program, 7 se	emester): Specialisation Mechanical	Engineering, Foo	cus Aircraft Systems
	Engineering: Elective Compulsory			
	General Engineering Science (German program, 7 se	emester): Specialisation Mechanical	Engineering, Foo	cus Energy Systems:
	Elective Compulsory			
	General Engineering Science (German program, 7 seme			den Committee
	General Engineering Science (German program, 7 seme		omental Enginee	ring: Compulsory
	Energy Systems: Technical Complementary Course Core		mantal Engineer	ina. Camanulaan
	General Engineering Science (English program, 7 semes			
	General Engineering Science (English program, 7 se Elective Compulsory	mester). Specialisation Mechanical I	Linginieering, FOC	us Lifergy Systems:
	General Engineering Science (English program, 7 semes	ster): Specialisation Naval Architecture	e: Compulsorv	
	General Engineering Science (English program, 7 series			cus Aircraft Systems
	Engineering: Elective Compulsory	, .,	J	
	Mechanical Engineering: Specialisation Energy Systems	: Elective Compulsory		
	Mechanical Engineering: Specialisation Aircraft Systems			
	Naval Architecture: Core qualification: Compulsory			
	Technomathematics: Specialisation III. Engineering Scie	nce: Elective Compulsory		

Course L0235: Computational Fluid Dynamics I		
Тур	Lecture	
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	Fundamentals of computational modelling of thermofluid dynamic problems. Development of numerical algorithms.	
	1. Partial differential equations 2. Foundations of finite numerical approximations 3. Computation of potential flows 4. Introduction of finite-differences 5. Approximation of convective, diffusive and transient transport processes 6. Formulation of boundary conditions and initial conditions 7. Assembly and solution of algebraic equation systems 8. Facets of weighted -residual approaches 9. Finite volume methods 10. Basics of grid generation	
Literature	Ferziger and Peric: Computational Methods for Fluid Dynamics, Springer	

Course L0419: Computationa	Course 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	

Typ Hrs/wk CP  Lecture 2 3  Recitation Section (small) 2 3  rrne  (I + II for Engineering Students (german or english) or Analysis & Linear Algebra I + II for Technomathemath AB/Python knowledge  uccessfully, students have reached the following learning results  to  erical methods for interpolation, integration, least squares problems, eigenvalue problems, nonlinear root find to explain their core ideas, vergence statements for the numerical methods, ects for the practical execution of numerical methods with respect to computational and storage complexit.
Lecture 2 3 Recitation Section (small) 2 3  Trine  (I + II for Engineering Students (german or english) or Analysis & Linear Algebra I + II for Technomathemal AB/Python knowledge  uccessfully, students have reached the following learning results  to  erical methods for interpolation, integration, least squares problems, eigenvalue problems, nonlinear root find to explain their core ideas, vergence statements for the numerical methods,
Lecture 2 3 Recitation Section (small) 2 3  recently a second section (small) 2 3  recently a sect
The state of the following learning results (some of the following learning results) or Analysis & Linear Algebra I + II for Technomathemath (AB/Python knowledge) accessfully, students have reached the following learning results to the following learning results are reached the following learning results are reached the following learning results to the following learning results are reached the following lea
(I + II for Engineering Students (german or english) <b>or</b> Analysis & Linear Algebra I + II for Technomathema AB/Python knowledge uccessfully, students have reached the following learning results to erical methods for interpolation, integration, least squares problems, eigenvalue problems, nonlinear root find to explain their core ideas, vergence statements for the numerical methods,
AB/Python knowledge  uccessfully, students have reached the following learning results  to  erical methods for interpolation, integration, least squares problems, eigenvalue problems, nonlinear root find to explain their core ideas, vergence statements for the numerical methods,
AB/Python knowledge  uccessfully, students have reached the following learning results  to  erical methods for interpolation, integration, least squares problems, eigenvalue problems, nonlinear root find to explain their core ideas, vergence statements for the numerical methods,
AB/Python knowledge  uccessfully, students have reached the following learning results  to  erical methods for interpolation, integration, least squares problems, eigenvalue problems, nonlinear root find to explain their core ideas, vergence statements for the numerical methods,
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vergence statements for the numerical methods,
ects for the practical execution of numerical methods with respect to computational and storage complexit.
to
apply and compare numerical methods using MATLAB/Python,
convergence behaviour of numerical methods with respect to the problem and solution algorithm,
execute a suitable solution approach for a given problem.
to
ner in heterogeneously composed teams (i.e., teams from different study programs and background knowle
oretical foundations and support each other with practical aspects regarding the implementation of algorith
ble
hether the supporting theoretical and practical excercises are better solved individually or in a team,
neir individual progess and, if necessary, to ask questions and seek help.
y Time 124, Study Time in Lecture 56
ng Science (German program, 7 semester): Specialisation Computer Science: Compulsory
ring Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Materi
ces: Compulsory
ng Science (German program, 7 semester): Specialisation Biomedical Engineering: Compulsory
ing Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Biomech
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ng Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Theoretical Mech
pulsory
ing Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Aircraft Sy
ive Compulsory
ng Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Mechatronics: El
ing Colones (Common average 7 commontal) Constitution March 1 1 5 1 1 1 5 1
ing Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Energy Sys
ory
ering: Specialisation A - General Bioprocess Engineering: Elective Compulsory
:: Specialisation Computational Mathematics: Elective Compulsory
:: Specialisation II. Mathematics and Engineering Science: Elective Compulsory
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Computational Science and Engineering: Core qualification: Compulsory

Mechanical Engineering: Specialisation Theoretical Mechanical Engineering: Compulsory

Mechanical Engineering: Specialisation Energy Systems: Elective Compulsory

Mechanical Engineering: Specialisation Mechatronics: Elective Compulsory

Theoretical Mechanical Engineering: Technical Complementary Course Core Studies: Elective Compulsory

Process Engineering: Specialisation Process Engineering: Elective Compulsory

ourse L0417: Numerical Mathematics I		
Тур	Lecture	
Hrs/wk	2	
СР	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 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
Electrical Machines and Actuators	(L0293)	Lecture	3	4
Electrical Machines and Actuators	(L0294)	Recitation Section (large)	2	2
Module Responsible	Prof. Thorsten Kern			
Admission Requirements	None			
Recommended Previous	Basics of mathematics, in particular complexe numbers	s, integrals, differentials		
Knowledge	Basics of electrical engineering and mechanical engine	oring		
	basics of electrical engineering and mechanical engine	ering		
Educational Objectives	After taking part successfully, students have reached the	he following learning results		
<b>Professional Competence</b>				
Knowledge	Students can to draw and explain the basic principles of	f electric and magnetic fields.		
	They can describe the function of the standard ty	nes of electric machines and prese	ent the correspon	ding equations ar
	characteristic curves. For typically used drives they car			
	from the power grid to the driven engine.			
Skills	Students are able to calculate two-dimensional electri	ic and magnetic fields in particular fe	rromagnetic circ	uits with air gan F
SKIIS	this they apply the usual methods of the design auf ele			an and
	They can calulate the operational performance of elec	ctric machines from their given chara	cteristic data and	d selected quantitie
	and characteristic curves. They apply the usual equival		cteristic data am	a selected qualititie
	and characteristic curves. They apply the assure equiva-	ent en cares and grapmed methods.		
Personal Competence				
Social Competence				
Autonomy		and magnatic fields for applications. The	nev are able to a	nalyse independent
Autonomy				
	the operational performance of electric machines from	n the charactersitic data and theycan	r calculate thereo	i selected quantiti
	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 of desig	n files		
scale				
Assignment for the	General Engineering Science (German program, 7 seme	ester): Specialisation Electrical Engine	ering: Elective Co	mpulsory
Following Curricula	General Engineering Science (German program, 7 s	emester): Specialisation Mechanical	Engineering, Foo	us Energy System
	Compulsory			
	General Engineering Science (German program, 7	semester): Specialisation Mechanica	al Engineering,	Focus Mechatronic
	Compulsory			
	General Engineering Science (German program, 7 sem	ester): Specialisation Mechanical Engi	neering, Focus Th	eoretical Mechanic
	Engineering: Elective Compulsory			
	Company Francisco Colonia (Company and San 7 and		omental Enginee	
	General Engineering Science (German program, 7 seme	ester): Specialisation Energy and Envir	omental Enginee	ring: Compulsory
	Digital Mechanical Engineering: Core qualification: Com		omental Enginee	ring: Compulsory
		npulsory	omental Enginee	ring: Compulsory
	Digital Mechanical Engineering: Core qualification: Com	npulsory pulsory	omental Enginee	ring: Compulsory
	Digital Mechanical Engineering: Core qualification: Corr Electrical Engineering: Core qualification: Elective Com	npulsory pulsory ion: Compulsory	-	
	Digital Mechanical Engineering: Core qualification: Corr Electrical Engineering: Core qualification: Elective Com Energy and Environmental Engineering: Core qualificat	npulsory pulsory ion: Compulsory ster): Specialisation Mechanical Engin	eering: Elective C	
	Digital Mechanical Engineering: Core qualification: Com Electrical Engineering: Core qualification: Elective Com Energy and Environmental Engineering: Core qualificat General Engineering Science (English program, 7 seme	npulsory pulsory ion: Compulsory ster): Specialisation Mechanical Engination Energy Technology: Elective Com	eering: Elective C	
	Digital Mechanical Engineering: Core qualification: Com Electrical Engineering: Core qualification: Elective Com Energy and Environmental Engineering: Core qualificat General Engineering Science (English program, 7 seme Green Technologies: Energy, Water, Climate: Specialisa	npulsory pulsory ion: Compulsory ster): Specialisation Mechanical Engination Energy Technology: Elective Comice: Elective Compulsory	eering: Elective C	
	Digital Mechanical Engineering: Core qualification: Com Electrical Engineering: Core qualification: Elective Com Energy and Environmental Engineering: Core qualificat General Engineering Science (English program, 7 seme Green Technologies: Energy, Water, Climate: Specialisa Logistics and Mobility: Specialisation Engineering Scien	npulsory pulsory inn: Compulsory ister): Specialisation Mechanical Engination Energy Technology: Elective Com ice: Elective Compulsory and Systems: Elective Compulsory	eering: Elective C ipulsory	
	Digital Mechanical Engineering: Core qualification: Com Electrical Engineering: Core qualification: Elective Com Energy and Environmental Engineering: Core qualificat General Engineering Science (English program, 7 seme Green Technologies: Energy, Water, Climate: Specialisa Logistics and Mobility: Specialisation Engineering Scien Logistics and Mobility: Specialisation Traffic Planning an	npulsory pulsory ion: Compulsory ister): Specialisation Mechanical Engine ation Energy Technology: Elective Com ice: Elective Compulsory and Systems: Elective Compulsory ement and Processes: Elective Compu	eering: Elective C ipulsory	
	Digital Mechanical Engineering: Core qualification: Com Electrical Engineering: Core qualification: Elective Com Energy and Environmental Engineering: Core qualificat General Engineering Science (English program, 7 seme Green Technologies: Energy, Water, Climate: Specialisa Logistics and Mobility: Specialisation Engineering Scien Logistics and Mobility: Specialisation Traffic Planning ar Logistics and Mobility: Specialisation Production Manag	npulsory pulsory ion: Compulsory ister): Specialisation Mechanical Engine ation Energy Technology: Elective Com ice: Elective Compulsory and Systems: Elective Compulsory ement and Processes: Elective Compu	eering: Elective C ipulsory	
	Digital Mechanical Engineering: Core qualification: Com Electrical Engineering: Core qualification: Elective Com Energy and Environmental Engineering: Core qualificat General Engineering Science (English program, 7 seme Green Technologies: Energy, Water, Climate: Specialisa Logistics and Mobility: Specialisation Engineering Scien Logistics and Mobility: Specialisation Traffic Planning ar Logistics and Mobility: Specialisation Production Manag Mechanical Engineering: Core qualification: Elective Co	npulsory pulsory pulsory ion: Compulsory ster): Specialisation Mechanical Engine ation Energy Technology: Elective Com ice: Elective Compulsory and Systems: Elective Compulsory iement and Processes: Elective Compu impulsory	eering: Elective C ipulsory	
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Course L0293: Electrical Mac	chines and Actuators
Тур	Lecture
Hrs/wk	3
СР	4
Workload in Hours	Independent Study Time 78, Study Time in Lecture 42
Lecturer	Prof. Thorsten Kern, Dennis Kähler
Language	DE
Cycle	SoSe
Content	Electric field: Coulomb´s law, flux (field) line, work, potential, capacitor, energy, force, capacitive actuators
	Magnetic field: force, flux line, Ampere´s law, field at bounderies, flux, magnetic circuit, hysteresis, induction, self-induction, mutual inductance, transformer, electromagnetic actuators
	Synchronous machines, construction and layout, equivalent single line diagrams, no-load and short-cuircuit characteristics, vector diagrams, motor and generator operation, stepper motors
	DC-Machines: Construction and layout, torque generation mechanismen, torque vs speed characteristics, commutation,
	Asynchronous Machines. Magnetic field, construction and layout, equivalent single line diagram, complex stator current diagram (Heylands 'diagram), torque vs. speed characteristics, rotor layout (squirrel-cage vs. sliprings),
	Drives with variable speed, inverter fed operation, special drives
Literature	Hermann Linse, Roland Fischer: "Elektrotechnik für Maschinenbauer", Vieweg-Verlag; Signatur der Bibliothek der TUHH: ETB 313
	Ralf Kories, Heinz Schmitt-Walter: "Taschenbuch der Elektrotechnik"; Verlag Harri Deutsch; Signatur der Bibliothek der TUHH: ETB 122
	"Grundlagen der Elektrotechnik" - anderer Autoren
	Fachbücher "Elektrische Maschinen"

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

		Typ Lecture Recitation Section (small)	<b>Hrs/wk</b> 3 2	<b>CP</b> 3 3
Prof. Sibylle Fröschle				
None				
After taking part successfully, students have re	eached the following	ng learning results		
Independent Study Time 110. Study Time in Le	ecture 70			
Compulsory Bonus Form	Description			
No 10 % Attestation	Testate finde	n semesterbegleitend statt.		
Written exam				
120 min				
	gram, 7 semester	r): Specialisation Mechanica	al Engineering, F	Focus Biomechanics
• •				
Compulsory General Engineering Science (German progr. Compulsory General Engineering Science (German progr. Engineering: Compulsory General Engineering Science (German progr. Engineering Science: (German progr. Engineering Science: (German progr. Engineering Science: (German progr. Compulsory General Engineering Science: (German progr. Engineering: Compulsory General Engineering Science: (German progr. Engineering: Compulsory General Engineering Science: (German progr. Engineering: Core (German progr. Eneral Engineering: Core qualification: Com. Electrical Engineering: Core qualification: Com. Energy and Environmental Engineering: Core of General Engineering Science: (English program.	ram, 7 semester): ram, 7 semester): gram, 7 semester gram, 7 semester m, 7 semester): Sp m, 7 semester): Sp mpulsory upulsory qualification: Comp n, 7 semester): Spe	Specialisation Mechanical  Specialisation Mechanical  Specialisation Mechanical  Specialisation Mechanical  Specialisation Mechanical Enginerialisation Electrical Enginerialisation  Specialisation Process Engineerialisation Process Engineerialisation Process Engineerialisation	Engineering, Footal Engineering, Footal Engineering, al Engineering, Focus Thineering, Focus Fering: Elective Compg: Elective	us Energy Systems  tus Aircraft System  Focus Materials in  Focus Mechatronics  neoretical Mechanical  Product Developmen  mpulsory
	rogramming Concepts, Data Handling & Communic Prof. Sibylle Fröschle  None  After taking part successfully, students have reference of the successfully, stu	After taking part successfully, students have reached the following and the following part successfully, students have reached the following part of the f	rogramming Concepts, Data Handling & Communication (L2689)  Prof. Sibylle Fröschle  None  After taking part successfully, students have reached the following learning results  Independent Study Time 110, Study Time in Lecture 70  6  Compulsory Bonus Form Description  No 10 % Attestation Testate finden semesterbegleitend statt.  Written exam  120 min  General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering Science (German program, 7 semester): Specialisation Mechanical Compulsory  General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering Science (German program, 7 semester): Specialisation Mechanical Compulsory  General Engineering Science (German program, 7 semester): Specialisation Mechanical Compulsory  General Engineering Science (German program, 7 semester): Specialisation Mechanical Compulsory  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: Compulsory  General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering: Compulsory  General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering: Compulsory  General Engineering Science (German program, 7 semester): Specialisation Electrical Engineering: Core qualification: Compulsory  General Engineering: Core qualification: Compulsory  General Engineering: Core qualification: Compulsory  Energy and Environmental Engineering: Core qualification: Compulsory  Energy and Environmental Engineering: Core qualification: Compulsory	rogramming Concepts, Data Handling & Communication (L2689) Lecture 3 rogramming Concepts, Data Handling & Communication (L2690) Recitation Section (small) 2  Prof. Sibylle Fröschle  None  After taking part successfully, students have reached the following learning results  Independent Study Time 110, Study Time in Lecture 70  6  Compulsory Bonus Form Description No 10 % Attestation Testate finden semesterbegleitend statt.  Written exam  120 min  General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Green Technologies, Focus Renew Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering. Focus Renew Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Planjineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Planjineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Planjineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Planjineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Planjineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Planjineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Planjineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Planjineering: Compulsory Gene

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

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

Module M0618: Rene	wables Energy Systems			
Courses				
Title Power Industry (L0316) Energy Systems and Energy Industry (L0315) Renewable Energy (L0313)		Typ Lecture Lecture Lecture	Hrs/wk 1 2 2	CP 1 2 2
Renewable Energy (L1434)	Prof. Martin Kaltschmitt	Recitation Section (small)	1	1
Recommended Previous Knowledge				
<b>Educational Objectives</b>	After taking part successfully, students have reache	ed the following learning results		
<b>Professional Competence</b>				
Knowledge	With completion of this module, the students can efficiency. They can explain the issues occurring in distribution and power trading wih regard to su applicable to many energy systems in general, especies the students can explain the environmental benefit:	this context. Furthermore, they can explain bject-related contexts. The students c pecially for renewable energy systems a	ain details of power an explain these	er generation, power aspects, which are
Skills	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 the 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		ally and design them rules, also for not	
	and to put them them into the right context.			
Personal Competence				
Social Competence	The students are able to analyze suitable technic criteria under sustainability aspects. This allows the			
Autonomy	Students can independently exploit sources , acqueutions.	uire the particular knowledge about the	subject area and	transform it to new
Workload in Hours	Independent Study Time 96, Study Time in Lecture	84		
Credit points	6			
Course achievement	None			
Examination	Written exam			
Examination duration and scale	3 hours written exam			
Assignment for the	General Engineering Science (German program, 7 s	- · ·		
Following Curricula	General Engineering Science (German program, 7 s General Engineering Science (German program, 7 s General Engineering Science (German program, Elective Compulsory Civil- and Environmental Engineering: Specialisation Civil- and Environmental Engineering: Specialisation Civil- and Environmental Engineering: Specialisation Energy and Environmental Engineering: Core qualification General Engineering Science (English program, 7 Elective Compulsory	emester): Specialisation Energy and Envi 7 semester): Specialisation Mechanical In Civil Engineering: Elective Compulsory In Traffic and Mobility: Elective Compulsor In Water and Environment: Elective Compulsor In Compulsory	romental Enginee Engineering, Foo y ulsory	sus Energy Systems:

Course L0316: Power Industr	у
Тур	Lecture
Hrs/wk	1
СР	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	Folien der Vorlesung

Course L0315: Energy Systems and Energy Industry	
Тур	Lecture
Hrs/wk	2
СР	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Prof. Martin Kaltschmitt
Language	DE
Cycle	SoSe
Content	<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	ecture	
Hrs/wk		
СР		
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 Energy		
Тур	Recitation Section (small)	
Hrs/wk	1	
СР	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.

Module M0596: Advai	nced Mechanical Design Project
Courses	
Γitle	Typ Hrs/wk CP
Advanced Mechanical Design Proje	ct (L0266) Project-/problem-based Learning 4 6
Module Responsible	Dr. Jens Schmidt
<b>Admission Requirements</b>	None
Recommended Previous	Mechanical Engineering: Design
Knowledge	Advanced Mechanical Engineering Design
	Advanced Meditalited Engineering Design
Educational Objectives	After taking part successfully, students have reached the following learning results
Professional Competence	
Knowledge	After passing the module, students are able to:
	express the procedure for systematically handling of
	complex design tasks ,
	describe working principles, their use and combination possibilities,
	explain guidelines for designing for function and manufacturing,
	explain advanced use-oriented knowledge of machine elements.
Skills	After passing the module, students are able to:
	analyze complex tasks and develop principle solutions using sketches,
	convert principle solutions into a detailed design,
	<ul> <li>use methods to design and solve engineering design tasks systematically and solution-oriented,</li> </ul>
	create a technical documentation including all necessary technical drawings to understand the functions of the system,
	document calculations of selected machine elements clearly and in detail.
B	
Personal Competence	After access the module students are able to
Social Competence	After passing the module, students are able to:
	present and discuss solutions and technical drawings within groups,
	reflect the own results in the work groups of the course
Autonomy	After passing the module, students are able to:
	independently solve complex design projects, while motivating themselves, acquiring necessary knowledge and selecting
	appropriate methods,
	to independently solve problems.
Workload in Hours	
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 System
Following Curricula	
	General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Product Developmen
	and Production: Compulsory
	General Engineering Science (English program, 7 semester): Specialisation Mechanical Engineering, Focus Aircraft System
	Engineering: Compulsory
	General Engineering Science (English program, 7 semester): Specialisation Mechanical Engineering, Focus Product Developmen
	and Production: Compulsory
	General Engineering Science (English program, 7 semester): Specialisation Mechanical Engineering, Focus Theoretical Mechanic
	Engineering: Compulsory
	Mechanical Engineering: Core qualification: Compulsory

Course L0266: Advanced Mechanical Design Project		
Тур	Project-/problem-based Learning	
Hrs/wk	4	
СР	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 M0655: Comp	utational Fluid Dynamics I			
Courses				
<b>Title</b> Computational Fluid Dynamics I (LC Computational Fluid Dynamics I (LC Computational Fluid Dynamics I)		<b>Typ</b> Lecture Recitation Section (large)	Hrs/wk 2 2	<b>CP</b> 3 3
Module Responsible	Prof. Thomas Rung			
Admission Requirements	None			
Recommended Previous				
Knowledge	<ul> <li>Mathematical Methods for Engineers</li> <li>Fundamentals of Differential/integral calculus and</li> </ul>	series expansions		
Educational Objectives	After taking part successfully, students have reached the	following learning results		
Professional Competence				
-	The students are able to list the basic numerics of partial	differential equations.		
Skills	The students are able develop appropriate numerical integration in space and time for the governing partial differential equations.  They can code computational algorithms in a structured way.			
Personal Competence Social Competence	The students can arrive at work results in groups and doc	ument them.		
Autonomy	The students can independently analyse approaches to so	olving specific problems.		
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56			
Credit points	6			
Course achievement				
Examination	Written exam			
	2h			
Examination duration and scale	211			
Assignment for the	General Engineering Science (German program, 7 semes	tor). Specialisation Mechanical Engin	pooring Focus Th	poorotical Mochanical
Following Curricula	Engineering: Elective Compulsory	ter). Specialisation Mechanical Engli	leering, rocus ri	leoretical Mechanical
. oowing curricula	General Engineering Science (German program, 7 sen	nester): Specialisation Mechanical I	Engineering, Foo	cus Aircraft Systems
	Engineering: Elective Compulsory		gg,	
	General Engineering Science (German program, 7 sen	nester): Specialisation Mechanical E	Engineering, Foo	us Energy Systems:
	Elective Compulsory	•		
	General Engineering Science (German program, 7 semest	er): Specialisation Naval Architectur	e: Compulsory	
	General Engineering Science (German program, 7 semest	er): Specialisation Energy and Enviro	omental Enginee	ring: Compulsory
	Energy Systems: Technical Complementary Course Core	Studies: Elective Compulsory		
	General Engineering Science (English program, 7 semeste	er): Specialisation Energy and Enviro	mental Engineer	ing: Compulsory
	General Engineering Science (English program, 7 sem	ester): Specialisation Mechanical E	Engineering, Foo	us Energy Systems:
	Elective Compulsory			
	General Engineering Science (English program, 7 semeste			
	General Engineering Science (English program, 7 sem	nester): Specialisation Mechanical E	Engineering, Foo	cus Aircraft Systems
	Engineering: Elective Compulsory	Flortivo Compulsor:		
	Mechanical Engineering: Specialisation Energy Systems: I			
	Mechanical Engineering: Specialisation Aircraft Systems E Naval Architecture: Core qualification: Compulsory	ingineering, Elective Compulsory		
	Technomathematics: Specialisation III. Engineering Science	ce: Elective Compulsory		
	. sermematics. Specialisation in Engineering Scient	co. E.ective Compulsory		

Course L0235: Computational Fluid Dynamics I		
Тур	Lecture	
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	Fundamentals of computational modelling of thermofluid dynamic problems. Development of numerical algorithms.	
	1. Partial differential equations 2. Foundations of finite numerical approximations 3. Computation of potential flows 4. Introduction of finite-differences 5. Approximation of convective, diffusive and transient transport processes 6. Formulation of boundary conditions and initial conditions 7. Assembly and solution of algebraic equation systems 8. Facets of weighted -residual approaches 9. Finite volume methods 10. Basics of grid generation	
Literature	Ferziger and Peric: Computational Methods for Fluid Dynamics, Springer	

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

Module M0662: Nume	erical Mathematics I
Courses	
Courses	
Title Numerical Mathematics I (L0417)	Typ Hrs/wk CP Lecture 2 3
Numerical Mathematics I (L0418)	Recitation Section (small) 2 3
Module Responsible	Prof. Sabine Le Borne
Admission Requirements	None
Recommended Previous	
Knowledge	<ul> <li>Mathematik I + II for Engineering Students (german or english) or Analysis &amp; Linear Algebra I + II for Technomathematicia</li> <li>basic MATLAB/Python knowledge</li> </ul>
	basic MATEAU/Fython knowledge
Educational Objectives	After taking part successfully, students have reached the following learning results
Professional Competence	
Knowledge	Students are able to
	name numerical methods for interpolation, integration, least squares problems, eigenvalue problems, nonlinear root finding
	problems and to explain their core ideas,
	repeat convergence statements for the numerical methods,
	explain aspects for the practical execution of numerical methods with respect to computational and storage complexitx.
C1.''	
SKIIIS	Students are able to
	implement, apply and compare numerical methods using MATLAB/Python,
	justify the convergence behaviour of numerical methods with respect to the problem and solution algorithm,
	select and execute a suitable solution approach for a given problem.
Personal Competence	
Social Competence	Students are able to
	work together in heterogeneously composed teams (i.e., teams from different study programs and background knowledge
	explain theoretical foundations and support each other with practical aspects regarding the implementation of algorithms.
Autonomy	Students are capable
	• to assess whether the supporting theoretical and practical excercises are better solved individually or in a team,
	to assess their individual progess and, if necessary, to ask questions and seek help.
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56
	6
Credit points  Course achievement	
Course achievement  Examination	None
Course achievement	None Written exam
Course achievement Examination	None Written exam
Course achievement Examination Examination duration and scale	None Written exam
Course achievement Examination Examination duration and scale Assignment for the	None Written exam  90 minutes  General Engineering Science (German program, 7 semester): Specialisation Computer Science: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Materials
Course achievement Examination Examination duration and scale Assignment for the	None Written exam  90 minutes  General Engineering Science (German program, 7 semester): Specialisation Computer Science: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Materials Engineering Sciences: Compulsory
Course achievement Examination Examination duration and scale Assignment for the	None Written exam 90 minutes  General Engineering Science (German program, 7 semester): Specialisation Computer Science: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Materials Engineering Sciences: Compulsory General Engineering Science (German program, 7 semester): Specialisation Biomedical Engineering: Compulsory
Course achievement Examination Examination duration and scale Assignment for the	None  Written exam  90 minutes  General Engineering Science (German program, 7 semester): Specialisation Computer Science: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Materials Engineering Sciences: Compulsory General Engineering Science (German program, 7 semester): Specialisation Biomedical Engineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Biomechanical
Course achievement Examination Examination duration and scale Assignment for the	None Written exam 90 minutes  General Engineering Science (German program, 7 semester): Specialisation Computer Science: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Materials Engineering Sciences: Compulsory General Engineering Science (German program, 7 semester): Specialisation Biomedical Engineering: Compulsory
Course achievement Examination Examination duration and scale Assignment for the	None Written exam  90 minutes  General Engineering Science (German program, 7 semester): Specialisation Computer Science: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Materials Engineering Sciences: Compulsory General Engineering Science (German program, 7 semester): Specialisation Biomedical Engineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Biomechanic Compulsory
Course achievement Examination Examination duration and scale Assignment for the	None Written exam 90 minutes  General Engineering Science (German program, 7 semester): Specialisation Computer Science: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Materials Engineering Sciences: Compulsory General Engineering Science (German program, 7 semester): Specialisation Biomedical Engineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Biomechanic Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Theoretical Mechanic Engineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Aircraft System
Course achievement Examination Examination duration and scale Assignment for the	None Written exam 90 minutes  General Engineering Science (German program, 7 semester): Specialisation Computer Science: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Materials Engineering Sciences: Compulsory General Engineering Science (German program, 7 semester): Specialisation Biomedical Engineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Biomechanic Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Theoretical Mechanic Engineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Aircraft System Engineering: Elective Compulsory
Course achievement Examination Examination duration and scale Assignment for the	None  Written exam  90 minutes  General Engineering Science (German program, 7 semester): Specialisation Computer Science: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Materials Engineering Sciences: Compulsory General Engineering Science (German program, 7 semester): Specialisation Biomedical Engineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Biomechanic Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Theoretical Mechanic Engineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Aircraft System Engineering: Elective Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Mechatronics: Elective General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Mechatronics: Elective
Course achievement Examination Examination duration and scale Assignment for the	Written exam  90 minutes  General Engineering Science (German program, 7 semester): Specialisation Computer Science: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Materials Engineering Sciences: Compulsory General Engineering Science (German program, 7 semester): Specialisation Biomedical Engineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Biomechanic Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Theoretical Mechanic Engineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Aircraft System Engineering: Elective Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Mechatronics: Elective Compulsory
Course achievement Examination Examination duration and scale Assignment for the	None  Written exam  90 minutes  General Engineering Science (German program, 7 semester): Specialisation Computer Science: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Materials Engineering Sciences: Compulsory General Engineering Science (German program, 7 semester): Specialisation Biomedical Engineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Biomechanic Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Theoretical Mechanic Engineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Aircraft System Engineering: Elective Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Mechatronics: Elective General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Mechatronics: Elective
Course achievement Examination Examination duration and scale Assignment for the	Written exam  90 minutes  General Engineering Science (German program, 7 semester): Specialisation Computer Science: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Materials Engineering Sciences: Compulsory General Engineering Science (German program, 7 semester): Specialisation Biomedical Engineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Biomechanic Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Theoretical Mechanic Engineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Aircraft System Engineering: Elective Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Mechatronics: Elective Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Mechatronics: Elective Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Mechatronics: Elective Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Mechatronics: Elective Compulsory
Course achievement Examination Examination duration and scale Assignment for the	Written exam  90 minutes  General Engineering Science (German program, 7 semester): Specialisation Computer Science: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Materials Engineering Sciences: Compulsory General Engineering Science (German program, 7 semester): Specialisation Biomedical Engineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Biomechanic Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Theoretical Mechanic Engineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Aircraft System Engineering: Elective Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Mechatronics: Electiv Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Mechatronics: Electiv Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Mechatronics: Electiv Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Mechatronics: Electiv Compulsory
Course achievement Examination Examination duration and scale Assignment for the	Written exam  90 minutes  General Engineering Science (German program, 7 semester): Specialisation Computer Science: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Materials Engineering Sciences: Compulsory General Engineering Science (German program, 7 semester): Specialisation Biomedical Engineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Biomechanic Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Theoretical Mechanic Engineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Aircraft Systen Engineering: Elective Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Mechatronics: Elective Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Mechatronics: Elective Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Energy System Elective Compulsory Bioprocess Engineering: Specialisation A - General Bioprocess Engineering: Elective Compulsory Computer Science: Specialisation Computational Mathematics: Elective Compulsory Computer Science: Specialisation II. Mathematics and Engineering Science: Elective Compulsory
Course achievement Examination Examination duration and scale Assignment for the	Written exam  90 minutes  General Engineering Science (German program, 7 semester): Specialisation Computer Science: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Materials Engineering Sciences: Compulsory General Engineering Science (German program, 7 semester): Specialisation Biomedical Engineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Biomechanic Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Theoretical Mechanic Engineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Aircraft System Engineering: Elective Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Mechatronics: Elective Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Mechatronics: Elective Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Energy System Elective Compulsory Bioprocess Engineering: Specialisation A - General Bioprocess Engineering: Elective Compulsory Computer Science: Specialisation Computational Mathematics: Elective Compulsory Computer Science: Specialisation II. Mathematics and Engineering Science: Elective Compulsory Data Science: Core qualification: Compulsory
Course achievement Examination Examination duration and scale Assignment for the	Written exam  90 minutes  General Engineering Science (German program, 7 semester): Specialisation Computer Science: Compulsory General Engineering Sciences: Compulsory General Engineering Sciences: Compulsory General Engineering Sciences: Compulsory General Engineering Science (German program, 7 semester): Specialisation Biomedical Engineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Biomechanic Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Theoretical Mechanic Engineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Aircraft Systen Engineering: Elective Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Mechatronics: Elective Engineering: Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Mechatronics: Elective Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Mechatronics: Elective Compulsory General Engineering: Specialisation A - General Bioprocess Engineering: Elective Compulsory Computer Science: Specialisation Computational Mathematics: Elective Compulsory Computer Science: Specialisation II. Mathematics and Engineering Science: Elective Compulsory Electrical Engineering: Core qualification: Elective Compulsory
Course achievement Examination Examination duration and scale Assignment for the	Written exam  90 minutes  General Engineering Science (German program, 7 semester): Specialisation Computer Science: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Materials Engineering Sciences: Compulsory General Engineering Science (German program, 7 semester): Specialisation Biomedical Engineering; Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Biomechanic Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Theoretical Mechanic Engineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Aircraft Systen Engineering: Elective Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Mechatronics: Electiv Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Mechatronics: Electiv Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Mechatronics: Electiv Compulsory General Engineering: Specialisation A - General Bioprocess Engineering: Elective Compulsory Computer Science: Specialisation Computational Mathematics: Elective Compulsory Computer Science: Specialisation II. Mathematics and Engineering Science: Elective Compulsory Electrical Engineering: Core qualification: Elective Compulsory Engineering Science: Core qualification: Compulsory
Course achievement Examination Examination duration and scale Assignment for the	Written exam  90 minutes  General Engineering Science (German program, 7 semester): Specialisation Computer Science: Compulsory General Engineering Sciences: Compulsory General Engineering Sciences: Compulsory General Engineering Sciences: Compulsory General Engineering Science (German program, 7 semester): Specialisation Biomedical Engineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Biomechanic Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Theoretical Mechanic Engineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Aircraft Systen Engineering: Elective Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Mechatronics: Elective Engineering: Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Mechatronics: Elective Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Mechatronics: Elective Compulsory General Engineering: Specialisation A - General Bioprocess Engineering: Elective Compulsory Computer Science: Specialisation Computational Mathematics: Elective Compulsory Computer Science: Specialisation II. Mathematics and Engineering Science: Elective Compulsory Electrical Engineering: Core qualification: Elective Compulsory
Course achievement Examination Examination duration and scale Assignment for the	Mritten exam  90 minutes  General Engineering Science (German program, 7 semester): Specialisation Computer Science: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Materials Engineering Sciences: Compulsory General Engineering Science (German program, 7 semester): Specialisation Biomedical Engineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Biomechanical Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Theoretical Mechanic Engineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Aircraft System Engineering: Elective Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Mechatronics: Elective Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Mechatronics: Elective Compulsory General Engineering: Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Energy System Elective Compulsory Bioprocess Engineering: Specialisation A - General Bioprocess Engineering: Elective Compulsory Computer Science: Specialisation Computational Mathematics: Elective Compulsory Computer 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
Course achievement Examination Examination duration and scale Assignment for the	None  Written exam  90 minutes  General Engineering Science (German program, 7 semester): Specialisation Computer Science: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Materials Engineering Sciences: Compulsory General Engineering Science (German program, 7 semester): Specialisation Biomedical Engineering; Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Biomechanical Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Theoretical Mechanical Engineering; Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Aircraft System Engineering; Elective Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Mechatronics: Elective Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Mechatronics: Elective Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Energy System Elective Compulsory Bioprocess Engineering: Specialisation A - General Bioprocess Engineering: Elective Compulsory Computer Science: Specialisation Computational Mathematics: Elective Compulsory Computer Science: Specialisation II. Mathematics and Engineering Science: Elective Compulsory Data Science: Core qualification: Compulsory Engineering Science: Core qualification: Compulsory General Engineering Science (English program, 7 semester): Core qualification: Compulsory
Course achievement Examination Examination duration and scale Assignment for the	Written exam  90 minutes  General Engineering Science (German program, 7 semester): Specialisation Computer Science: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Materials Engineering Sciences: Compulsory General Engineering Science (German program, 7 semester): Specialisation Biomedical Engineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Biomechanic Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Theoretical Mechanic Engineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Aircraft Systen Engineering: Elective Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Mechatronics: Electiv Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Mechatronics: Electiv Compulsory Bioprocess Engineering: Specialisation A - General Bioprocess Engineering: Elective Compulsory Computer Science: Specialisation Computational Mathematics: Elective Compulsory Computer Science: Specialisation II. Mathematics and Engineering Science: Elective Compulsory Electrical Engineering: Core qualification: Compulsory Engineering Science: Core qualification: Compulsory Engineering Science: Core qualification: Compulsory General Engineering Science (English program, 7 semester): Specialisation Mechanical Engineering, Focus Biomechanic Compulsory
Course achievement Examination Examination duration and scale Assignment for the	None  Written exam  90 minutes  General Engineering Science (German program, 7 semester): Specialisation Computer Science: Compulsory  General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Materials Engineering Sciences: Compulsory  General Engineering Science (German program, 7 semester): Specialisation Biomedical Engineering: Compulsory  General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Biomechanic Compulsory  General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Theoretical Mechanic Engineering: Compulsory  General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Aircraft Systen Engineering: Elective Compulsory  General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Mechatronics: Elective Compulsory  General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Mechatronics: Elective Compulsory  General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Energy System Elective Compulsory  General 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  General Engineering Science (English program, 7 semester): Specialisation Computer Science: Compulsory  General Engineering Science (English program, 7 semester): Specialisation Computer Science: Compulsory  General Engineering Science (English program, 7 semester): Specialisation Mechanical Engineering, Focus Biomechanic  Compulsory  General Engineering Science (English program, 7 semester): Specialisation Mechanical Engineering, Focus Materials in Engine
Course achievement Examination Examination duration and scale Assignment for the	None Written exam  90 minutes  General Engineering Science (German program, 7 semester): Specialisation Computer Science: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Materials Engineering Sciences: Compulsory General Engineering Science (German program, 7 semester): Specialisation Biomedical Engineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Biomechanic Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Theoretical Mechanic Engineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Aircraft Systen Engineering: Elective Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Mechatronics: Elective Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Mechatronics: Elective Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Energy System Elective 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 General Engineering Science (English program, 7 semester): Specialisation Computer Science: Compulsory General Engineering Science (English program, 7 semester): Specialisation Mechanical Engineering, Focus Biomechanic Compulsory General Engineering Science (English program, 7 semester): Specialisation Mechanical Engineering, Focus Biomechanic Compulsory
Course achievement Examination Examination duration and scale Assignment for the	None Written exam 90 minutes  General Engineering Science (German program, 7 semester): Specialisation Computer Science: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Materials Engineering Sciences: Compulsory General Engineering Science (German program, 7 semester): Specialisation Biomedical Engineering; Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Biomechanic Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Theoretical Mechanic Engineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Aircraft Systen Engineering: Elective Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Mechatronics: Elective Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Mechatronics: Elective Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Energy System Elective Compulsory Bioprocess Engineering: Specialisation A - General Bioprocess Engineering: Elective Compulsory Computer Science: Specialisation Computational Mathematics: Elective Compulsory Computer Science: Specialisation Computational Mathematics: Elective Compulsory Electrical Engineering: Core qualification: Elective Compulsory Engineering Science: Core qualification: Compulsory Engineering Science: Core qualification: Compulsory General Engineering Science (English program, 7 semester): Specialisation Mechanical Engineering, Focus Biomechanic Compulsory General Engineering Science (English program, 7 semester): Specialisation Mechanical Engineering, Focus Biomechanic Compulsory General Engineering Science (English program, 7 semester): Specialisation Mechanical Engineering, Focus Materials in Engineering Sciences: Compuls
Course achievement Examination Examination duration and scale Assignment for the	None Written exam  90 minutes  General Engineering Science (German program, 7 semester): Specialisation Computer Science: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Materials Engineering Sciences: Compulsory General Engineering Science (German program, 7 semester): Specialisation Biomedical Engineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Biomechanic Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Theoretical Mechanic Engineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Aircraft Systen Engineering: Elective Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Mechatronics: Elective Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Mechatronics: Elective Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Energy System Elective 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 General Engineering Science (English program, 7 semester): Specialisation Computer Science: Compulsory General Engineering Science (English program, 7 semester): Specialisation Mechanical Engineering, Focus Biomechanic Compulsory General Engineering Science (English program, 7 semester): Specialisation Mechanical Engineering, Focus Biomechanic Compulsory
Course achievement Examination Examination duration and scale Assignment for the	None Written exam  90 minutes  General Engineering Science (German program, 7 semester): Specialisation Computer Science: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Materials Engineering Sciences: Compulsory General Engineering Science (German program, 7 semester): Specialisation Biomedical Engineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Biomechanic Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Theoretical Mechanic Engineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Aircraft Systen Engineering: Elective Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Mechatronics: Elective Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Mechatronics: Elective Compulsory General Engineering: Specialisation A - General Bioprocess Engineering: Elective Compulsory General Engineering: Specialisation A - General Bioprocess Engineering: Elective Compulsory Computer Science: Specialisation II. Mathematics and Engineering Science: Elective Compulsory Data Science: Specialisation Compulsory Electrical Engineering: Core qualification: Compulsory Engineering Science: Core qualification: Compulsory General Engineering Science (English program, 7 semester): Specialisation Computer Science: Compulsory General Engineering Science (English program, 7 semester): Specialisation Mechanical Engineering, Focus Materials in Engineering Computers: Compulsory General Engineering Science (English program, 7 semester): Specialisation Mechanical Engineering, Focus Materials in Engineering Computers: Compulsory
Course achievement Examination Examination duration and scale Assignment for the	None Written exam 90 minutes  General Engineering Science (German program, 7 semester): Specialisation Computer Science: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Materials Engineering Sciences: Compulsory General Engineering Science (German program, 7 semester): Specialisation Biomedical Engineering; Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Biomechanic Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Theoretical Mechanic Engineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Aircraft Systen Engineering: Elective Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Aircraft Systen Engineering: Elective Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Mechatronics: Elective Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Mechatronics: Elective Compulsory General Engineering: Specialisation A - General Bioprocess Engineering: Elective Compulsory Computer Science: Specialisation Computational Mathematics: Elective Compulsory Computer Science: Specialisation I. Mathematics and Engineering Science: Elective Compulsory Data Science: Core qualification: Compulsory Electrical Engineering: Core qualification: Compulsory Engineering Science: Core qualification: Compulsory General Engineering Science (English program, 7 semester): Specialisation Mechanical Engineering, Focus Biomechanic Compulsory General Engineering Science (English program, 7 semester): Specialisation Mechanical Engineering, Focus Biomechanic Compulsory General Engineering Science (English program, 7 semester): Specialisation Mechanical Engineering, Focus Materials in Engineering Sciences

Computational Science and Engineering: Core qualification: Compulsory

Mechanical Engineering: Specialisation Theoretical Mechanical Engineering: Compulsory

Mechanical Engineering: Specialisation Energy Systems: Elective Compulsory

Mechanical Engineering: Specialisation Mechatronics: Elective Compulsory

Theoretical Mechanical Engineering: Technical Complementary Course Core Studies: Elective Compulsory Process Engineering: Specialisation Process Engineering: Elective Compulsory

Course L0417: Numerical Mathematics I		
Тур	Lecture	
Hrs/wk	2	
СР	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 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	

Module M1320: Simulation and Design of Mechatronic Systems			
nic Systems (L1822)	Typ Lecture Pocitation Section (Jarge)	Hrs/wk	<b>CP</b> 2 2
-	=		2
			-
Fundatmentals of mechanics, control theory and electrical engineering			
After taking part successfully, students have reached the following	ng learning results		
Students are able to describe methods and calculations for design, modeling, simulation and optimization of mechatronic systems.			hatronic systems.
Students are able to apply modern algorithms for modeling of mechatronic systems. They can identify, simulate and design simple systems and implement those in laboratory conditions.			and design simple
Students are able to work goal-oriented in small mixed groups and present results to target groups.			
Students are able to recognize and improve knowledge deficits independently.			
With instructor assistance, students are able to evaluate their ov	wn knowledge level and define a	further course o	f study.
Independent Study Time 124, Study Time in Lecture 56			
6			
None			
Written exam			
90 min			
Compulsory  General Engineering Science (German program, 7 semester).  Engineering: Elective Compulsory  Digital Mechanical Engineering: Core qualification: Compulsory  General Engineering Science (English program, 7 semester): Sp  Engineering: Elective Compulsory  General Engineering Science (English program, 7 semester): Engineering: Elective Compulsory  General Engineering Science (English program, 7 semester): Sp  Compulsory  Mechanical Engineering: Specialisation Theoretical Mechanical E  Mechanical Engineering: Specialisation Aircraft Systems Engineer  Mechanical Engineering: Specialisation Mechatronics: Compulsory  Mechanical Engineering: Specialisation Mechatronics: Elective Compulsory	: Specialisation Mechanical Engineer : Specialis	gineering, Focus ring, Focus Theo gineering, Focus ring, Focus Mec	Aircraft Systems retical Mechanical Aircraft Systems
	ic Systems (L1823) ic Systems (L1824)  NN  None  Fundatmentals of mechanics, control theory and electrical enginer and electrical enginering: Engineering: Science (English program, 7 semester): Sp. Engineering: Elective Compulsory  General Engineering Science (English program, 7 semester): Sp. Engineering: Elective Compulsory  General Engineering Science (English program, 7 semester): Sp. Engineering: Elective Compulsory  General Engineering Science (English program, 7 semester): Sp. Engineering: Elective Compulsory  General Engineering Science (English program, 7 semester): Sp. Engineering: Elective Compulsory  General Engineering Science (English program, 7 semester): Sp. Engineering: Elective Compulsory  General Engineering Science (English program, 7 semester): Sp. Engineering: Elective Compulsory  General Engineering Science (English program, 7 semester): Sp. Engineering: Elective Compulsory  General Engineering Science (English program, 7 semester): Sp. Engineering: Elective Compulsory  General Engineering Science (English program, 7 semester): Sp. Engineering: Elective Compulsory  General Engineering Science (English program, 7 semester): Sp. Engineering: Elective Compulsory  General Engineering Science (English program, 7 semester): Sp. Engineering: Elective Compulsory  Mechanical Engineering: Specialisation Aircraft Systems Engineer  Mechanical Engineering: Specialisation Aircraft Systems Engineer  Mechanical Engineering: Specialisation Mechatronics: Compulsor	ic Systems (L1822) Ic Systems (L1823) Ic Systems (L1823) Ic Systems (L1823) Ic Systems (L1823) Ic Systems (L1824)  NN  None  Fundatmentals of mechanics, control theory and electrical engineering  After taking part successfully, students have reached the following learning results  Students are able to describe methods and calculations for design, modeling, simulation and opt Students are able to apply modern algorithms for modeling of mechatronic systems. They can id systems and implement those in laboratory conditions.  Students are able to work goal-oriented in small mixed groups and present results to target grou Students are able to recognize and improve knowledge deficits independently.  With instructor assistance, students are able to evaluate their own knowledge level and define a Independent Study Time 124, Study Time in Lecture 56  None  Written exam  General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering: Elective Compulsory  General Engineering Science (English program, 7 semester): Specialisation Mechanical Engineering: Elective Compulsory  General Engineering Science (English program, 7 semester): Specialisation Mechanical Engineering: Elective Compulsory  General Engineering Science (English program, 7 semester): Specialisation Mechanical Engineering: Elective Compulsory  General Engineering: Specialisation Theoretical Mechanical Engineering: Compulsory  Mechanical Engineering: Specialisation Aircraft Systems Engineering: Elective Compulsory  Mechanical Engineering: Specialisation Mechatronics: Compulsory  Mechanical Engineering: Specialisation Mechatronics: Elective Compulsory	ic Systems (L1822) Ic Systems (L1823) Recitation Section (large) 1 Ic Systems (L1823) Recitation Section (large) 1 In Systems (L1824) In

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 <sup>®</sup> and Simulink <sup>®</sup>	
Literature	Skript zur Veranstaltung	
	Weitere Literatur in der Veranstaltung	

Course L1823: Simulation and Design of Mechatronic Systems	
Тур	Recitation Section (large)
Hrs/wk	1
СР	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 and Design of Mechatronic Systems	
Тур	Practical Course
Hrs/wk	1
СР	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

Module M0599: Integ	rated Product Development and Lig	htweight Design		
Courses				
<b>Title</b> CAE-Team Project (L0271) Development of Lightweight Design		<b>Typ</b> Project-/problem-based Learning Lecture	Hrs/wk 2 2	<b>CP</b> 2 2
Integrated Product Development I (	(L0269)	Lecture	2	2
Module Responsible	Prof. Dieter Krause			
Admission Requirements	None			
	Advanced Knowledge about engineering design:			
Knowledge	Fundamentals of Mechanical Engineering Design			
	Mechanical Engineering: Design			
	Advanced Mechanical Engineering Design			
Educational Objectives	After taking part successfully, students have reached	I the following learning results		
<b>Professional Competence</b>				
Knowledge	After completing the module, students are capable o	f:		
	explaining the functional principle of 3D-CAD-     describing the interaction of the different CAE.		SS	
Skills				
SKIIIS	After completing the module, students are able to:			
	evaluate different CAD- and PDM-Systems w product structuring     design an exemplary product using CAD-,PDM			ication schemes and
	After completing the module, students are able to:  To develop a project plan and allocate work ap  Present project results as a team for instance		of group disc	ussions
Autonomy	Students are capable of:			
	independently adapt to a CAE-Tool and complete	ete a given practical task with it		
Workload in Hours	Independent Study Time 96, Study Time in Lecture 8	4		
Credit points				
Course achievement		escription AE-Teamprojekt inkl. Vortrag und Ausarbeit	ung	
Examination	Written exam			
Examination duration and scale				
Assignment for the	General Engineering Science (German program, 7	semester): Specialisation Mechanical En	nineering Foo	rus Aircraft Systems
-	Engineering: Compulsory		,eeinig, 100	Jysteills
	General Engineering Science (German program, 7 s	emester): Specialisation Mechanical Engine	erina. Focus F	Product Development
	and Production: Compulsory	3	3,	
	Engineering Science: Specialisation Mechanical Engin	neering: Elective Compulsory		
	General Engineering Science (English program, 7	, ,	gineering, Foo	us Aircraft Systems
	Engineering: Compulsory	., ., .,	,	
	General Engineering Science (English program, 7 se	emester): Specialisation Mechanical Engine	erina. Focus F	roduct Development
	and Production: Compulsory	,	J, •	
	General Engineering Science (English program, 7 ser	nester): Specialisation Mechanical Engineer	ing: Elective C	ompulsory
	Mechanical Engineering: Specialisation Product Deve			· -
	Mechanical Engineering: Specialisation Aircraft Syste	ms Engineering: Compulsory		
	1	hnical Complementary Course Core Studies		

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> Description Part of the module is a project based team orientated practical course using the PBL method. In this course, students learn the handling of modern CAD, PDM and FEM systems (Creo, Windchill and Hyperworks). After a short introduction in the applied software systems, students work in teams on a task during the semester. The aim is the development of one product out of several CAD parts models using a PDM system including FEM calculations of selected parts and 3D printing of parts. The developed product must be presented in a joint presentation.
Literature	

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

Course L0269: Integrated Pr	oduct Development I
Тур	Lecture
Hrs/wk	2
СР	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Prof. Dieter Krause
Language	DE
Cycle	SoSe
Content	Introduction to Integrated Product Development  3D CAD -Systems and CAD interfaces  Administration of part lists / PDM systems  PDM in different industries  Selection of CAD-/PDM Systems  Simulation  Construction methods  Design for X
Literature	<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>

Module M0865: Funda	nmentals of Production and (	Quality Management		
Courses				
Title		Тур	Hrs/wk	СР
Production Process Organization (LC	0925)	Lecture	2	3
Quality Management (L0926)		Lecture	2	3
Module Responsible	Prof. Hermann Lödding			
Admission Requirements	None			
Recommended Previous	None			
Knowledge				
<b>Educational Objectives</b>	After taking part successfully, students ha	ve reached the following learning results		
Professional Competence				
Knowledge	Students are able to explain the contents	of the lecture of the module.		
Skills	Students are able to apply the methods and models in the module to industrial problems.			
Personal Competence				
Social Competence	-			
Autonomy	-			
Workload in Hours	Independent Study Time 124, Study Time	in Lecture 56		
Credit points	6			
Course achievement	None			
Examination	Written exam			
Examination duration and	180 Minuten			
scale				
Assignment for the	General Engineering Science (German p	program, 7 semester): Specialisation Mechan	ical Engineering, Foc	us Aircraft Systems
Following Curricula	Engineering: Compulsory			
	General Engineering Science (German pro	ogram, 7 semester): Specialisation Mechanical	Engineering, Focus P	roduct Development
	and Production: Compulsory			
	Engineering Science: Core qualification: C	'		
		gram, 7 semester): Specialisation Mechanical E	-	ompulsory
		gram, 7 semester): Core qualification: Compuls	•	
	* '	uction Management and Processes: Compulsor	у	
	Logistics and Mobility: Specialisation Engin	. ,		
	Mechanical Engineering: Core qualification			
	Engineering and Management - Major in L	ogistics and Mobility: Specialisation Production	Management and Pro-	cesses: Compulsory

Course L0925: Production Pr	·
Тур	Lecture
Hrs/wk	12
СР	3
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
	(D) Procurement
	(E) Manufacturing
	(F) Production planning and control (PPC)
	(G) Distribution
	(H) Cooperation
Literature	Wiendahl, HP.: Betriebsorganisation für Ingenieure
	Vorlesungsskript

Course L0926: Quality Manag	gement
Тур	Lecture
Hrs/wk	2
СР	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 M0767: Aeron	autical 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			
Recommended Previous	Basics of mathematics, mechanics and thermodynar	nics		
Knowledge				
Educational Objectives	After taking part successfully, students have reached	d the following learning results		
Professional Competence				
Knowledge	Students get a basic understanding of the structur	e and design of an aircraft, as well as a	n overview of th	e systems inside an
	aircraft. In addition, a basic knowledge of the relatio	nchips, the key parameters, roles and wa	ys of working in	different subsystems
	in the air transport is acquired.			
Skills	//s Due to the learned cross-system thinking students can gain a deeper understanding of different system concepts and th		concepts and their	
	technical system implementation. In addition, they o	an apply the learned methods for the des	ign and assessm	ent of subsystems of
	the air transportation system in the context of the o	verall system.		
Personal Competence				
Social Competence	Students are made aware of interdisciplinary commu	unication in groups.		
Autonomy	Students are able to independently analyze different system concepts and their technical implementation as well as to think			
	system oriented.			
Workload in Hours	Independent Study Time 96, Study Time in Lecture 8	34		
Credit points	6			
Course achievement	None			
Examination	Written exam			
Examination duration and	150 min			
scale				
Assignment for the	General Engineering Science (German program, 7	semester): Specialisation Mechanical I	Engineering, Foo	us Aircraft Systems
Following Curricula	Engineering: Compulsory			
	General Engineering Science (English program, 7	semester): Specialisation Mechanical E	ingineering, Foc	us Aircraft Systems
	Engineering: Compulsory			
	Logistics and Mobility: Specialisation Logistics and M	obility: Elective Compulsory		
	Logistics and Mobility: Specialisation Traffic Planning	and Systems: Elective Compulsory		
	Mechanical Engineering: Specialisation Aircraft Syste	ems Engineering: Compulsory		
	Engineering and Management - Major in Logistics an	d Mobility: Specialisation Traffic Planning	and Systems: Ele	ective Compulsory

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

ourse L0816: Air Transportation Systems			
Тур	Recitation Section (large)		
Hrs/wk	1		
СР	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		

20					
Courses					
itle	regramming Consents Data Handling 5 Communication / 26	Typ		Hrs/wk	<b>CP</b> 3
	rogramming Concepts, Data Handling & Communication (L26 rogramming Concepts, Data Handling & Communication (L26		on Section (small)	3 2	3
		,so, necitation	on section (sman)		
Module Responsible	•				
Admission Requirements	None				
Recommended Previous					
Knowledge	***				
	After taking part successfully, students have reached the	ne following learni	ng results		
Professional Competence					
Knowledge					
Skills					
Personal Competence					
Social Competence					
Autonomy					
Workload in Hours	Independent Study Time 110, Study Time in Lecture 70	)			
Credit points	6				
Course achievement		cription			
	No 10 % Attestation Test	tate finden semes	terbegleitend statt.		
Examination	Written exam				
Examination duration and	120 min				
scale					
Assignment for the	General Engineering Science (German program, 7	semester): Speci	alisation Mechanical	Engineering, F	ocus Biomechanic
Following Curricula	Compulsory				
	Compulsory General Engineering Science (German program, 7 set Compulsory General Engineering Science (German program, 7 set Engineering: Compulsory General Engineering Science (German program, 7 set Engineering Sciences: Compulsory General Engineering Science (German program, 7 Engineering Sciences: Compulsory General Engineering Science (German program, 7 semental Engineering Science (German program, 7 semental Engineering: Compulsory General Engineering Science (German program, 7 semental Engineering: Compulsory General Engineering Science (German program, 7 semental Engineering: Core qualification: Compulsory Electrical Engineering: Core qualification: Compulsory Energy and Environmental Engineering: Core qualification General Engineering Science (English program, 7 semental Engineering Science (English pro	emester): Special semester): Special semester): Specialisation: Specialisation: Compulsory ster): Specialisation: Specialisati	lisation Mechanical Ecialisation Mechanical ialisation Mechanical Enginetion Mechanical Enginetion Mechanical Enginetion Electrical Engineerin Process Engineerin lisation Energy and ems: Elective Compuls	ingineering, Food al Engineering, Engineering, eering, Focus Theering, Focus Forms: Elective Compactions of Elective Compactions of Environmental Elective Compactions of Environmental Elective Compactions of Elective Compa	Focus Materials Focus Mechatronic Recretical Mechanic Product Developme Impulsory
	Mechatronics: Core qualification: Compulsory Process Engineering: Core qualification: Compulsory Engineering and Management - Major in Logistics and M			ınology: Compul	sory

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

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

## **Focus 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.

Cources			
Courses			
Fitle	Typ	Hrs/wk 2	CP
Numerical Mathematics I (L0417) Numerical Mathematics I (L0418)	Lecture Recitation Section (small)	2	3
Module Responsible			
	None		
Recommended Previous	Mathematik I + II for Engineering Students (german or english) or Analysis & Linear Algorithms	ebra I + II for Te	chnomathematicia
Knowledge	basic MATLAB/Python knowledge		
	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 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	<ul> <li>Students are able to</li> <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>	nd solution algori	thm,
Personal Competence			
-	Students are able to		
Autonomy	work together in heterogeneously composed teams (i.e., teams from different study pro- explain theoretical foundations and support each other with practical aspects regarding Students are capable	the implementa	tion of algorithms.
	<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 of in	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 scale	90 minutes		
	General Engineering Science (German program, 7 semester): Specialisation Computer Science General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering Sciences: Compulsory  General Engineering Science (German program, 7 semester): Specialisation Biomedical Engine 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 Engineering: Elective Compulsory  General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineerial Engineering Science (German program, 7 semester): Specialisation Mechanical Elective Compulsory  General Engineering Science (German program, 7 semester): Specialisation Mechanical Elective Compulsory  Bioprocess Engineering: Specialisation A - General Bioprocess Engineering: Elective Compulsory  Computer Science: Specialisation Computational Mathematics: Elective Compulsory  Computer Science: Specialisation II. Mathematics and Engineering Science: Elective Compulsory  Electrical Engineering: Core qualification: Elective Compulsory  Engineering Science: Core qualification: Elective Compulsory	eering: Compulso Engineering, F eering, Focus Th Engineering, Focus Engineering, Focus M Engineering, Focus M	ory ocus Biomechanic eoretical Mechanic us Aircraft Syster echatronics: Electi

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 Theoretical Mechanical Engineering: Compulsory

General Engineering Science (English program, 7 semester): Specialisation Biomedical Engineering: Compulsory

General Engineering Science (English program, 7 semester): Specialisation Mechanical Engineering, Focus Mechatronics: Elective Compulsory

Computational Science and Engineering: Core qualification: Compulsory

Mechanical Engineering: Specialisation Theoretical Mechanical Engineering: Compulsory

Mechanical Engineering: Specialisation Energy Systems: Elective Compulsory

Mechanical Engineering: Specialisation Mechatronics: Elective Compulsory

Theoretical Mechanical Engineering: Technical Complementary Course Core Studies: Elective Compulsory

Process Engineering: Specialisation Process Engineering: Elective Compulsory

Course L0417: Numerical Mathematics I			
Тур	Lecture		
Hrs/wk	2		
СР	3		
Workload in Hours	ndependent Study Time 62, Study Time in Lecture 28		
Lecturer	Prof. Sabine Le Borne		
Language	EN		
Cycle	WiSe		
Content			
	Interpolation: polynomial, spline and trigonometric interpolation		
	4. Nonlinear equations: fixed point iteration, root finding algorithms, Newton's method		
	5. Linear and nonlinear least squares problems: normal equations, Gram Schmidt and Householder orthogonalization, singular		
	value decomposition, regularizatio, Gauss-Newton and Levenberg-Marquardt methods		
	6. Eigenvalue problems: power iteration, inverse iteration, QR algorithm		
	7. Numerical differentiation		
	8. Numerical integration: Newton-Cotes rules, error estimates, Gauss quadrature, adaptive quadrature		
Literature	Gander/Gander/Kwok: Scientific Computing: An introduction using Manle and MATLAR Springer (2014)		
Language Cycle Content	EN  WiSe  1. Finite precision arithmetic, error analysis, conditioning and stability 2. Linear systems of equations: LU and Cholesky factorization, condition 3. Interpolation: polynomial, spline and trigonometric interpolation 4. Nonlinear equations: fixed point iteration, root finding algorithms, Newton's method 5. Linear and nonlinear least squares problems: normal equations, Gram Schmidt and Householder orthogonalization, value decomposition, regularizatio, Gauss-Newton and Levenberg-Marquardt methods 6. Eigenvalue problems: power iteration, inverse iteration, QR algorithm 7. Numerical differentiation		

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

Module M0988: Structural Materials				
Courses				
Title		Тур	Hrs/wk	СР
Fundamentals of Mechanical Prope	Fundamentals of Mechanical Properties of Materials (L1090)		2	3
Welding Technology (L1123)		Lecture	3	3
Module Responsible	Prof. Claus Emmelmann			
Admission Requirements	None			
Recommended Previous	Fundamentals of Materials Science			
Knowledge				
Educational Objectives	After taking part successfully, students have reached th	e following learning results		
Professional Competence				
Knowledge	The students get to know the principles that are responsin modelling of the materials behaviour. Furthermore, the loads. The students get to know the most important winfluence of welding on the materials and design.	ne students learn about the beh	aviour of metals under	static and dynamic
Skills	The students know the mechanical properties of meta factors on the welding behaviour of steel materials.  The students are able to select between alloys accordin between different welding techniques and select the sui able to dimension weld joints within design tasks.	g to the desired mechaincal pro	perties and welability. T	hey can distinguish
Personal Competence				
Social Competence	none			
Autonomy	none			
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	semester): Specialisation Med	hanical Engineering,	Focus Materials in
Following Curricula	Engineering Sciences: Compulsory			
	General Engineering Science (English program, 7 semes Sciences: Compulsory Mechanical Engineering: Specialisation Materials in Engi		Engineering, Focus Mate	erials in Engineering

	of Mechanical Properties of Materials
Тур	Lecture
Hrs/wk	2
СР	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Prof. Norbert Huber
Language	DE
Cycle	SoSe
Content	1. Introduction and overview
	2. Bonding and crystallography, stress, strain, linear elasticity
	3. Plasticity of metallic materials
	4. Dislocations: Structure, stress, strain, strain energy
	5. Dislocations: Motion and forces
	6. Partial dislocations, dislocation interactions, jogs and kinks
	7. Strengthening mechanisms
	8. Introduction to modelling of materials behaviour, classification of
	phenomena
	9. Linear and nonlinear elasticity
	10. Plasticity, tensile loading, cyclic loading
	11. Viscoelasticity, effects of loading history, creep, relaxation
	12. Viscoplasticity, overstress, rate sensitivity of metallic materials
	13. Identification of material parameters
Literature	Hull and Bacon: Introduction to Dislocations (1984)
	G. Gottstein: Physik. Grundlagen der Materialk. (2001)
	N.Huber: Scriptum "Materialtheorie" Uni Karlsruhe (1998)
	P. Haupt: Cont. Mechanics and Theory of Materials (2002)
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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	
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.

Module M1009: Material Science Laboratory				
Courses				
Title		Тур	Hrs/wk	СР
Companion Lecture for Materials So		Lecture	2	2
Material Science Laboratory (L1235	5)	Practical Course	4	4
Module Responsible	Prof. Bodo Fiedler			
Admission Requirements	None			
Recommended Previous	none			
Knowledge				
Educational Objectives	After taking part successfully, students have reached the	e following learning results		
Professional Competence				
Knowledge	Students are able to give a summary of the technical	details of experiments in the a	area of materials sci	iences and illustrate
	respective relationships. They are capable of describing	and communicating relevant pr	roblems and question	ns using appropriate
	technical language. They can explain the typical process	of solving practical problems and	d present related resu	ults.
Skille	The students can transfer their fundamental knowledge	on material sciences to the pro	nees of solving prac	tical problems. They
Skiiis	identify and overcome typical problems during the realiz	·		
	the real problems adming the realization	action or experiments in the conte	Ac or material serence	
Personal Competence				
Social Competence	Students are able to cooperate in small groups in order to conduct experiments in the context of materials sciences. They are able			
	to effectively present and explain their results alone or in	groups in front of a qualified au	dience.	
Autonomy	Students are capable of solving problems in the context	of materials sciences using prov	vided literature. They	are able to fill gaps
riaconomy	in as well as extent their knowledge using the literature	- ·	-	are abre to mi gaps
Workload in Hours	Independent Study Time 96, Study Time in Lecture 84	· · · · · · · · · · · · · · · · · · ·	·	
Credit points	, ,			
Course achievement	None			
Examination	Subject theoretical and practical work			
Examination duration and	Test reports on the respective tests and online learning r	modules with integrated success	control	
scale		-		
Assignment for the	General Engineering Science (German program, 7	semester): Specialisation Mech	anical Engineering,	Focus Materials in
Following Curricula	Engineering Sciences: Compulsory			
	General Engineering Science (German program, 7 seme	ster): Specialisation Mechanical	Engineering, Focus P	roduct Development
	and Production: Elective Compulsory			
	General Engineering Science (English program, 7 semest	er): Specialisation Mechanical En	gineering, Focus Mat	erials in Engineering
	Sciences: Compulsory			
	Mechanical Engineering: Specialisation Product Developr	nent and Production: Compulsory		
	Mechanical Engineering: Specialisation Materials in Engir	neering Sciences: Compulsory		
	Product Development, Materials and Production: Technic	al Complementary Course Core S	tudies: Elective Com	pulsory

Course L1088: Companion Lecture for Materials Science Laboratory		
Тур	Lecture	
Hrs/wk	2	
СР	2	
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28	
Lecturer	Prof. Bodo Fiedler	
Language	DE	
Cycle	WiSe	
Content	Physico-chemical backgrounds and fundamental experimental principles with regard to the following experiments, the topics to be	
	addressed are indicated in brackets for each experiment:	
	1. Phase diagrams, heat treatment, hardness measurements (thermodynamics, elastic properties of solids)	
	2. notch impact test (elastic properties of solids)	
	3. Processes during the solidifaction of metals (thermodynamics and kinetics of solid-liquid phase transitions)	
	4. tensile test (elastic properties of solids)	
	5. Identificiation of polymers (polymer physics)	
	6. fiber-reinforced polymers (physical principles of composite materials)	
	7. Production and microstructure of ceramic materials (physico-chemical principles of ceramics)	
	8. Mechanical properties of ceramic materials (elastic properties of solids and composite materials)	
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 L1235: Material Science Laboratory		
Тур	Practical Course	
Hrs/wk	4	
СР	4	
Workload in Hours	Independent Study Time 64, Study Time in Lecture 56	
Lecturer	Prof. Bodo Fiedler, Prof. Stefan Müller, Prof. Patrick Huber, Prof. Gerold Schneider, Prof. Jörg Weißmüller	
Language	DE	
Cycle	WiSe	
Content		
Literature	Vorlesungsunterlagen Grundlagen der Werkstoffwissenschaft I & II	

Module M1005: Enhar	nced Fundamentals of Materials Sci	ence		
Courses				
Title		Тур	Hrs/wk	СР
Enhanced Fundamentals: Ceramics	and Polymers (L1233)	Lecture	2	2
Enhanced Fundamentals: Ceramics		Recitation Section (large)	1	1
Enhanced Fundamentals: Metals (L	1086)	Lecture	2	3
Module Responsible	Prof. Gerold Schneider			
Admission Requirements	None			
Recommended Previous	Module "Fundamentals of Materials Science"			
Knowledge	Module "Materials Science Laboratory"			
	Module "Advanced Materials"			
Educational Objectives	After taking part successfully, students have reached	the following learning results		
Professional Competence				
Knowledge	The students are able to give an enhanced overview	over the following topics		
	in metals, polymers and ceramics: Atomic bonds,	•		and mass transport,
	microstructure and phase diagrams. They are capab	le to explain the corresponding technical	terms.	
Skills	The students are able to apply the appropriate physical and chemical methods for the above mentioned subjects.			
Personal Competence				
Social Competence				
· · · · · · · · · · · · · · · · · · ·	The students are capable to understand independently the structure and propeties of ceramics, metals and polymers. They should			
	be able to critally evaluate the profoundness of their knowledge.			
	,			
Workload in Hours	Independent Chief. Time 110 Chief. Time in Leature	70		
Credit points	Independent Study Time 110, Study Time in Lecture 6	70		
Course achievement				
Examination				
Examination duration and				
scale	100 11111			
	General Engineering Science (German program,	7 semester): Specialisation Mechanic	cal Engineering	Focus Materials in
Following Curricula	Engineering Sciences: Compulsory		Linginicaling,	
	Data Science: Core qualification: Elective Compulsor	v		
	General Engineering Science (English program, 7 ser		eering, Focus Mat	erials in Engineering
	Sciences: Compulsory		<u>.</u>	5
	General Engineering Science (English program, 7 se	emester): Specialisation Mechanical Eng	ineering, Focus P	roduct Development
	and Production: Compulsory	3	-	•
	Mechanical Engineering: Specialisation Materials in E	ingineering Sciences: Compulsory		
	Technomathematics: Specialisation III. Engineering S			
	. 3 44 3 4	· · · ·		

Course L1233: Enhanced Fun	damentals: Ceramics and Polymers
Тур	Lecture
Hrs/wk	2
СР	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
	Prof. Gerold Schneider, Prof. Robert Meißner
Language	
Cycle	
Content	1. Einführung
	Natürliche "Keramiken" - Steine
	"Künstliche" Keramik - vom Porzellan bis zur Hochleistungskeramik Anwendungen von Hochleistungskeramik
	2. Pulverherstellung
	Einteilung der Pulversyntheseverfahren
	Der Bayer-Prozess zur Al2O3-Herstellung
	Der Acheson-Prozess zur SiC-Herstellung
	Chemical Vapour Deposition
	Pulveraufbereitung
	Bank language.
	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
	6. Elektrische Eigenschaften von Keramiken
	Ferroelektische Keramiken
	Piezo-, ferroelektrische Materialeigenschaften Anwendungen
	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 €
	. 5

Course L1234: Enhanced Fundamentals: Ceramics and Polymers	
Тур	Recitation Section (large)
Hrs/wk	1
СР	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

Content	See interlocking course
Literature	See interlocking course
•	
Course L1086: Enhanced Fun	idamentals: Metals
	Lecture
Hrs/wk	
СР	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Prof. Jörg Weißmüller
Language	DE
Cycle	
Content	Advanced understanding of metals:
	Physical materials properties
	o Materials behaviour - elastic, thermal, electrical
	o Superelasticity and shape memory effect
	o Fundamentals of electrical conductivity in metals and semiconductors
	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
	o Galvanic cells and cell voltage
	o Galvanic series
	o Nernst equation
	o Polarizable electrodes
	o Electrochemical double layer
	o Capacitive and pseudocapacitive processes
	o Capacitive currents and Faraday currents
	Electrochemical (or "wet") corrosion and corrosion 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
	o Nickel-metal hydride accumulators
	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
	o Phenomenology: magnetic field and magnetization
	o Para-, ferro-, antiferromagnets; Curie transition
	o Magnetism at the atomic scale; exchange coupling
	o Magnetization isotherms, domains
	o Measurement methods
	o Magnetocrystalline anisotropy and domain walls
	o Hard magnetic materials and their applications
1	

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

	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

Module M0934: Adva	nced Materials			
Courses				
Title		Тур	Hrs/wk	СР
Advanced Materials Characterization	on (L1087)	Lecture	2	2
Advanced Materials Design (L1091)	)	Lecture	2	2
Advanced Materials Design (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 reached the	following learning results		
Professional Competence				
Knowledge	The students will be able to explain the properties of adv	anced materials along with their a	pplications in tecl	nnology, in particular
	metallic, ceramic, polymeric, semiconductor, modern com	posite materials (biomaterials) and	nanomaterials.	
Chille	The students will be able to releat metasic least month			h. d. d
SKIIIS	The students will be able to select material configuration	*		
	materials considering architectural principles from the		-	
	modern materials science, which enables them to select o	ptimum materiais combinations de	pending on the te	echnical applications.
Personal Competence				
Social Competence	The students are able to present solutions to specialists ar	nd to develop ideas further.		
Autonomy	The students are able to			
	<ul> <li>assess their own strengths and weaknesses.</li> </ul>			
	<ul> <li>define tasks independently.</li> </ul>			
Workload in Hours	Independent Study Time 96, Study Time in Lecture 84			
•				
Course achievement	None			
Examination	Written exam			
Examination duration and	90 min			
scale				
Assignment for the	General Engineering Science (German program, 7 ser	mester): Specialisation Mechanica	al Engineering, F	ocus Biomechanics:
Following Curricula	Compulsory			
	General Engineering Science (German program, 7 se	emester): Specialisation Mechani	cal Engineering,	Focus Materials in
	Engineering Sciences: Compulsory			
	Data Science: Specialisation Materials Science: Compulsor	У		
	General Engineering Science (English program, 7 semeste		eering: Elective C	ompulsory
	Mechanical Engineering: Core qualification: Elective Comp	ulsory		

Course L1087: Advanced Materials Characterization		
Тур	Lecture	
Hrs/wk	2	
СР	2	
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28	
Lecturer	Prof. Patrick Huber	
Language	DE	
Cycle	SoSe	
Content		
Literature	William D. Callister und David G. Rethwisch, Materialwissenschaften und Werkstofftechnik, Wiley&Sons, Asia (2011).	
	William D. Callister, Materials Science and Technology, Wiley& Sons, Inc. (2007).	

Course L1091: Advanced Materials Design	
Тур	Lecture
Hrs/wk	2
СР	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Prof. Bodo Fiedler, Prof. Stefan Müller, Prof. Patrick Huber, Prof. Gerold Schneider, Prof. Jörg Weißmüller
Language	DE/EN
Cycle	SoSe
Content	
Literature	Vorlesungsunterlagen

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

		Typ Lecture Recitation Section (small)	<b>Hrs/wk</b> 3 2	<b>CP</b> 3 3
Prof. Sibylle Fröschle				
None				
After taking part successfully, students have re	eached the following	ng learning results		
Independent Study Time 110. Study Time in Le	ecture 70			
Compulsory Bonus Form	Description			
No 10 % Attestation	Testate finde	n semesterbegleitend statt.		
Written exam				
120 min				
	gram, 7 semester	r): Specialisation Mechanica	al Engineering, F	Focus Biomechanics
• •				
Compulsory General Engineering Science (German progr. Compulsory General Engineering Science (German progr. Engineering: Compulsory General Engineering Science (German progr. Engineering Science: (German progr. Engineering Science: (German progr. Engineering Science: (German progr. Compulsory General Engineering Science: (German progr. Engineering: Compulsory General Engineering Science: (German progr. Engineering: Compulsory General Engineering Science: (German progr. Engineering: Core (German progr. Eneral Engineering: Core qualification: Com. Electrical Engineering: Core qualification: Com. Energy and Environmental Engineering: Core of General Engineering Science: (English program.	ram, 7 semester): ram, 7 semester): gram, 7 semester gram, 7 semester m, 7 semester): Sp m, 7 semester): Sp mpulsory upulsory qualification: Comp n, 7 semester): Spe	Specialisation Mechanical  Specialisation Mechanical  Specialisation Mechanical  Specialisation Mechanical  Specialisation Mechanical Enginerialisation Electrical Enginerialisation  Specialisation Process Engineerialisation Process Engineerialisation Engineerialisation Engineerialisation Engineerialisation	Engineering, Footal Engineering, Footal Engineering, al Engineering, Focus Thineering, Focus Fering: Elective Compg: Elective	us Energy Systems  tus Aircraft System  Focus Materials in  Focus Mechatronics  neoretical Mechanical  Product Developmen  mpulsory
	rogramming Concepts, Data Handling & Communic Prof. Sibylle Fröschle  None  After taking part successfully, students have reference of the successfully, stu	After taking part successfully, students have reached the following and the following part successfully, students have reached the following part of the f	rogramming Concepts, Data Handling & Communication (L2689)  Prof. Sibylle Fröschle  None  After taking part successfully, students have reached the following learning results  Independent Study Time 110, Study Time in Lecture 70  6  Compulsory Bonus Form Description  No 10 % Attestation Testate finden semesterbegleitend statt.  Written exam  120 min  General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering Science (German program, 7 semester): Specialisation Mechanical Compulsory  General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering Science (German program, 7 semester): Specialisation Mechanical Compulsory  General Engineering Science (German program, 7 semester): Specialisation Mechanical Compulsory  General Engineering Science (German program, 7 semester): Specialisation Mechanical Compulsory  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: Compulsory  General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering Engineering Science (German program, 7 semester): Specialisation Mechanical Engineerings Compulsory  General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering: Compulsory  General Engineering Science (German program, 7 semester): Specialisation Electrical Engineering: Core qualification: Compulsory  General Engineering Science (German program, 7 semester): Specialisation Electrical Engineering: Core qualification: Compulsory  General Engineering Science (German program, 7 semester): Specialisation Electrical Engineering: Core qualification	rogramming Concepts, Data Handling & Communication (L2689) Lecture 3 rogramming Concepts, Data Handling & Communication (L2690) Recitation Section (small) 2  Prof. Sibylle Fröschle  None  After taking part successfully, students have reached the following learning results  Independent Study Time 110, Study Time in Lecture 70  6  Compulsory Bonus Form Description No 10 % Attestation Testate finden semesterbegleitend statt.  Written exam  120 min  General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Green Technologies, Focus Renew Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering. Focus Renew Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Planjineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Planjineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Planjineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Planjineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Planjineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Planjineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Planjineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Planjineering: Compulsory Gene

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

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

## **Focus 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.

Module M0708: Elect	trical Engineering III: Circuit Theory and Transients	
Courses		
Title	Typ Hrs/wk CP	
Circuit Theory (L0566)	Lecture 3 4	
Circuit Theory (L0567)	Recitation Section (small) 2 2	
Module Responsible	Prof. Alexander Kölpin	
Admission Requirements	None	
Recommended Previous	s Electrical Engineering I and II, Mathematics I and II	
Knowledge	2	
Educational Objectives	s After taking part successfully, students have reached the following learning results	
Professional Competence		
Knowledge	e Students are able to explain the basic methods for calculating electrical circuits. They know the Fourier series analysis networks driven by periodic signals. They know the methods for transient analysis of linear networks in time and in f domain, and they are able to explain the frequency behaviour and the synthesis of passive two-terminal-circuits.	
Skills	The students are able to calculate currents and voltages in linear networks by means of basic methods, also when of periodic signals. They are able to calculate transients in electrical circuits in time and frequency domain and are able to expressed transient behaviour. They are able to analyse and to synthesize the frequency behaviour of passive two-circuits.	xplain the
Personal Competence Social Competence	e Students work on exercise tasks in small guided groups. They are encouraged to present and discuss their results w group.	within the
Autonomy	The students are able to find out the required methods for solving the given practice problems. Possibilities are given to knowledge during the lectures continuously by means of short-time tests. This allows them to control independent educational objectives. They can link their gained knowledge to other courses like Electrical Engineering I and Mathematic	ntly their
Workload in Hours	s 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 semester): Specialisation Mechanical Engineering, Focus Mech	hatronics
Following Curricula		
	General Engineering Science (German program, 7 semester): Specialisation Electrical Engineering: Compulsory	
	Electrical Engineering: Core qualification: Compulsory	
	Engineering Science: Specialisation Electrical Engineering: Compulsory	
	General Engineering Science (English program, 7 semester): Specialisation Mechanical Engineering, Focus Mech Compulsory	hatronics
	Computational Science and Engineering: Specialisation II. Mathematics & Engineering Science: Elective Compulsory	
	Mechatronics: Core qualification: Compulsory  Technomathematics: Specialisation III. Engineering Science: Elective Compulsory	
	recombination access Specialisation in Engineering Science. Elective Compulsory	

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

Course L0567: Circuit Theory	
Тур	Recitation Section (small)
Hrs/wk	2
СР	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

Module M1320: Simul	ation and Design of Mechatronic Syste	ms		
Courses				
Title Simulation and Design of Mechatror Simulation and Design of Mechatror Simulation and Design of Mechatror	nic Systems (L1823)	Typ Lecture Recitation Section (large) Practical Course	<b>Hrs/wk</b> 2 1	<b>CP</b> 2 2 2
Module Responsible		Tractical course	ı	2
Admission Requirements				
	Fundatmentals of mechanics, control theory and electrical	ll engineering		
<b>Educational Objectives</b>	After taking part successfully, students have reached the	following learning results		
Professional Competence				
Knowledge	Students are able to describe methods and calculations f	or design, modeling, simulation and	optimization of m	echatronic systems.
Skills	Students are able to apply modern algorithms for modeli systems and implement those in laboratory conditions.	ng of mechatronic systems. They can	n identify, simula	te and design simple
Personal Competence				
Social Competence	Students are able to work goal-oriented in small mixed go	oups and present results to target g	roups.	
Autonomy	Students are able to recognize and improve knowledge d	eficits independently.		
	With instructor assistance, students are able to evaluate	their own knowledge level and define	e a further course	e of study.
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	90 min			
Assignment for the	General Engineering Science (German program, 7 semes	ter): Specialisation Mechanical Engi	neering, Focus M	echatronics: Elective
Following Curricula	Compulsory			
	General Engineering Science (German program, 7 ser	nester): Specialisation Mechanical	Engineering, Foc	us Aircraft Systems
	Engineering: Elective Compulsory			
	Digital Mechanical Engineering: Core qualification: Compu General Engineering Science (English program, 7 semes	•	ooring Focus Th	corotical Machanical
	Engineering: Elective Compulsory	er): Specialisation Mechanical Engli	ieering, Focus in	eoreticai Mechanicai
	General Engineering Science (English program, 7 sen	nester): Specialisation Mechanical	Engineering, Foc	us Aircraft Systems
	Engineering: Elective Compulsory		gg,	
	General Engineering Science (English program, 7 semes	ter): Specialisation Mechanical Engi	neering, Focus M	echatronics: Elective
	Compulsory			
	Mechanical Engineering: Specialisation Theoretical Mechanical	nical Engineering: Elective Compuls	ory	
	Mechanical Engineering: Specialisation Aircraft Systems I			
	Mechanical Engineering: Specialisation Aircraft Systems I			
	Mechanical Engineering: Specialisation Mechatronics: Co			
	Mechanical Engineering: Specialisation Mechatronics: Ele Mechatronics: Core qualification: Compulsory	cuve Compulsory		
	Mechatronics: Core qualification: Compulsory  Mechatronics: Core qualification: Elective Compulsory			

Course L1822: Simulation an	d 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 <sup>®</sup> and Simulink <sup>®</sup>
Literature	Skript zur Veranstaltung
	Weitere Literatur in der Veranstaltung

Course L1823: Simulation an	d Design of Mechatronic Systems
Тур	Recitation Section (large)
Hrs/wk	1
СР	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	d Design of Mechatronic Systems
Тур	Practical Course
Hrs/wk	1
СР	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

	erical Mathematics I
Courses	
Title	Typ Hrs/wk CP
Numerical Mathematics I (L0417)	Lecture 2 3
Numerical Mathematics I (L0418)	Recitation Section (small) 2 3
Module Responsible	Prof. Sabine Le Borne
Admission Requirements	None
Recommended Previous	
Knowledge	Mathematik I + II for Engineering Students (german or english) or Analysis & Linear Algebra I + II for Technomathematicia
	basic MATLAB/Python knowledge
Educational Objectives	After taking part successfully, students have reached the following learning results
Professional Competence	3, 3, 3, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4,
•	Students are able to
, une meage	
	<ul> <li>name numerical methods for interpolation, integration, least squares problems, eigenvalue problems, nonlinear root findi</li> </ul>
	problems and to explain their core ideas,
	repeat convergence statements for the numerical methods,
	<ul> <li>explain aspects for the practical execution of numerical methods with respect to computational and storage complexitx.</li> </ul>
Skills	Students are able to
	implement, apply and compare numerical methods using MATLAB/Python,
	<ul> <li>justify the convergence behaviour of numerical methods with respect to the problem and solution algorithm,</li> </ul>
	<ul> <li>select and execute a suitable solution approach for a given problem.</li> </ul>
Personal Competence	
•	Students are able to
Social competence	State and ask to
	work together in heterogeneously composed teams (i.e., teams from different study programs and background knowledg
	explain theoretical foundations and support each other with practical aspects regarding the implementation of algorithms.
Autonomy	Students are capable
	to assess whether the supporting theoretical and practical excercises are better solved individually or in a team,
	to assess their individual progess and, if necessary, to ask questions and seek help.
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56
Credit points	6
Course achievement	None
Examination	Written exam
<b>Examination duration and</b>	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 Mechanical Engineering, Focus Materials
	Engineering Sciences: 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 Mechanical Engineering, Focus Biomechani
	General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Biomechanic
	General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Biomechani Compulsory
	General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Biomechani Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Theoretical Mechanic
	General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Biomechani Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Theoretical Mechanic
	General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Biomechani Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Theoretical Mechani Engineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Aircraft System
	General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Biomechani Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Theoretical Mechanic Engineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Aircraft System Engineering: Elective Compulsory
	General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Biomechanic Compulsory  General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Theoretical Mechanic Engineering: Compulsory  General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Aircraft System Engineering: Elective Compulsory  General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Mechatronics: Elective Compulsory
	General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Biomechanic Compulsory  General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Theoretical Mechanic Engineering: Compulsory  General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Aircraft System Engineering: Elective Compulsory  General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Mechatronics: Electic Compulsory
	General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Biomechanic Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Theoretical Mechanic Engineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Aircraft System Engineering: Elective Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Mechatronics: Electic Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Energy System
	General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Biomechanic Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Theoretical Mechanic Engineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Aircraft System Engineering: Elective Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Mechatronics: Electic Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Mechatronics: Electic Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Energy System Elective Compulsory
	General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Biomechanic Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Theoretical Mechanic Engineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Aircraft System Engineering: Elective Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Mechatronics: Electic Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Energy System Elective Compulsory Bioprocess Engineering: Specialisation A - General Bioprocess Engineering: Elective Compulsory
	General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Biomechanic Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Theoretical Mechanic Engineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Aircraft System Engineering: Elective Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Mechatronics: Electic Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Mechatronics: Electic Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Energy System Elective Compulsory Bioprocess Engineering: Specialisation A - General Bioprocess Engineering: Elective Compulsory Computer Science: Specialisation Computational Mathematics: Elective Compulsory
	General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Biomechanic Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Theoretical Mechanic Engineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Aircraft System Engineering: Elective Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Mechatronics: Electic Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Mechatronics: Electic Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Energy System Elective Compulsory Bioprocess Engineering: Specialisation A - General Bioprocess Engineering: Elective Compulsory Computer Science: Specialisation Computational Mathematics: Elective Compulsory Computer Science: Specialisation II. Mathematics and Engineering Science: Elective Compulsory
	General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Biomechanic Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Theoretical Mechanic Engineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Aircraft System Engineering: Elective Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Mechatronics: Electic Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Mechatronics: Electic Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Energy System Elective Compulsory Bioprocess Engineering: Specialisation A - General Bioprocess Engineering: Elective Compulsory Computer Science: Specialisation Computational Mathematics: Elective Compulsory Data Science: Core qualification: Compulsory
	General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Biomechanic Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Theoretical Mechanic Engineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Aircraft System Engineering: Elective Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Mechatronics: Elective Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Energy System Elective Compulsory Bioprocess Engineering: Specialisation A - General Bioprocess Engineering: Elective Compulsory Computer Science: Specialisation Computational Mathematics: Elective Compulsory Computer Science: Specialisation II. Mathematics and Engineering Science: Elective Compulsory Data Science: Core qualification: Compulsory Electrical Engineering: Core qualification: Elective Compulsory
	General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Biomechanic Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Theoretical Mechanic Engineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Aircraft System Engineering: Elective Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Mechatronics: Elective Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Energy System Elective Compulsory Bioprocess Engineering: Specialisation A - General Bioprocess Engineering: Elective Compulsory Computer Science: Specialisation Computational Mathematics: 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
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Computational Science and Engineering: Core qualification: Compulsory

 ${\it Mechanical\ Engineering: Specialisation\ Theoretical\ Mechanical\ Engineering:\ Compulsory}$ 

Mechanical Engineering: Specialisation Energy Systems: Elective Compulsory

Mechanical Engineering: Specialisation Mechatronics: Elective Compulsory

Theoretical Mechanical Engineering: Technical Complementary Course Core Studies: Elective Compulsory

Process Engineering: Specialisation Process Engineering: Elective Compulsory

Course L0417: Numerical Mathematics I		
Тур	Lecture	
Hrs/wk	2	
СР	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 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
Electrical Machines and Actuators	(L0293)	Lecture	3	4
Electrical Machines and Actuators	(L0294)	Recitation Section (large)	2	2
Module Responsible	Prof. Thorsten Kern			
Admission Requirements	None			
Recommended Previous	Basics of mathematics, in particular complexe number	s, integrals, differentials		
Knowledge	Basics of electrical engineering and mechanical engine	ooring		
	basics of electrical engineering and mechanical engine	sering		
Educational Objectives	After taking part successfully, students have reached t	the following learning results		
<b>Professional Competence</b>				
Knowledge	Students can to draw and explain the basic principles of	of electric and magnetic fields.		
	They can describe the function of the standard ty	mes of electric machines and prese	nt the correspon	nding equations as
	characteristic curves. For typically used drives they ca			
	from the power grid to the driven engine.	in explain the major parameters of the	energy emclency	of the whole syste
	Them the power grid to the driven engine.			
Skills	Students are able to calculate two-dimensional electr	ic and magnetic fields in particular fe	rromagnetic circu	uits with air gap. F
	this they apply the usual methods of the design auf ele	ectric machines.		
	They can calulate the operational performance of ele	ectric machines from their given chara	cteristic data and	d selected quantitie
	and characteristic curves. They apply the usual equiva			
	3, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1,	3 .,		
Personal Competence				
Social Competence				
Autonomy		and magnatic fields for applications. Th	nev are able to ar	nalvee independent
Autonomy	the operational performance of electric machines from			
	and characteristic curves.	in the charactersitic data and theycan	calculate thereo	i selected qualititi
	and characteristic curves.			
Workload in Hours	Independent Study Time 110, Study Time in Lecture 70	n		
Credit points				
Course achievement				
Examination				
Examination duration and	,	an filos		
scale				
		gii illes		
assignment for the			ering: Flective Co	mnulsory
Assignment for the		ester): Specialisation Electrical Enginee	9	. ,
Assignment for the Following Curricula	General Engineering Science (German program, 7 s	ester): Specialisation Electrical Enginee	9	. ,
-	General Engineering Science (German program, 7 s Compulsory	rester): Specialisation Electrical Enginee semester): Specialisation Mechanical	Engineering, Foc	us Energy System
-	General Engineering Science (German program, 7 s Compulsory General Engineering Science (German program, 7	rester): Specialisation Electrical Enginee semester): Specialisation Mechanical	Engineering, Foc	us Energy System
-	General Engineering Science (German program, 7 s Compulsory General Engineering Science (German program, 7 Compulsory	nester): Specialisation Electrical Enginee semester): Specialisation Mechanical semester): Specialisation Mechanica	Engineering, Foc	us Energy System
-	General Engineering Science (German program, 7 s Compulsory General Engineering Science (German program, 7 Compulsory General Engineering Science (German program, 7 sem	nester): Specialisation Electrical Enginee semester): Specialisation Mechanical semester): Specialisation Mechanica	Engineering, Foc	us Energy System
-	General Engineering Science (German program, 7 s Compulsory General Engineering Science (German program, 7 Compulsory	nester): Specialisation Electrical Enginee semester): Specialisation Mechanical semester): Specialisation Mechanica nester): Specialisation Mechanical Engin	Engineering, Foc	Focus Mechatronic
-	General Engineering Science (German program, 7 s Compulsory General Engineering Science (German program, 7 Compulsory General Engineering Science (German program, 7 sem Engineering: Elective Compulsory General Engineering Science (German program, 7 sem	nester): Specialisation Electrical Engineersemester): Specialisation Mechanical semester): Specialisation Mechanical nester): Specialisation Mechanical Engineerser): Specialisation Energy and Environmental Engineerser): Specialisation Energy and Environmental Engineersery: Specialisation Energy and Environmental Engineersery:	Engineering, Foc	Focus Mechatronic
-	General Engineering Science (German program, 7 s Compulsory General Engineering Science (German program, 7 Compulsory General Engineering Science (German program, 7 sem Engineering: Elective Compulsory	nester): Specialisation Electrical Engineersemester): Specialisation Mechanical semester): Specialisation Mechanical nester): Specialisation Mechanical Engineerser): Specialisation Energy and Environpulsory	Engineering, Foc	Focus Mechatronic
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-	General Engineering Science (German program, 7 scompulsory General Engineering Science (German program, 7 compulsory General Engineering Science (German program, 7 semential Engineering: Core qualification: Confective Indication Engineering: Core qualification: Elective Comferency and Environmental Engineering: Core qualification:	nester): Specialisation Electrical Enginees semester): Specialisation Mechanical semester): Specialisation Mechanical nester): Specialisation Mechanical Enginees nester): Specialisation Energy and Environ npulsory npulsory tion: Compulsory ester): Specialisation Mechanical Engine	Engineering, Focal Engineering, Interesting, Focus Theomental Engineering: Elective C	us Energy System Focus Mechatronic neoretical Mechanic ring: Compulsory
-	General Engineering Science (German program, 7 scompulsory General Engineering Science (German program, 7 compulsory General Engineering Science (German program, 7 semential Engineering: Core qualification: Considerical Engineering: Core qualification: Elective Communication Engineering Science (English program, 7 semential Engineering E	nester): Specialisation Electrical Enginees semester): Specialisation Mechanical semester): Specialisation Mechanical nester): Specialisation Mechanical Engine nester): Specialisation Energy and Envir npulsory npulsory tion: Compulsory ester): Specialisation Mechanical Engine ation Energy Technology: Elective Com	Engineering, Focal Engineering, Interesting, Focus Theomental Engineering: Elective C	us Energy System Focus Mechatronic neoretical Mechanic ring: Compulsory
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-	General Engineering Science (German program, 7 scompulsory General Engineering Science (German program, 7 compulsory General Engineering Science (German program, 7 compulsory General Engineering Science (German program, 7 semengineering: Elective Compulsory General Engineering Science (German program, 7 semengiated Mechanical Engineering: Core qualification: Contelectrical Engineering: Core qualification: Elective Compulsory General Engineering: Core quali	nester): Specialisation Electrical Enginees semester): Specialisation Mechanical semester): Specialisation Mechanical nester): Specialisation Mechanical Engine nester): Specialisation Energy and Envir npulsory npulsory tion: Compulsory nester): Specialisation Mechanical Engine ation Energy Technology: Elective Com nece: Elective Compulsory nd Systems: Elective Compulsory gement and Processes: Elective Compu	Engineering, Focal Engineering, Interesting, Focus Theomental Engineering: Elective Copulsory	us Energy System Focus Mechatronic neoretical Mechanic ring: Compulsory
-	General Engineering Science (German program, 7 scompulsory General Engineering Science (German program, 7 compulsory General Engineering Science (German program, 7 compulsory General Engineering Science (German program, 7 semendering: Elective Compulsory General Engineering Science (German program, 7 semendering: Elective Compulsory General Engineering: Core qualification: Elective Compulsion Electrical Engineering: Core qualification: Elective Compulsion Electrical Engineering: Core qualification: Elective Compulsion Engineering Science (English program, 7 semendering Engineering Science (English program, 7 semendering Engineering Energy, Water, Climate: Specialist Logistics and Mobility: Specialisation Engineering Science Logistics and Mobility: Specialisation Production Managemental Engineering: Core qualification: Elective Core	nester): Specialisation Electrical Enginees semester): Specialisation Mechanical semester): Specialisation Mechanical nester): Specialisation Mechanical Enginees nester): Specialisation Energy and Environ npulsory npulsory tion: Compulsory nester): Specialisation Mechanical Engine ation Energy Technology: Elective Com nece: Elective Compulsory nd Systems: Elective Compulsory	Engineering, Focal Engineering, Interesting, Focus Theomental Engineering: Elective Copulsory	us Energy System Focus Mechatronic neoretical Mechanic ring: Compulsory
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Course L0293: Electrical Mac	chines 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"

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

Module M0777: Semio	onductor Circuit Design			
Courses				
Fitle Semiconductor Circuit Design (L076		<b>Typ</b> Lecture Recitation Section (small)	Hrs/wk 3 1	<b>CP</b> 4 2
emiconductor Circuit Design (L086  Module Responsible		Recitation Section (Smail)	1	2
Admission Requirements	None			
Recommended Previous	Fundamentals of electrical engineering			
Knowledge	Tundamentals of electrical engineering			
3	Basics of physics, especially semiconductor physics			
<b>Educational Objectives</b>	After taking part successfully, students have reache	ed the following learning results		
<b>Professional Competence</b>				
Knowledge	Students are able to explain the functionality Students are able to explain how analog circu Students are able to explain the functionality Students know the fundamental digital logic Students have knowledge about memory circu Students know the appropriate fields for the	uits functions and where they are applied.  of fundamental operational amplifiers and circuits and can discuss their advantages acuits and can explain their functionality an	d their specificati and disadvantag	
Skills	<ul> <li>Students can calculate the specifications of c</li> <li>Students are able to develop different logic c</li> <li>Students can use MOS devices, operational a</li> </ul>	ircuits and can design different types of lo	gic circuits.	ctronic circuits.
Personal Competence Social Competence Autonomy	<ul> <li>Students are able work efficiently in heteroge</li> <li>Students working together in small groups ca</li> <li>Students are able to assess their level of kno</li> </ul>	an solve problems and answer professiona	l questions.	
Weedlend in Herm	Index and an Charle Time 124 Charle Time in Landau	- 50		
Workload in Hours	Independent Study Time 124, Study Time in Lecture	200		
Credit points  Course achievement	None			
Examination	Written exam			
Examination duration and	120 min			
scale	120 11111			
Assignment for the	General Engineering Science (German program, 7 s	emester): Specialisation Electrical Enginee	ering: Compulsor	V
Following Curricula	General Engineering Science (German program,			
	Compulsory			
	Data Science: Core qualification: Elective Compulso	ry		
	Electrical Engineering: Core qualification: Compulso			
	Engineering Science: Specialisation Electrical Engine	, ,		
	Engineering Science: Specialisation Mechatronics: C General Engineering Science (English program, 7 se	• •	ring: Compulsors	,
	General Engineering Science (English program,			
	Compulsory		gccinig,	
	General Engineering Science (English program, 7 se	emester): Specialisation Mechatronics: Con	npulsory	
	Computational Science and Engineering: Specialisat			ulsory
	Mechanical Engineering: Specialisation Mechatronic	s: Compulsory		
	Mechatronics: Core qualification: Compulsory			
	${\bf Technomathematics: Specialisation  III.  Engineering}$	Science: Elective Compulsory		

Course L0763: Semiconducto	or Circuit Design
Тур	Lecture
Hrs/wk	3
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: 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
СР	2
Workload in Hours	Independent Study Time 46, Study Time in Lecture 14
Lecturer	Prof. Matthias Kuhl, Weitere Mitarbeiter
Language	DE
Cycle	SoSe
Content	Basic circuits and characteristic curves of bipolar transistors Basic circuits and characteristic curves of MOS transistors for amplifiers Realization and dimensioning of operational amplifiers Realization of logic functions Basic circuits with MOS transistors for combinational and sequential logic Memory circuits Circuits for analog-to-digital and digital-to-analog converters Design of exemplary circuits
Literature	U. Tietze und Ch. Schenk, E. Gamm, Halbleiterschaltungstechnik, Springer Verlag, 14. Auflage, 2012, ISBN 3540428496  R. J. Baker, CMOS - Circuit Design, Layout and Simulation, J. Wiley & Sons Inc., 3. Auflage, 2011, ISBN: 0471700555  H. Göbel, Einführung in die Halbleiter-Schaltungstechnik, Berlin, Heidelberg Springer-Verlag Berlin Heidelberg, 2011, ISBN: 9783642208874 ISBN: 9783642208867  URL: http://site.ebrary.com/lib/alltitles/docDetail.action?docID=10499499  URL: http://dx.doi.org/10.1007/978-3-642-20887-4  URL: http://ebooks.ciando.com/book/index.cfm/bok_id/319955  URL: http://www.ciando.com/img/bo

Module M0854: Math	ematics IV				
Courses					
Title		Ту		Hrs/wk	СР
Differential Equations 2 (Partial Differential Equations) (L1043)  Lecture 2 1  Differential Equations 2 (Partial Differential Equations) (L1044)  Recitation Section (small) 1				1	
Differential Equations 2 (Partial Dif			citation Section (large)	1	1
Complex Functions (L1038)		Lee	cture	2	1
Complex Functions (L1041)			citation Section (small)	1	1
Complex Functions (L1042)	T	Re	citation Section (large)	1	1
Module Responsible					
Admission Requirements  Recommended Previous					
Knowledge	Mathematics 1 - III				
Educational Objectives	After taking part successfully, students have reached	the following I	earning results		
Professional Competence	3,,	<u> </u>	J		
Knowledge					
	Students can name the basic concepts in Mathe				-
	Students can discuss logical connections between	een these con	cepts. They are capable of	of illustrating the	ese connections with
	<ul> <li>the help of examples.</li> <li>They know proof strategies and can reproduce</li> </ul>	them			
	They know proof strategies and carrieproduce	them.			
Skills					
	Students can model problems in Mathematics		elp of the concepts studie	d in this course.	Moreover, they are
	capable of solving them by applying established		ations batuson the consen	to obviding in the	
	<ul> <li>Students are able to discover and verify further</li> <li>For a given problem, the students can develo</li> </ul>				
	results.	op and execut	e a suitable approach, an	id are able to cr	itically evaluate the
	. coald.				
Personal Competence					
Social Competence					
	Students are able to work together in teams. The decision are the second and the second are second as the second are				-
	<ul> <li>In doing so, they can communicate new conception</li> <li>design examples to check and deepen the under</li> </ul>			erating partners.	Moreover, they can
	design examples to effect and deepen the unite	erstanding or t	neil peers.		
Autonomy					
	Students are capable of checking their understanding of complex concepts on their own. They can specify open questions     procisely and know where to get help in solving them.				
	precisely and know where to get help in solving them.  • Students have developed sufficient persistence to be able to work for longer periods in a goal-oriented manner on hard				
	problems.	e to be able i	to work for longer periods	ili a goai-orielit	eu manner on naru
	problems.				
Workload in Hours	Independent Study Time 68, Study Time in Lecture 11	.2			
Credit points	6				
Course achievement	None				
Examination	Written exam				
Examination duration and	60 min (Complex Functions) + 60 min (Differential Equ	uations 2)		·	
scale					
Assignment for the			_		
Following Curricula		semester):	Specialisation Mechanical	Engineering, F	ocus Mechatronics:
	Compulsory General Engineering Science (German program, 7 sen	nactor): Specia	disation Naval Architecture	: Compulsory	
	General Engineering Science (German program, 7 sen				eoretical Mechanical
	Engineering: Elective Compulsory	,. Speci			
	Computer Science: Specialisation Computational Math	nematics: Elect	ive Compulsory		
	Electrical Engineering: Core qualification: Compulsory				
	General Engineering Science (English program, 7 sem		-		
	General Engineering Science (English program, 7	semester):	Specialisation Mechanical	Engineering, F	ocus Mechatronics:
	Compulsory		disation Markari 15	navina F T	a a making l AA1
	General Engineering Science (English program, 7 sem	nester): Specia	nisation Mechanical Engine	eering, Focus The	eoreticai Mechanical
	Engineering: Compulsory Computational Science and Engineering: Specialisatio	n II Mathemat	ics & Engineering Science:	Flective Comput	Isory
	Mechanical Engineering: Specialisation Mechatronics:		.cs & Engineering science:	Liective Compu	1301 y
	Mechanical Engineering: Specialisation Theoretical Me		neering: Elective Compulso	ry	
	Mechatronics: Core qualification: Compulsory		J	-	
	Naval Architecture: Core qualification: Compulsory				
	Theoretical Mechanical Engineering: Technical Comple	ementary Cour	se Core Studies: Elective C	Compulsory	

Course L1043: Differential Equations 2 (Partial Differential Equations)	
Тур	Lecture
Hrs/wk	2
СР	1
Workload in Hours	Independent Study Time 2, Study Time in Lecture 28
Lecturer	Dozenten des Fachbereiches Mathematik der UHH
Language	DE
Cycle	SoSe
Content	Main features of the theory and numerical treatment of partial differential equations
Literature	<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> </ul>
Literature	http://www.math.uni-hamburg.de/teaching/export/tuhh/index.html

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

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

Course L1038: Complex Func	tions
Тур	Lecture
Hrs/wk	2
СР	1
Workload in Hours	Independent Study Time 2, Study Time in Lecture 28
Lecturer	Dozenten des Fachbereiches Mathematik der UHH
Language	DE
Cycle	SoSe
Content	Main features of 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> <li>http://www.math.uni-hamburg.de/teaching/export/tuhh/index.html</li> </ul>

Course L1041: Complex Functions	
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 L1042: Complex Fund	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					
itle	rearramming Consents Data Us	andling Communication (13690)	Typ	Hrs/wk	<b>CP</b> 3
omputer Science for Engineers - P computer Science for Engineers - P			Lecture  Recitation Section (small)	3 2	3
		mamig a communication (E2000)	necitation section (small)	-	
Module Responsible					
Admission Requirements	None				
Recommended Previous Knowledge					
	After telding part guessefull		allauring languing gasulta		
	Arter taking part succession	y, students have reached the f	ollowing learning results		
Professional Competence					
Knowledge Skills					
SKIIIS					
<b>Personal Competence</b>					
Social Competence					
Autonomy					
Workload in Hours	Independent Study Time 11	0, Study Time in Lecture 70			
Credit points	6				
Course achievement	Compulsory Bonus Form	Descript	ion		
	No 10 % Attes	station Testate	finden semesterbegleitend stati		
Examination	Written exam				
$ \   \textbf{Examination duration and} \\$	120 min				
scale					
Assignment for the	General Engineering Scien	ce (German program, 7 ser	nester): Specialisation Mechani	cal Engineering, I	Focus Biomechanic
Following Curricula	Compulsory				
	General Engineering Science Compulsory	e (German program, 7 semeste	er): Specialisation Biomedical Eng er): Specialisation Green Technolo ester): Specialisation Mechanica	ogies, Focus Renew	vable Energy: Electi
	Compulsory		ester): Specialisation Mechanica		
	Engineering: Compulsory General Engineering Scien	nce (German program, 7 se	mester): Specialisation Mechai	nical Engineering,	Focus Materials
	Engineering Sciences: Comp General Engineering Scien		nester): Specialisation Mechan	cal Engineering,	Focus Mechatronic
	Compulsory				
	General Engineering Science Engineering: Compulsory	e (German program, 7 semest	er): Specialisation Mechanical En	gineering, Focus Tl	neoretical Mechanic
	General Engineering Science and Production: Elective Con		er): Specialisation Mechanical E	ngineering, Focus I	Product Developme
	General Engineering Science Bioprocess Engineering: Cor	· -	r): Specialisation Electrical Engir	eering: Elective Co	ompulsory
	Electrical Engineering: Core	qualification: Compulsory			
	Energy and Environmental E	Engineering: Core qualification:	Compulsory		
	General Engineering Science	e (English program, 7 semeste	:): Specialisation Process Enginee	ering: Elective Com	pulsory
	General Engineering Scien Compulsory	ce (English program, 7 sem	ester): Specialisation Energy a	nd Enviromental E	Engineering: Electi
	Green Technologies: Energy Logistics and Mobility: Core	·	n Energy Systems: Elective Comp	oulsory	
		alisation Information Technolo	gy: Compulsory		
	Mechatronics: Core qualifica		S		
	Process Engineering: Core q	• •			

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

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

## **Focus 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.

Module M0596: Advar	nced Mechanica	l Design Proj	ject				
Courses							
Title				Тур		Hrs/wk	СР
Advanced Mechanical Design Projec	et (L0266)			Project	-/problem-based Learning	4	6
Module Responsible	Dr. Jens Schmidt						
Admission Requirements	None						
Recommended Previous	- Machanical Fra	inaaring, Daalan					
Knowledge	Mechanical Eng     Advanced Mech	anical Engineering	Design				
	- Advanced Meen	amear Engineering	Design				
<b>Educational Objectives</b>	After taking part succe	essfully, students h	ave reached	the following learn	ing results		
<b>Professional Competence</b>							
Knowledge	After passing the mod	ule, students are a	ble to:				
	express the pro	cedure for systema	atically hand	lling of			
	complex design		acically mana	9 0.			
			use and com	nbination possibilitie	es,		
	<ul> <li>explain guidelin</li> </ul>	es for designing fo	r function ar	nd manufacturing,			
	<ul> <li>explain advance</li> </ul>	ed use-oriented kno	owledge of n	machine elements.			
Skills	After passing the mod	ule, students are a	ble to:				
				solutions using sket	ches,		
		e solutions into a d					
		-	-	-	natically and solution-ori		s of the system
				ements clearly and	al drawings to understand in detail	a the function	is of the system,
	• document carco	lations of selected	illacilile ele	errierits clearly and	iii detaii.		
Personal Competence							
Social Competence	After passing the mod	ule, students are a	ble to:				
	<ul> <li>present and dis</li> </ul>	cuss solutions and	technical dra	awings within group	os.		
		results in the work					
Autonomic	After persion the model	ula atualanta ava al	blo to				
Autonomy	After passing the mod	uie, students are a	ible to:				
	<ul> <li>independently s</li> </ul>	solve complex desi	ign projects,	, while motivating	themselves, acquiring n	ecessary kno	wledge and selecting
	appropriate me	thods,					
	<ul> <li>to independent</li> </ul>	y solve problems.					
Workload in Hours	Independent Study Tir	ne 124, Study Time	e in Lecture	56			
	6						
·	Compulsory Bonus	Form	De	escription			
	Yes None	Attestation					
Examination	Written exam						
Examination duration and	180						
scale							
Assignment for the	General Engineering	Science (German	program, 7	semester): Specia	alisation Mechanical Eng	ineering, Fo	cus Aircraft Systems
Following Curricula	Engineering: Compulse	•					
	3 3		rogram, 7 se	emester): Specialis	ation Mechanical Engine	ering, Focus I	Product Development
	and Production: Comp	-			Barbina Mark 1 1 =		Airent C
			program, 7	semester): Specia	lisation Mechanical Eng	ineering, Foo	cus Aircraft Systems
	Engineering: Compulse	-	rogram 7 sa	mostor). Enosialia	ation Mochanical Engine	oring Focus !	Product Dovolonmant
	and Production: Comp		ograni, / Se	mester). Specialisa	ation Mechanical Engine	anny, rocus i	Toduct Development
		-	ogram 7 ser	mester): Specialisa	tion Mechanical Enginee	rina. Focus Th	neoretical Mechanical
	Engineering: Compulse		- 3, 7 361				caca. Accidincui
	Mechanical Engineerin	-	on: Compulso	ory			

Course L0266: Advanced Med	chanical Design Project
Тур	Project-/problem-based Learning
Hrs/wk	4
СР	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 M0726: Produ	uction Technology			
Courses				
Title		Тур	Hrs/wk	СР
Fundamentals of Machine Tools (L0	0689)	Lecture	2	2
Fundamentals of Machine Tools (L1	1992)	Recitation Section (large)	1	1
Forming and Cutting Technology (L		Lecture	2	2
Forming and Cutting Technology (L		Recitation Section (large)	1	1
Module Responsible				
	without major course assessment			
Knowledge	internship recommended			
	Previous knowledge in mathematics, mechanic	cs and electrical engineering		
Educational Objectives	After taking part successfully, students have re	eached the following learning results		
Professional Competence	The taking part succession, find a re-	additional and to the wind to determine the state of the		
•	Students are able to			
	explain the basics of chip formation and			
	· ·	sign and analysis of metal forming, machining	•	
		ool building and give an overview on trends in		-
		ns of CNC-machines and give an overview on i	nuiti-machine sys	items.
	explain equipment components.			
Skills	Students are able to			
	select tool geometry, cutting materials.	, process parameters and appropriate measur	ring technique in	accordance with the
	requirements.			
	estimate occurring forces and temperat			
		chining and create NC programs for turning ar	ıd milling.	
	assess the quality of a machine tools an	id to detect weak points.		
Personal Competence				
Social Competence	Students are able to			
	develop solutions in a production enviro	nment with qualified personnel at technical lev	el and represent	decisions.
Autonomy	Students are able to			
	interpret independently cutting process	es		
	create independently NC programs.	cs.		
	select independently machine tools by r	reference to appropriate requirements.		
	assess own strengths and weaknesses i			
	assess their learning progress and defin	-		
	assess possible consequences of their a	ctions.		
Workload in Hours	Independent Study Time 96, Study Time in Lec	cture 84		
Credit points	6			
Course achievement	None			
Examination	Written exam			
Examination duration and scale	180 min			
	General Engineering Science (German program	m, 7 semester): Specialisation Mechanical End	ineering. Focus F	Product Development
-	and Production: Compulsory	,	, , ,	
	General Engineering Science (English program	n, 7 semester): Specialisation Mechanical End	ineering, Focus F	Product Development
		. ,	5,	
	and Production: Compulsory			
	and Production: Compulsory  Mechanical Engineering: Specialisation Production	t Development and Production: Compulsory		

Course L0689: Fundamentals	s of Machine Tools
Тур	Lecture
Hrs/wk	2
СР	2
	Independent Study Time 32, Study Time in Lecture 28
	Prof. Thorsten Schüppstuhl
Language Cycle	
	Terminology and trends in machine tool building
	CNC controls
	NC programming and NC programming systems
	Types, construction and function of CNC machines
	Multi-machinesystems
	Equipmentcomponents for machine tools
	Assessment of machine tools
Literature	Conrad, K.J
	Taschenbuch der Werkzeugmaschinen
	9783446406414
	Fachbuchverlag 2006
	Perović, Božina
	Spanende Werkzeugmaschinen - Ausführungsformen und Vergleichstabellen
	ISBN: 3540899529
	Berlin [u.a.]: Springer, 2009
	Weck, Manfred
	Werkzeugmaschinen 1 - Maschinenarten und Anwendungsbereiche
	ISBN: 9783540225041
	Berlin [u.a.]: Springer, 2005
	Weck, Manfred; Brecher, Christian
	Werkzeugmaschinen 4 - Automatisierung von Maschinen und Anlagen
	ISBN: 3540225072
	Berlin [u.a.]: Springer, 2006
	Weck, Manfred; Brecher, Christian
	Werkzeugmaschinen 5 - Messtechnische Untersuchung und Beurteilung, dynamische Stabilität
	ISBN: 3540225056
	Berlin [u.a.]: Springer, 2006

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

Course L0613: Forming and	Cutting Technology
Тур	Lecture
Hrs/wk	2
СР	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Prof. 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	ourse L0614: Forming and Cutting Technology	
Тур	Recitation Section (large)	
Hrs/wk	1	
СР	1	
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14	
Lecturer	Prof. Wolfgang Hintze	
Language	DE	
Cycle	WiSe	
Content	See interlocking course	
Literature	See interlocking course	

Module M0725: Produ	uction Engineering			
Courses				
Title		Тур	Hrs/wk	СР
Production Engineering I (L0608)		Lecture	2	2
Production Engineering I (L0612)		Recitation Section (large)	1	1
Production Engineering II (L0610)		Lecture	2	2
Production Engineering II (L0611)		Recitation Section (large)	1	1
Module Responsible	Prof. Wolfgang Hintze			
Admission Requirements	None			
Recommended Previous	no course assessments required			
Knowledge	internship recommended			
	internship recommended			
Educational Objectives	After taking part successfully, students have reached the	e following learning results		
Professional Competence				
Knowledge	Students are able to			
	name basic criteria for the selection of manufactu			
	name the main groups of Manufacturing Technolo			
	name the application areas of different manufacture			
	name boundaries, advantages and disadvantages			
	describe elements, geometric properties and kine	·	tools, workpiece	and process.
	explain the essential models of manufacturing tec	nnology.		
Skills	Students are able to			
	<ul> <li>select manufacturing processes in accordance wit</li> </ul>	h the requirements.		
	design manufacturing processes for simple tasks to the design manufacturing processes for the design		e component to b	e produced.
	assess components in terms of their production-or			
	·			
Personal Competence				
	Students are able to			
Social competence	Students are usie to			
	<ul> <li>develop solutions in a production environment wit</li> </ul>	h qualified personnel at technical lev	el and represent	decisions.
Autonomy	Students are able to			
	interpret independently the manufacturing process	5.		
	assess own strengths and weaknesses in general.	h a inamura ya d		
	assess their learning progress and define gaps to	be improved.		
	<ul> <li>assess possible consequences of their actions.</li> </ul>			
Workload in Hours	Independent Study Time 96, Study Time in Lecture 84			
Credit points	6			
Course achievement				
Examination				
Examination duration and				
scale	120 11111			
	General Engineering Science (German program, 7 seme	ector). Specialisation Mechanical Fra	incoring Focus D	roduct Dovolonment
Assignment for the Following Curricula		seer). Specialisation Mechanical Eng	meening, rocus P	rodact Development
rollowing curricula	General Engineering Science (German program, 7 seme	stor). Specialisation Mechanical Engir	nooring Focus Th	oorotical Mochanical
	Engineering: Elective Compulsory	ster). Specialisation Mechanical Engli	leering, rocus in	eoretical Mechanical
	Digital Mechanical Engineering: Core qualification: Comp	ulsory		
	Engineering Science: Specialisation Mechanical Engineer	•		
	General Engineering Science (English program, 7 semest		eering: Compulso	rv
	General Engineering Science (English program, 7 semestration of the Company of th	- ·		-
		ner). Specialisation Mechanical Engli	reening, rocus III	eorencai Mechanical
	Engineering: Elective Compulsory  Green Technologies: Energy, Water, Climate: Specialisate	ion Energy Technology: Flactive Com	nulsory	
	Green Technologies: Energy, Water, Climate: Specialisat Logistics and Mobility: Specialisation Production Manage		puisui y	
	Logistics and Mobility: Specialisation Production Manage Logistics and Mobility: Specialisation Engineering Science	, ,		
	Mechanical Engineering: Core qualification: Compulsory	c. Elective Compulsory		
	Mechatronics: Core qualification: Compulsory			
	Engineering and Management - Major in Logistics and Mo	obility: Specialisation Production Man	agement and Pro-	cesses: Compulsory
	and management - major in Logistics and Mc		agament and 110	ccosco. Compulsory

Course L0608: Production Er	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 Engineering I	
Тур	Recitation Section (large)
Hrs/wk	1
СР	1
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14
Lecturer	Prof. Wolfgang Hintze
Language	DE
Cycle	WiSe
Content	See interlocking course
Literature	See interlocking course

Course L0610: Production Er	ngineering II
Тур	Lecture
Hrs/wk	2
СР	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	Geometrically undefined machining (grinding, lapping, honing) Introduction into erosion technology Introduction into blastig processes Introduction to the manufacturing process forming (Casting, Powder Metallurgy, Composites) Fundamentals of Laser Technology Process versions and Fundamentals of Laser Joining Technology
Literature	Klocke, F., König, W.: Fertigungsverfahren Bd. 2 Schleifen, Honen, Läppen, 4. Aufl., Springer (2005)  Klocke, F., König, W.: Fertigungsverfahren Bd. 3 Abtragen, Generieren und Lasermaterialbearbeitung. 4. Aufl., Springer (2007)  Spur, Günter (Stöferle, Theodor.;): Urformen. München [u.a.]: Hanser, 1981  Schatt, Werner (Wieters, Klaus-Peter,; Kieback, Bernd,;): Pulvermetallurgie: Technologien und Werkstoffe. Berlin [u.a.]: Springer, 2007

Course L0611: Production Engineering II	
Тур	Recitation Section (large)
Hrs/wk	1
СР	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

Module M1009: Material Science Laboratory				
Courses				
Title		Тур	Hrs/wk	СР
Companion Lecture for Materials Science Laboratory (L1088)		Lecture	2	2
Material Science Laboratory (L1235	Practical Course 4 4			4
Module Responsible	Prof. Bodo Fiedler			
Admission Requirements	None			
Recommended Previous	none			
Knowledge				
Educational Objectives	After taking part successfully, students have reached th	e following learning results		
Professional Competence				
Knowledge	Students are able to give a summary of the technical	I details of experiments in the a	area of materials sci	ences and illustrate
	respective relationships. They are capable of describin	g and communicating relevant p	roblems and question	ns using appropriate
	technical language. They can explain the typical process	s of solving practical problems and	d present related resu	ılts.
Skille	The students can transfer their fundamental knowledge	e on material sciences to the pro	nees of solving prac	tical problems. They
Skills	identify and overcome typical problems during the realize	•		
	racinary and overcome typical problems dailing the realis	adion of experiments in the conte	Ac or material serence	
Personal Competence				
Social Competence	Students are able to cooperate in small groups in order	to conduct experiments in the cor	ntext of materials sci	ences. They are able
	to effectively present and explain their results alone or i	n groups in front of a qualified au	dience.	
Autonomy	Students are capable of solving problems in the context	of materials sciences lusing prov	vided literature. They	are able to fill gaps
,	in as well as extent their knowledge using the literature	- ·	-	are acres so sim gapes
Workload in Hours	Independent Study Time 96, Study Time in Lecture 84	· · · · · · · · · · · · · · · · · · ·	·	
Credit points				
Course achievement	None			
Examination	Subject theoretical and practical work			
Examination duration and	Test reports on the respective tests and online learning	modules with integrated success	control	
scale	, ,	3		
Assignment for the	General Engineering Science (German program, 7	semester): Specialisation Mech	anical Engineering,	Focus Materials in
Following Curricula	Engineering Sciences: Compulsory			
	General Engineering Science (German program, 7 seme	ester): Specialisation Mechanical	Engineering, Focus P	roduct Development
	and Production: Elective Compulsory			
	General Engineering Science (English program, 7 semes	ter): Specialisation Mechanical En	gineering, Focus Mat	erials in Engineering
	Sciences: Compulsory			
	Mechanical Engineering: Specialisation Product Develop	ment and Production: Compulsory		
	Mechanical Engineering: Specialisation Materials in Engi	neering Sciences: Compulsory		
	Product Development, Materials and Production: Technic	cal Complementary Course Core S	tudies: Elective Com	oulsory

Course L1088: Companion Lecture for Materials Science Laboratory		
Тур	Lecture	
Hrs/wk	2	
СР	2	
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28	
Lecturer	Prof. Bodo Fiedler	
Language	DE	
Cycle	WiSe	
Content	Physico-chemical backgrounds and fundamental experimental principles with regard to the following experiments, the topics to be	
	addressed are indicated in brackets for each experiment:	
	1. Phase diagrams, heat treatment, hardness measurements (thermodynamics, elastic properties of solids)	
	2. notch impact test (elastic properties of solids)	
	3. Processes during the solidifaction of metals (thermodynamics and kinetics of solid-liquid phase transitions)	
	4. tensile test (elastic properties of solids)	
	5. Identificiation of polymers (polymer physics)	
	6. fiber-reinforced polymers (physical principles of composite materials)	
	7. Production and microstructure of ceramic materials (physico-chemical principles of ceramics)	
	8. Mechanical properties of ceramic materials (elastic properties of solids and composite materials)	
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 L1235: Material Science Laboratory		
Тур	Practical Course	
Hrs/wk	4	
СР	4	
Workload in Hours	Independent Study Time 64, Study Time in Lecture 56	
Lecturer	Prof. Bodo Fiedler, Prof. Stefan Müller, Prof. Patrick Huber, Prof. Gerold Schneider, Prof. Jörg Weißmüller	
Language	DE	
Cycle	WiSe	
Content		
Literature	Vorlesungsunterlagen Grundlagen der Werkstoffwissenschaft I & II	

Module M0599: Integ	rated Product Development an	nd Lightweigh	t Design		
Courses					
<b>Title</b> CAE-Team Project (L0271) Development of Lightweight Design			<b>Typ</b> Project-/problem-based Learning Lecture	Hrs/wk 2 2	<b>CP</b> 2 2
Integrated Product Development I (	L0269)		Lecture	2	2
Module Responsible	Prof. Dieter Krause				
Admission Requirements	None				
	Advanced Knowledge about engineering des	sign:			
Knowledge	Fundamentals of Mechanical Engineering De	esign			
	Mechanical Engineering: Design				
	Advanced Mechanical Engineering Design				
Educational Objectives	After taking part successfully, students have	reached the following	ng learning results		
Professional Competence					
Knowledge	After completing the module, students are c	apable of:			
	<ul><li>explaining the functional principle of 3</li><li>describing the interaction of the differ</li></ul>			ss	
Skills					
Simil	After completing the module, students are a	ble to:			
	<ul> <li>evaluate different CAD- and PDM-Sy- product structuring</li> <li>design an exemplary product using CA</li> </ul>			uch as classifi	cation schemes and
	After completing the module, students are a  • To develop a project plan and allocate  • Present project results as a team for i  Students are capable of:	e work appropriate w		of group discu	ıssions
	<ul> <li>independently adapt to a CAE-Tool an</li> </ul>	nd complete a given p	practical task with it		
Workload in Hours	Independent Study Time 96, Study Time in L	ecture 84			
Credit points	6				
Course achievement		<b>Description</b> I and CAE-Teampro	ojekt inkl. Vortrag und Ausarbeit	ung	
Examination	·				
Examination duration and scale					
Assignment for the	General Engineering Science (German pro	ogram. 7 semester).	Specialisation Mechanical End	ineering Foc	us Aircraft Systems
-	Engineering: Compulsory	.g. 2, , Semester).		,	/c.a.c Jyscellis
	General Engineering Science (German progr	ram. 7 semester): Si	pecialisation Mechanical Engine	erina. Focus P	roduct Development
	and Production: Compulsory	,, .,	,	3,	
	Engineering Science: Specialisation Mechani	ical Engineering: Elec	ctive Compulsory		
	General Engineering Science (English pro	3	, ,	ineering, Foc	us Aircraft Systems
	Engineering: Compulsory	J , , , , , , , , , , , , , , , , , , ,	,	,	,
	General Engineering Science (English progr	am. 7 semester): Sp	pecialisation Mechanical Engine	erina. Focus P	roduct Development
	and Production: Compulsory			J !	
	General Engineering Science (English progra	am, 7 semester): Spe	cialisation Mechanical Engineeri	ng: Elective Co	ompulsory
					· •
	Mechanical Engineering: Specialisation Produ	uct Development and	a Production: Compulsory		
	Mechanical Engineering: Specialisation Produ Mechanical Engineering: Specialisation Aircr	•	• •		

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> Description Part of the module is a project based team orientated practical course using the PBL method. In this course, students learn the handling of modern CAD, PDM and FEM systems (Creo, Windchill and Hyperworks). After a short introduction in the applied software systems, students work in teams on a task during the semester. The aim is the development of one product out of several CAD parts models using a PDM system including FEM calculations of selected parts and 3D printing of parts. The developed product must be presented in a joint presentation.
Literature	

Course 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 Pro	oduct Development I
Тур	Lecture
Hrs/wk	2
СР	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Prof. Dieter Krause
Language	DE
Cycle	SoSe
Content	Introduction to Integrated Product Development  3D CAD -Systems and CAD interfaces  Administration of part lists / PDM systems  PDM in different industries  Selection of CAD-/PDM Systems  Simulation  Construction methods  Design for X
Literature	<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>

Module M0865: Funda	nmentals of Production and (	Quality Management		
Courses				
Title		Тур	Hrs/wk	СР
Production Process Organization (LC	0925)	Lecture	2	3
Quality Management (L0926)		Lecture	2	3
Module Responsible	Prof. Hermann Lödding			
Admission Requirements	None			
Recommended Previous	None			
Knowledge				
<b>Educational Objectives</b>	After taking part successfully, students ha	ve reached the following learning results		
Professional Competence				
Knowledge	Students are able to explain the contents	of the lecture of the module.		
Skills	Students are able to apply the methods a	nd models in the module to industrial problems	i.	
Personal Competence				
Social Competence	-			
Autonomy	-			
Workload in Hours	Independent Study Time 124, Study Time	in Lecture 56		
Credit points	6			
Course achievement	None			
Examination	Written exam			
Examination duration and	180 Minuten			
scale				
Assignment for the	General Engineering Science (German p	program, 7 semester): Specialisation Mechan	ical Engineering, Foc	us Aircraft Systems
Following Curricula	Engineering: Compulsory			
	General Engineering Science (German pro	ogram, 7 semester): Specialisation Mechanical	Engineering, Focus P	roduct Development
	and Production: Compulsory			
	Engineering Science: Core qualification: C	'		
		gram, 7 semester): Specialisation Mechanical E	-	ompulsory
		gram, 7 semester): Core qualification: Compuls	•	
	* '	uction Management and Processes: Compulsor	у	
	Logistics and Mobility: Specialisation Engin	. ,		
	Mechanical Engineering: Core qualification			
	Engineering and Management - Major in L	ogistics and Mobility: Specialisation Production	Management and Pro-	cesses: Compulsory

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

Course L0926: Quality Management		
Тур	Lecture	
Hrs/wk	2	
СР	3	
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28	
Lecturer	Prof. Hermann Lödding	
Language	EN	
Cycle	SoSe	
Content	Definition and Relevance of Quality     Continuous Quality Improvement     Quality Management in Product Development     Quality Management in Production Processes     Design of Experiments	
Literature	<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>	

Courses					
itle	rearramming Consents Data Us	andling Communication (13690)	Typ	Hrs/wk	<b>CP</b> 3
omputer Science for Engineers - P computer Science for Engineers - P			Lecture  Recitation Section (small)	3 2	3
		mamig a communication (E2000)	necitation section (small)	-	
Module Responsible					
Admission Requirements	None				
Recommended Previous Knowledge					
	After telding part guessefull		allawing languing gasulta		
	Arter taking part succession	y, students have reached the f	ollowing learning results		
Professional Competence					
Knowledge Skills					
SKIIIS					
<b>Personal Competence</b>					
Social Competence					
Autonomy					
Workload in Hours	Independent Study Time 11	0, Study Time in Lecture 70			
Credit points	6				
Course achievement	Compulsory Bonus Form	Descript	ion		
	No 10 % Attes	station Testate	finden semesterbegleitend stati		
Examination	Written exam				
$ \   \textbf{Examination duration and} \\$	120 min				
scale					
Assignment for the	General Engineering Scien	ce (German program, 7 ser	nester): Specialisation Mechani	cal Engineering, I	Focus Biomechanic
Following Curricula	Compulsory				
	General Engineering Science Compulsory	e (German program, 7 semeste	er): Specialisation Biomedical Eng er): Specialisation Green Technolo ester): Specialisation Mechanica	ogies, Focus Renew	vable Energy: Electi
	Compulsory		ester): Specialisation Mechanica		
	Engineering: Compulsory General Engineering Scien	nce (German program, 7 se	mester): Specialisation Mechai	nical Engineering,	Focus Materials
	Engineering Sciences: Comp General Engineering Scien		nester): Specialisation Mechan	cal Engineering,	Focus Mechatronic
	Compulsory				
	General Engineering Science Engineering: Compulsory	e (German program, 7 semest	er): Specialisation Mechanical En	gineering, Focus Tl	neoretical Mechanic
	General Engineering Science and Production: Elective Con		er): Specialisation Mechanical E	ngineering, Focus I	Product Developme
	General Engineering Science Bioprocess Engineering: Cor	· -	r): Specialisation Electrical Engir	eering: Elective Co	ompulsory
	Electrical Engineering: Core	qualification: Compulsory			
	Energy and Environmental E	Engineering: Core qualification:	Compulsory		
	General Engineering Science	e (English program, 7 semeste	:): Specialisation Process Enginee	ering: Elective Com	pulsory
	General Engineering Scien Compulsory	ce (English program, 7 sem	ester): Specialisation Energy a	nd Enviromental E	Engineering: Electi
	Green Technologies: Energy Logistics and Mobility: Core	·	n Energy Systems: Elective Comp	oulsory	
		alisation Information Technolo	gy: Compulsory		
	Mechatronics: Core qualifica		S		
	Process Engineering: Core q	• •			

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

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

## **Focus 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	
Courses	
Title	Typ Hrs/wk CP
Numerical Mathematics I (L0417) Numerical Mathematics I (L0418)	Lecture 2 3 Recitation Section (small) 2 3
	Prof. Sabine Le Borne
Admission Requirements	
Recommended Previous	<ul> <li>Mathematik I + II for Engineering Students (german or english) or Analysis &amp; Linear Algebra I + II for Technomathematic</li> </ul>
Knowledge	basic MATLAB/Python knowledge
Educational Objectives	
Professional Competence	
Knowledge	Students are able to
	name numerical methods for interpolation, integration, least squares problems, eigenvalue problems, nonlinear root find
	problems and to explain their core ideas,
	repeat convergence statements for the numerical methods,
	<ul> <li>explain aspects for the practical execution of numerical methods with respect to computational and storage complexitx.</li> </ul>
	Companies of the process of the proc
CI-III-	Charles and the to
SKIIIS	5 Students are able to
	implement, apply and compare numerical methods using MATLAB/Python,
	justify the convergence behaviour of numerical methods with respect to the problem and solution algorithm,
	<ul> <li>select and execute a suitable solution approach for a given problem.</li> </ul>
	,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,
Personal Competence	4
Social Competence	s Students are able to
	work together in heterogeneously composed teams (i.e., teams from different study programs and background knowled)
	explain theoretical foundations and support each other with practical aspects regarding the implementation of algorithm
Autonomy	/ Students are capable
Autonomy	Security are copuse
	to assess whether the supporting theoretical and practical excercises are better solved individually or in a team,
	to assess their individual progess and, if necessary, to ask questions and seek help.
Workload in Hours	
Credit points	i 6
Course achievement	None
Examination	Written exam
Examination duration and	90 minutes
scale	
Assignment for the	
Following Curricula	General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Materials
	Engineering Sciences: Compulsory
	General Engineering Science (German program, 7 semester): Specialisation Biomedical Engineering: Compulsory
	General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Biomechan
	Compulsory
	General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Theoretical Mechan
	Engineering: Compulsory
	Engineering. Compulsory
	General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Aircraft Syste
	General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Aircraft Syste
	General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Aircraft Syste Engineering: Elective Compulsory
	General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Aircraft Syste Engineering: Elective Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Mechatronics: Elec
	General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Aircraft Syste Engineering: Elective Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Mechatronics: Elec Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Energy Syste
	General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Aircraft Syste Engineering: Elective Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Mechatronics: Electompulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Energy Syste Elective Compulsory
	General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Aircraft Syste Engineering: Elective Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Mechatronics: Elec Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Energy Syste
	General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Aircraft Syste Engineering: Elective Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Mechatronics: Electompulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Energy Syste Elective Compulsory Bioprocess Engineering: Specialisation A - General Bioprocess Engineering: Elective Compulsory Computer Science: Specialisation Computational Mathematics: Elective Compulsory
	General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Aircraft Syste Engineering: Elective Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Mechatronics: Electompulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Energy Syste Elective Compulsory Bioprocess Engineering: Specialisation A - General Bioprocess Engineering: Elective Compulsory Computer Science: Specialisation Computational Mathematics: Elective Compulsory Computer Science: Specialisation II. Mathematics and Engineering Science: Elective Compulsory
	General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Aircraft Syste Engineering: Elective Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Mechatronics: Electompulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Energy Syste Elective Compulsory Bioprocess Engineering: Specialisation A - General Bioprocess Engineering: Elective Compulsory Computer Science: Specialisation Computational Mathematics: Elective Compulsory Computer Science: Specialisation II. Mathematics and Engineering Science: Elective Compulsory Data Science: Core qualification: Compulsory
	General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Aircraft Syste Engineering: Elective Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Mechatronics: Electompulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Energy Syste Elective Compulsory Bioprocess Engineering: Specialisation A - General Bioprocess Engineering: Elective Compulsory Computer Science: Specialisation Computational Mathematics: Elective Compulsory Computer Science: Specialisation II. Mathematics and Engineering Science: Elective Compulsory Data Science: Core qualification: Compulsory Electrical Engineering: Core qualification: Elective Compulsory
	General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Aircraft Syste Engineering: Elective Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Mechatronics: Electompulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Energy Syste Elective Compulsory Bioprocess Engineering: Specialisation A - General Bioprocess Engineering: Elective Compulsory Computer Science: Specialisation Computational Mathematics: 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
	General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Aircraft Syste Engineering: Elective Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Mechatronics: Electompulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Energy Syste Elective Compulsory Bioprocess Engineering: Specialisation A - General Bioprocess Engineering: Elective Compulsory Computer Science: Specialisation Computational Mathematics: 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
	General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Aircraft Syste Engineering: Elective Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Mechatronics: Electompulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Energy Syste Elective Compulsory Bioprocess Engineering: Specialisation A - General Bioprocess Engineering: Elective Compulsory Computer Science: Specialisation Computational Mathematics: 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 General Engineering Science (English program, 7 semester): Core qualification: Compulsory
	General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Aircraft Syste Engineering: Elective Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Mechatronics: Electompulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Energy Syste Elective Compulsory Bioprocess Engineering: Specialisation A - General Bioprocess Engineering: Elective Compulsory Computer Science: Specialisation Computational Mathematics: 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 General Engineering Science (English program, 7 semester): Core qualification: Compulsory General Engineering Science (English program, 7 semester): Specialisation Computer Science: Compulsory
	General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Aircraft Syste Engineering: Elective Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Mechatronics: Electompulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Energy Syste Elective Compulsory Bioprocess Engineering: Specialisation A - General Bioprocess Engineering: Elective Compulsory Computer Science: Specialisation Computational Mathematics: 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 General Engineering Science (English program, 7 semester): Core qualification: 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 Theoretical Mechanical Engineering: Compulsory

General Engineering Science (English program, 7 semester): Specialisation Biomedical Engineering: Compulsory

General Engineering Science (English program, 7 semester): Specialisation Mechanical Engineering, Focus Mechatronics: Elective Compulsory

Computational Science and Engineering: Core qualification: Compulsory

Mechanical Engineering: Specialisation Theoretical Mechanical Engineering: Compulsory

Mechanical Engineering: Specialisation Energy Systems: Elective Compulsory

Mechanical Engineering: Specialisation Mechatronics: Elective Compulsory

Theoretical Mechanical Engineering: Technical Complementary Course Core Studies: Elective Compulsory

Process Engineering: Specialisation Process Engineering: Elective Compulsory

Course L0417: Numerical Mathematics I		
Тур	Lecture	
Hrs/wk	2	
СР	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 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

Module M0684: Heat	Transfer			
Courses				
<b>Title</b> Heat Transfer (L0458) Heat Transfer (L0459)		<b>Typ</b> Lecture Recitation Section (large)	<b>Hrs/wk</b> 3 2	<b>CP</b> 4 2
Module Responsible	Dr. Andreas Moschallski			
Admission Requirements	None			
Recommended Previous Knowledge	Technical Thermodynamics I, II and Fluid Dynamics			
<b>Educational Objectives</b>	After taking part successfully, students have reached the following	owing learning results		
Professional Competence				
Knowledge	The students are able to			
	- describe the different physical mechanism of Heat Transfer,	,		
	- explain the technical terms,			
	- to analyse comlex heat transfer processes in a critical way.			
Skills	The students are able to			
	- understand the physics of Heat Transfer,			
	- calculate and evaluate complex Heat Transfer processes,			
	- solve excersises self-consistent and in small groups.			
Personal Competence				
Social Competence	The students are able to discuss in small groups and develop	an approach.		
Autonomy	The students are able to develop a complex problem self-cor	nsistent and analyse the results i	n a critical way. A	qualified exchange
	with other students is given.			
Workload in Hours	Independent Study Time 110, Study Time in Lecture 70			
Credit points	6			
Course achievement	None			
Examination	Written exam			
Examination duration and	120 min			
scale				
Assignment for the		er): Specialisation Mechanical I	Engineering, Focu	is Energy Systems:
Following Curricula	1	6		
	General Engineering Science (German program, 7 semester): General Engineering Science (German program, 7 semester)			-
	Engineering: Compulsory	. Specialisation Mechanical Engli	icering, rocus rin	soretical Mechanical
	Energy Systems: Technical Complementary Course Core Stud	dies: Elective Compulsory		
	General Engineering Science (English program, 7 semeste	, ,	Engineering, Focu	ıs Energy Systems:
	Compulsory			
	General Engineering Science (English program, 7 semester):		ering: Compulsor	у
	Mechanical Engineering: Specialisation Energy Systems: Com			
	Mechanical Engineering: Specialisation Theoretical Mechanical	al Engineering: Elective Compuls	ory	

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	
Тур	Recitation Section (large)
Hrs/wk	2
СР	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	uction Engineering			
Courses				
Title		Тур	Hrs/wk	СР
Production Engineering I (L0608)		Lecture	2	2
Production Engineering I (L0612)		Recitation Section (large)	1	1
Production Engineering II (L0610) Production Engineering II (L0611)		Lecture Recitation Section (large)	2 1	2
Module Responsible	Prof. Wolfgang Hintze			
Admission Requirements				
Recommended Previous	no course assessments required			
Knowledge	internship recommended			
	·			
Educational Objectives	After taking part successfully, students have reached th	e following learning results		
Professional Competence				
Knowledge	Students are able to			
	name basic criteria for the selection of manufactu	uring processes.		
	name the main groups of Manufacturing Technology	pgy.		
	<ul> <li>name the application areas of different manufact</li> </ul>	<del>-</del> '		
	name boundaries, advantages and disadvantages			
	describe elements, geometric properties and kine     explain the essential models of manufacturing terms.		toois, workpiece	and process.
	explain the essential models of manufacturing te	ermology.		
Skills	Students are able to			
	coloct manufacturing processes in accordance with	th the requirements		
	<ul> <li>select manufacturing processes in accordance wi</li> <li>design manufacturing processes for simple tasks</li> </ul>		e component to b	e produced
	assess components in terms of their production-or		e component to b	e produced.
Personal Competence				
Social Competence	Students are able to			
	develop solutions in a production environment wi	th qualified personnel at technical lev	el and represent	decisions.
Autonomy	Students are able to			
	interpret independently the manufacturing proce	SS.		
	assess own strengths and weaknesses in general			
	assess their learning progress and define gaps to	be improved.		
	assess possible consequences of their actions.			
Washing die Harres	Index and set Charle Time OC Charle Time in Leature OA			
Workload in Hours	Independent Study Time 96, Study Time in Lecture 84			
Credit points	6			
Course achievement	None			
Examination				
Examination duration and				
scale Assignment for the		octor). Specialization Mechanical Eng	incoring Facus B	radust Davalanment
Following Curricula		ester): Specialisation Mechanical Eng	ineering, Focus P	roduct Development
	General Engineering Science (German program, 7 seme	ester): Specialisation Mechanical Engir	neering, Focus Th	eoretical Mechanical
	Engineering: Elective Compulsory		J.	
	Digital Mechanical Engineering: Core qualification: Com	oulsory		
	Engineering Science: Specialisation Mechanical Enginee	ring: Compulsory		
	General Engineering Science (English program, 7 semes	- ·		-
	General Engineering Science (English program, 7 seme	ster): Specialisation Mechanical Engir	neering, Focus Th	eoretical Mechanical
	Engineering: Elective Compulsory  Green Technologies: Energy, Water, Climate: Specialisa	tion Energy Technology: Floative Com	nulcon	
	Green Technologies: Energy, Water, Climate: Specialisat Logistics and Mobility: Specialisation Production Manage		pui50i y	
	Logistics and Mobility: Specialisation Froduction Manage Logistics and Mobility: Specialisation Engineering Science			
	Mechanical Engineering: Core qualification: Compulsory			
	Mechatronics: Core qualification: Compulsory			
	Engineering and Management - Major in Logistics and M	obility: Specialisation Production Man	agement and Pro	cesses: Compulsory

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 Engineering I	
Тур	Recitation Section (large)
Hrs/wk	1
СР	1
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14
Lecturer	Prof. Wolfgang Hintze
Language	DE
Cycle	WiSe
Content	See interlocking course
Literature	See interlocking course

Course L0610: Production Er	igineering II
Тур	Lecture
Hrs/wk	2
СР	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	Geometrically undefined machining (grinding, lapping, honing) Introduction into erosion technology Introduction into blastig processes Introduction to the manufacturing process forming (Casting, Powder Metallurgy, Composites) Fundamentals of Laser Technology Process versions and Fundamentals of Laser Joining Technology  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 Engineering II	
Тур	Recitation Section (large)
Hrs/wk	1
СР	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

Module M0610: Electi	rical Machines and Actuators			
Courses				
<b>Title</b> Electrical Machines and Actuators ( Electrical Machines and Actuators (		Typ Lecture Recitation Section (large)	Hrs/wk 3 2	<b>CP</b> 4 2
Module Responsible	· · · · · · · · · · · · · · · · · · ·	recitation because (large)		
Admission Requirements				
Recommended Previous		ntegrals differentials		
Knowledge	busies of mathematics, in particular complexe numbers, in	ntegrals, amerentials		
	Basics of electrical engineering and mechanical engineering	ng		
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 e	lectric and magnetic fields.		
er 111	They can describe the function of the standard types characteristic curves. For typically used drives they can express the power grid to the driven engine.	xplain the major parameters of the	energy efficiency	of the whole system
Skills	Students are able to calculate two-dimensional electric a this they apply the usual methods of the design auf electr		rromagnetic circ	uits with air gap. Fo
	They can calulate the operational performance of electric machines from their given characteristic data and selected quantities and characteristic curves. They apply the usual equivalent circuits and graphical methods.			
Personal Competence Social Competence Autonomy				
Workload in Hours	Independent Study Time 110 Study Time in Lecture 70			
Workload in Hours	, ,			
Credit points  Course achievement				
Examination				
Examination duration and		llee		
scale	Design of four machines and actuators, review of design fi	iies		
Assignment for the	General Engineering Science (German program, 7 semesti	or). Specialisation Flootrical Engine	oring: Elective Co	mnulcon/
Following Curricula				
. ccg carricala	Compulsory	rester, specialisation recitamea.		as Energy Systems
	General Engineering Science (German program, 7 se	mester): Specialisation Mechanica	al Engineering,	Focus Mechatronics
	Compulsory			
	General Engineering Science (German program, 7 semest	er): Specialisation Mechanical Engi	neering, Focus Th	neoretical Mechanica
	Engineering: Elective Compulsory			
	General Engineering Science (German program, 7 semeste		omental Enginee	ring: Compulsory
	Digital Mechanical Engineering: Core qualification: Compu	•		
	Electrical Engineering: Core qualification: Elective Compul	•		
	Energy and Environmental Engineering: Core qualification General Engineering Science (English program, 7 semeste		pering: Flective C	ompulsory
	Green Technologies: Energy, Water, Climate: Specialisatio			ompuisory
	Logistics and Mobility: Specialisation Engineering Science:		,	
	Logistics and Mobility: Specialisation Traffic Planning and			
	Logistics and Mobility: Specialisation Production Managem		lsory	
	Mechanical Engineering: Core qualification: Elective Comp	pulsory		
	Mechatronics: Core qualification: Compulsory			
	Technomathematics: Specialisation III. Engineering Science	e: Elective Compulsory		
	Engineering and Management - Major in Logistics and Mot Engineering and Management - Major in Logistics and M Compulsory		-	

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

Module M1573: Modeling, Simulation and Optimization (EN)				
Courses				
Title		Тур	Hrs/wk	CP
Modeling, Simulation and Optimizat	tion (L2446)	Integrated Lecture	4	6
Module Responsible	Prof. Benedikt Kriegesmann			
Admission Requirements	None			
Recommended Previous	Sound knowledge of engineering mathematics, engineeri	ng mechanics and fluid mechanic	s	
Knowledge				
<b>Educational Objectives</b>	After taking part successfully, students have reached the	following learning results		
Professional Competence				
Knowledge	Students will have an overview of various technical prol	blems and the differential equat	ions, which describe	them. Students will
	gave an overview of different solution approaches and for	r which kind of problems they ca	n be used for.	
Skille	Students are able to solve different technical problems w	ith the introduced discretization i	mathads	
SKIIIS	Students are able to solve different technical problems w	itii tile liiti oddced discretization i	nethous.	
Personal Competence				
Social Competence	The students are able to discuss problems and jointly dev	elop solution strategies.		
Autonomou	The students are able to develop solution strategies for c	annular anablama salf sanaistant	and oritically analyses	. waa u lka
Autonomy	The students are able to develop solution strategies for c	omplex problems self-consistent	and critically alialyse	resuits.
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 program, 7 semes	ter): Specialisation Mechanical E	ngineering, Focus Th	eoretical Mechanical
Following Curricula	Engineering: Compulsory			
	Engineering Science: Core qualification: Compulsory			
	General Engineering Science (English program, 7 semeste	er): Core qualification: Compulso	У	
	General Engineering Science (English program, 7 semest	ter): Specialisation Mechanical E	ngineering, Focus Th	eoretical Mechanical
	Engineering: Elective Compulsory			
	Mechanical Engineering: Specialisation Theoretical Mecha		oulsory	
	Mechanical Engineering: Specialisation Theoretical Mecha			
	Technomathematics: Specialisation III. Engineering Science	ce: Elective Compulsory		

Course L2446: Modeling, Simulation and Optimization		
Тур	Integrated Lecture	
Hrs/wk	4	
СР	6	
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56	
Lecturer	Prof. Benedikt Kriegesmann, Prof. Thomas Rung, Prof. Alexander Düster, Prof. Robert Seifried	
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.	

Module M0854: Math	ematics IV			
Courses				
Title		Тур	Hrs/wk	СР
Differential Equations 2 (Partial Dif Differential Equations 2 (Partial Dif		Lecture Recitation Section (small)	2 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)	T	Recitation Section (large)	1	1
Module Responsible				
Admission Requirements  Recommended Previous				
Knowledge	Mathematics 1 - III			
Educational Objectives	After taking part successfully, students have reached the	ne following learning results		
Professional Competence	3,000			
Knowledge				
	Students can name the basic concepts in Mather			-
	Students can discuss logical connections between the help of everyles.	en these concepts. They are capa	ible of illustrating the	ese connections with
	<ul><li>the help of examples.</li><li>They know proof strategies and can reproduce the</li></ul>	nem		
	They know proof strategies and can reproduce the	iem.		
Skills				
	Students can model problems in Mathematics I'		tudied in this course	. Moreover, they are
	capable of solving them by applying established		nanta studied in the	
	<ul> <li>Students are able to discover and verify further I</li> <li>For a given problem, the students can develop</li> </ul>			
	results.	and execute a suitable approac	ii, aliu ale able to ci	itically evaluate the
	. course.			
Personal Competence				
Social Competence				
	Students are able to work together in teams. The			-
	<ul> <li>In doing so, they can communicate new concept design examples to check and deepen the under</li> </ul>		Looperating partners.	. Moreover, they can
	design examples to check and deepen the under	standing of their peers.		
Autonomy				
	Students are capable of checking their understa	, ,	eir own. They can sp	ecify open questions
	precisely and know where to get help in solving them.  Students have developed sufficient persistence to be able to work for longer periods in a goal-oriented manner on hard			
	problems.	to be able to work for longer pe	rious iii a goai-orieiii	ted manner on nard
	F. 55.5			
Workload in Hours	Independent Study Time 68, Study Time in Lecture 112			
Credit points	6			
Course achievement	None			
Examination	Written exam			
Examination duration and	60 min (Complex Functions) + 60 min (Differential Equa	ations 2)		
scale				
Assignment for the		-		
Following Curricula	General Engineering Science (German program, 7 Compulsory	semester): Specialisation Mecha	ıncar Engineering, F	ocus Mechatronics:
	General Engineering Science (German program, 7 seme	ester): Specialisation Naval Archite	cture: Compulsory	
	General Engineering Science (German program, 7 sem	•		eoretical Mechanical
	Engineering: Elective Compulsory	•	3	
	Computer Science: Specialisation Computational Mathematics: Elective Compulsory			
	Electrical Engineering: Core qualification: Compulsory			
	General Engineering Science (English program, 7 seme	- ·		
	General Engineering Science (English program, 7	semester): Specialisation Mecha	nical Engineering, F	ocus Mechatronics:
	Compulsory			corotical Machanis
	General Engineering Science (English program, 7 semester): Specialisation Mechanical Engineering, Focus Theoretical Mechanic			eoretical Mechanical
	Engineering: Compulsory  Computational Science and Engineering: Specialisation II. Mathematics & Engineering Science: Flective Compulsory		Isory	
	Computational Science and Engineering: Specialisation II. Mathematics & Engineering Science: Elective Compulsory  Mechanical Engineering: Specialisation Mechatronics: Compulsory			
	Mechanical Engineering: Specialisation Theoretical Mec		pulsory	
	Mechatronics: Core qualification: Compulsory	<u> </u>	. <del>.</del>	
	Naval Architecture: Core qualification: Compulsory			
	Theoretical Mechanical Engineering: Technical Compler	mentary Course Core Studies: Elect	tive Compulsory	

Course L1043: Differential Equations 2 (Partial Differential Equations)	
Тур	Lecture
Hrs/wk	2
СР	1
Workload in Hours	Independent Study Time 2, Study Time in Lecture 28
Lecturer	Dozenten des Fachbereiches Mathematik der UHH
Language	DE
Cycle	SoSe
Content	Main features of the theory and numerical treatment of partial differential equations
Literature	<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> </ul>
Literature	http://www.math.uni-hamburg.de/teaching/export/tuhh/index.html

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

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

Course L1038: Complex Functions	
Тур	Lecture
Hrs/wk	2
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 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> <li>http://www.math.uni-hamburg.de/teaching/export/tuhh/index.html</li> </ul>

Course L1041: Complex Functions	
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 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					
itle	rearramming Consents Data Us	andling Communication (13690)	Typ	Hrs/wk	<b>CP</b> 3
omputer Science for Engineers - P computer Science for Engineers - P			Lecture  Recitation Section (small)	3 2	3
		mamig a communication (E2000)	necitation section (small)	-	
Module Responsible					
Admission Requirements	None				
Recommended Previous Knowledge					
	After telding part guessefull		allawing languing gasulta		
	Arter taking part succession	y, students have reached the f	ollowing learning results		
Professional Competence					
Knowledge Skills					
SKIIIS					
<b>Personal Competence</b>					
Social Competence					
Autonomy					
Workload in Hours	Independent Study Time 11	0, Study Time in Lecture 70			
Credit points	6				
Course achievement	Compulsory Bonus Form	Descript	ion		
	No 10 % Attes	station Testate	finden semesterbegleitend stati		
Examination	Written exam				
$ \   \textbf{Examination duration and} \\$	120 min				
scale					
Assignment for the	General Engineering Scien	ce (German program, 7 ser	nester): Specialisation Mechani	cal Engineering, I	Focus Biomechanic
Following Curricula	Compulsory				
	General Engineering Science (German program, 7 semester): Specialisation Biomedical Engineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Green Technologies, Focus Renewable Energy: Electivic Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Energy Systems				
	Compulsory  General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Aircraft Systems  General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Aircraft Systems				
	Engineering: Compulsory  General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Materials in				
	Engineering Sciences: Comp General Engineering Scien		nester): Specialisation Mechan	cal Engineering,	Focus Mechatronic
	Compulsory				
	General Engineering Science Engineering: Compulsory	e (German program, 7 semest	er): Specialisation Mechanical En	gineering, Focus Tl	neoretical Mechanic
	General Engineering Science and Production: Elective Con		er): Specialisation Mechanical E	ngineering, Focus I	Product Developme
	General Engineering Science Bioprocess Engineering: Cor	· -	r): Specialisation Electrical Engir	eering: Elective Co	ompulsory
	Electrical Engineering: Core	qualification: Compulsory			
	Energy and Environmental E	Engineering: Core qualification:	Compulsory		
	General Engineering Science	e (English program, 7 semeste	:): Specialisation Process Enginee	ering: Elective Com	pulsory
	General Engineering Scien Compulsory	ce (English program, 7 sem	ester): Specialisation Energy a	nd Enviromental E	Engineering: Electi
	Green Technologies: Energy Logistics and Mobility: Core	·	n Energy Systems: Elective Comp	oulsory	
		alisation Information Technolo	gy: Compulsory		
	Mechatronics: Core qualifica		S		
	Process Engineering: Core q	• •			

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

Course L2690: Computer Science for Engineers - Programming Concepts, Data Handling & Communication	
Тур	Recitation Section (small)
Hrs/wk	2
СР	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

## **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.

Module M0933: Funda	amentals of Materials Science			
Courses				
<b>Title</b> Fundamentals of Materials Science Fundamentals of Materials Science Physical and Chemical Basics of Ma	II (Advanced Ceramic Materials, Polymers and Composites) (L0506)	Typ Lecture Lecture Lecture	Hrs/wk 2 2 2	<b>CP</b> 2 2 2
Module Responsible		Eccture		2
Admission Requirements				
	Highschool-level physics, chemistry und mathematics			
Knowledge	This is the state of the state			
Educational Objectives	After taking part successfully, students have reached the follow	ving learning results		
<b>Professional Competence</b>				
Knowledge	The students have acquired a fundamental knowledge on comprehensively. Fundamental knowledge here means specific phase transformations, corrosion and mechanical properties. T for materials and can identify relevant approaches for chaphenomena back to the underlying physical and chemical laws	cally the issues of ator he students know abo aracterizing specific p	mic structure, microstructu ut the key aspects of char	ure, phase diagrams, acterization methods
Skills	The students are able to trace materials phenomena back to the underlying physical and chemical laws of nature. Materials phenomena here refers to mechanical properties such as strength, ductility, and stiffness, chemical properties such as corrosion 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				
Examination	Written exam			
Examination duration and	180 min			
scale				
Assignment for the	General Engineering Science (German program, 7 semester): S	pecialisation Mechani	cal Engineering: Compulso	ory
Following Curricula	General Engineering Science (German program, 7 semester): S	pecialisation Biomedi	cal Engineering: Compulso	ory
	General Engineering Science (German program, 7 semester): S	pecialisation Naval Ar	chitecture: Compulsory	
	General Engineering Science (German program, 7 semester): S	pecialisation Energy a	and Enviromental Engineer	ring: Compulsory
	Data Science: Specialisation Materials Science: Compulsory			
	Digital Mechanical Engineering: Core qualification: Compulsory			
	Energy and Environmental Engineering: Core qualification: Con	. ,	tive Committee	
	Green Technologies: Energy, Water, Climate: Specialisation En		uve Compuisory	
	Logistics and Mobility: Specialisation Engineering Science: Elec Logistics and Mobility: Specialisation Production Management a		o Compulson;	
	Mechanical Engineering: Core qualification: Compulsory	ma riocesses. Electivi	e compuisory	
	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	. ,	duction Management and	Processes: Elective
	Compulsory	-	-	

Course L1085: Fundamentals	s of Materials Science I
Тур	Lecture
Hrs/wk	2
СР	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Prof. Jörg Weißmüller
Language	DE
Cycle	WiSe
Content	
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

•	Chemical Basics of Materials Science
Тур	Lecture
Hrs/wk	
СР	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Prof. Stefan 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	Für den Elektromagnetismus:  • Bergmann-Schäfer: "Lehrbuch der Experimentalphysik", Band 2: "Elektromagnetismus", de Gruyter  Für die Atomphysik:  • Haken, Wolf: "Atom- und Quantenphysik", Springer  Für die Materialphysik und Elastizität:  • Hornbogen, Warlimont: "Metallkunde", Springer

Module M0598: Mech	anical I	Enginee	ring: Design				
Courses							
Title				Тур		Hrs/wk	СР
Embodiment Design and 3D-CAD (L	L0268)			Lecture		2	1
Mechanical Design Project I (L0695	i)			Project-/problem-based	Learning	3	2
Mechanical Design Project II (L0592	2)			Project-/problem-based	l Learning	3	2
Team Project Design Methodology	(L0267)			Project-/problem-based	l Learning	2	1
Module Responsible	Prof. Diet	er Krause					
Admission Requirements							
Recommended Previous							
Knowledge	• Fur	ndamentals	of Mechanical Engineerin	g Design			
	• Me	echanics					
			of Materials Science				
	• Pro	oduction En	gineering				
Educational Objectives	After taki	ing part suc	cessfully, students have re	eached the following learning results			
Professional Competence		ng part sac	eessiany, stadents nave it	defice the following learning results			
-		sing the me	dula students are able to				
Knowleage	Arter pass	sing the mo	dule, students are able to				
	• ex	plain desigr	guidelines for machinery	parts e.g. considering load situation, ma	aterials an	d manufactur	ing requirements,
	• des	scribe basic	s of 3D CAD,				
	• ex	plain basics	methods of engineering of	lesigning.			
Skills	After pass	sing the mo	dule, students are able to	:			
	• ind	dependently	create sketches, technica	ıl drawings and documentations e.g. usiı	na 3D CAD	).	
			nents based on design gu			,	
			Iculate) used components				
				, ering design tasks systamtically and sol	lution-orie	nted	
			ty techniques in teams.	tering design tasks systamateany and son	ution-one	niccu,	
	app	pry Creativii	ly techniques in teams.				
<b>Personal Competence</b>							
Social Competence	After pass	sing the mo	dule, students are able to	:			
				s including making and documenting de	cisions,		
	moderate the use of scientific methods,						
	present and discuss solutions and technical drawings within groups,						
	• ref	lect the ow	n results in the work group	os of the course.			
Autonomy	Students	are able					
ratemony	Students	are abic					
	• to	estimate th	neir level of knowledge us	ng activating methods within the lectur	es (e.g. wi	ith clickers),	
	• To	solve engir	neering design tasks syste	matically.			
Workload in Hours	Independ	lent Study T	ime 10 Study Time in Lea	ture 140			
Credit points		ent study i	ime 40, Study Time in Lec	ture 140			
•	1	y Bonus	Form	Description			
Course achievement	Yes	None	Written elaboration	Teamprojekt Konstruktionsmethodi	k		
	Yes	None	Written elaboration	Konstruktionsprojekt 1			
	Yes	None	Written elaboration	Konstruktionsprojekt 2			
	Yes	None	Written elaboration	3D-CAD-Praktikum			
Examination	1						
		Adili					
Examination duration and							
scale	1		C-i (C	7	l En el	d== C :	
Assignment for the		-		n, 7 semester): Specialisation Mechanica	-		-
Following Curricula				n, 7 semester): Specialisation Biomedica			
		-		n, 7 semester): Specialisation Biomedica	-		-
				n, 7 semester): Specialisation Energy and	a Envirom	ental Enginee	ring: Compulsory
			ngineering: Core qualificat	, ,			
			nental Engineering: Core o				
	Engineeri	-	: Core qualification: Comp	•			
		Inginogring	Science (English program	, 7 semester): Specialisation Biomedical	Engineeri	ng: Compulso	ry
				pecialisation Energy Technology: Electiv	e Compul	sory	
	Green Te	chnologies:			e Compul	sory	
	Green Teo	chnologies:	Energy, Water, Climate: S		e Compul	sory	

Course L0268: Embodiment I	Design and 3D-CAD
Тур	Lecture
Hrs/wk	2
СР	1
Workload in Hours	Independent Study Time 2, Study Time in Lecture 28
Lecturer	Prof. Dieter Krause
Language	DE
Cycle	WiSe
Content	Basics of 3D CAD technology  Practical course to apply a 3D CAD system  Introduction to the system  Sketching and creation of components  Creation of assemblies  Deriving technical drawings
Literature	<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 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	Create a technical documentation of an existing mechanical model Consolidation of the following aspects of technical drawings: Presentation of technical objects and standardized parts (bearings, seals, shaft-hub joints, detachable connections, springs, axes and shafts) Sectional views Dimensioning Tolerances and surface specifications Creating a tally sheet
Literature	<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 De	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	Dubbel, Taschenbuch für Maschinenbau, Beitz, W., Küttner, KH, Springer-Verlag.  Maschinenelemente, Band I - III, Niemann, G., Springer-Verlag.  Maschinen- und Konstruktionselemente, Steinhilper, W., Röper, R., Springer-Verlag.  Einführung in die DIN-Normen, Klein, M., Teubner-Verlag.  Konstruktionslehre, Pahl, G., Beitz, W., Springer-Verlag.

Course L0267: Team Project	Design Methodology
Тур	Project-/problem-based Learning
Hrs/wk	2
СР	1
Workload in Hours	Independent Study Time 2, Study Time in Lecture 28
Lecturer	Prof. Dieter Krause
Language	DE
Cycle	SoSe
Content	Introduction to engineering designing methodology  Team Project Design Methodology  Creating requirement lists  Problem formulation  Creating functional structures  Finding solutions  Evaluation of the found concepts  Documentation of the taken methodological steps and the concepts using presentation slides
	<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 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 M0680: Fluid	Dynamics			
Courses				
Title		Тур	Hrs/wk	СР
Fluid Mechanics (L0454)		Lecture	3	4
Fluid Mechanics (L0455)		Recitation Section (large)	2	2
Module Responsible	Prof. Thomas Rung			
Admission Requirements	None			
Recommended Previous	Sound knowledge of engineering mathematics, engineer	ring mechanics and thermodynamics.		
Knowledge				
<b>Educational Objectives</b>	After taking part successfully, students have reached th	ne following learning results		
<b>Professional Competence</b>				
Knowledge	Students will have the required sound knowledge to	explain the general principles of flui	d engineering a	nd physics of fluids.
	Students can scientifically outline the rationale of flow	physics using mathematical models a	nd are familiar v	vith methods for the
	performance analysis and the prediciton of fluid engine	ering devices.		
Chille	Charles and able to each fluid and in a single state.	and flavoring and date for the consti		
SKIIIS	Students are able to apply fluid-engineering principles enables the student to carry out all necessary theore			-
	scientific level.	ical calculations for the huld dynamic	. design of engli	leering devices on a
	scientific level.			
<b>Personal Competence</b>				
Social Competence	The students are able to discuss problems and jointly d	evelop 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	180 min			
scale				
Assignment for the	General Engineering Science (German program, 7 seme	ester): Specialisation Mechanical Engine	eering: Compulso	ory
Following Curricula	General Engineering Science (German program, 7 seme	ster): Specialisation Biomedical Engine	eering: Compulso	ory
	General Engineering Science (German program, 7 seme	ester): Specialisation Naval Architecture	e: Compulsory	
	Mechanical Engineering: Core qualification: Compulsory			
	Naval Architecture: Core qualification: Compulsory			
	Technomathematics: Specialisation III. Engineering Scient	nce: Elective Compulsory		

Course L0454: Fluid Mechani	ics
Тур	Lecture
Hrs/wk	3
CP	4
Workload in Hours	Independent Study Time 78, Study Time in Lecture 42
Lecturer	Prof. Thomas Rung
Language	DE/EN
Cycle	SoSe
Content	<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</li></ul></li></ul>
	<ul> <li>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	ourse 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		

Module M0960: Mecha	anics IV (Oscillations, Analytical Mech	anics, Multibody Systems	s, Numerica	l Mechanics)
Courses				
Title  Mechanics IV (Oscillations, Analytical Mechanics, Numerical Mechanics) (L1137)  Mechanics IV (Oscillations, Analytical Mechanics, Numerical Mechanics) (L1138)		Typ Lecture Recitation Section (small)	Hrs/wk 3 2	<b>CP</b> 3 2
-	al Mechanics, Numerical Mechanics) (L1139)	Recitation Section (large)	1	1
Module Responsible		-		
Admission Requirements	None			
Recommended Previous Knowledge	Mathematics I-III and Mechanics I-III			
Educational Objectives	After taking part successfully, students have reached th	e following learning results		
Professional Competence				
Knowledge	The students can			
Skills	describe the axiomatic procedure used in mechar explain important steps in model design; present technical knowledge.  The students can explain the important elements of mathematical their own problems; apply basic methods to engineering problems; estimate the reach and boundaries of the method	/ mechanical analysis and model for		
Personal Competence				
Social Competence	The students can work in groups and support each other	r to overcome difficulties.		
Autonomy	Students are capable of determining their own strengths	s and weaknesses and to organize the	eir time and learn	ing based on those.
Workload in Hours	Independent Study Time 96, Study Time in Lecture 84			
Credit points				
Course achievement				
Examination	Written exam			
Examination duration and	120 min			
scale				
Assignment for the	General Engineering Science (German program, 7 seme			-
Following Curricula	General Engineering Science (German program, 7 seme General Engineering Science (German program, 7 seme			ory
	Energy Systems: Technical Complementary Course Core	•	re. Compulsory	
	Mechanical Engineering: Core qualification: Compulsory	Studies. Elective compaisory		
	Mechatronics: Core qualification: Compulsory			
	Naval Architecture: Core qualification: Compulsory			
	Technomathematics: Specialisation III. Engineering Scien	nce: Elective Compulsory		
	Theoretical Mechanical Engineering: Technical Complem	nentary Course Core Studies: 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	Elements of vibration theory     Vibration of Multi-degree of freedom systems     Analytical Mechanics     Multibody Systems     Numerical methods for time integration     Introduction to Matlab
Literature	K. Magnus, H.H. Müller-Slany: Grundlagen der Technischen Mechanik. 7. Auflage, Teubner (2009).  D. Gross, W. Hauger, J. Schröder, W. Wall: Technische Mechanik 1-4. 11. Auflage, Springer (2011).  W. Schiehlen, P. Eberhard: Technische Dynamik, Springer (2012).

Course 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
СР	1
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14
Lecturer	Prof. Robert Seifried
Language	DE
Cycle	SoSe
Content	See interlocking course
Literature	See interlocking course

Module M1277: MED I	: Introduction to Anatomy			
Courses				
Title		Тур	Hrs/wk	СР
Introduction to Anatomy (L0384)		Lecture	2	3
Module Responsible	Prof. Udo Schumacher			
Admission Requirements	None			
Recommended Previous	None			
Knowledge				
<b>Educational Objectives</b>	After taking part successfully, students have reache	d the following learning results		
Professional Competence				
Knowledge	The students can describe basal structures and fund	tions of internal organs and the mu	sculoskeletal system.	
	The students can describe the basic macroscopy an	d microscopy of those systems.		
Skille	The students can recognize the relationship betwee	n given anatomical facts and the de	volonment of some con	aman disassas: thay
Skills	can explain the relevance of structures and their fur	-		illiloii diseases, tiley
	can explain the relevance of structures and their far	ictions in the context of widespread	discuses.	
Personal Competence				
Social Competence	The students can participate in current discussions i	n biomedical research and medicine	e on a professional level	l.
Autonomy	The students are able to access anatomical knowle	edge by themselves, can participate	in conversations on th	ne tonic and acquire
Autonomy	the relevant knowledge themselves.	age by themselves, can participate	in conversacions on a	ic topic und acquire
Workload in Hours	Independent Study Time 62, Study Time in Lecture	28		
Credit points	3			
Course achievement	None			
Examination	Written exam			
Examination duration and	90 minutes			
scale				
Assignment for the	General Engineering Science (German program, 7 se	emester): Specialisation Biomedical	Engineering: Compulso	ry
Following Curricula	General Engineering Science (German program,	7 semester): Specialisation Mech	nanical Engineering, F	ocus Biomechanics:
	Compulsory			
	Data Science: Specialisation Medicine: Compulsory			
	Electrical Engineering: Specialisation Medical Technical			
	Engineering Science: Specialisation Biomedical Engi			
	General Engineering Science (English program, 7 se Mechanical Engineering: Specialisation Biomechanic	•	ingineering: Compulsor	у
	Biomedical Engineering: Specialisation Medical Tech		Compulsory	
	Biomedical Engineering: Specialisation Medical Technological Engineering: Specialisation Management			
	Biomedical Engineering: Specialisation Artificial Organical Engineering: Specialisation Engineering: Specialisatio			
	Biomedical Engineering: Specialisation Implants and			
	Technomathematics: Specialisation III. Engineering:		,	

Course L0384: Introduction t	o Anatomy	
Тур	Lecture	
Hrs/wk	2	
СР	3	
Workload in Hours	Independent Study	Fime 62, Study Time in Lecture 28
Lecturer	Prof. Tobias Lange	
Language		
Cycle		
Content	General Anatomy	
	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
	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

litle little		Тур	Hrs/wk	СР
ntroduction to Radiology and Radi		Lecture	2	3
Module Responsible				
Admission Requirements  Recommended Previous				
Knowledge				
<b>Educational Objectives</b>	After taking part successfully, students have reached the following	ng learning results		
Professional Competence				
Knowledge	Therapy The students can distinguish different types of currently used equ	uipment with respect	to its use in radiation the	erapy.
	The students can explain treatment plans used in radiation thera	py in interdisciplinary	contexts (e.g. surgery, i	nternal medicine)
	The students can describe the patients' passage from the	ir initial admittanc	e through to follow-up	care.
	Diagnostics			
	The students can illustrate the technical base concepts of proje well as sectional imaging techniques (CT, MRT, US).	ction radiography, ir:	ncluding angiography and	d mammography,
	The students can explain the diagnostic as well as therapeutic u techniques.	ise of imaging techni	ques, as well as the tech	inical basis for the
	The students can choose the right treatment method depending	on the patient's clinic	cal history and needs.	
	The student can explain the influence of technical errors on the in	maging techniques.		
	The student can draw the right conclusions based on the images'		or the error protocol	
Skills	Therapy	diagnostic infulligs c	i the error protocor.	
	The students can distinguish curative and palliative situations and the students can develop adequate therapy concepts and relate			
			nogical aspects.	
	The students can use the therapeutic principle (effects vs adverse	e effects)		
	The students can distinguish different kinds of radiation, can c tumor) and choose the energy needed in that situation (irradiation		depending on the situa	tion (location of
	The student can assess what an individual psychosocial service groups, self-help groups, social services, psycho-oncology).	ce should look like (	e.g. follow-up treatment	, sports, social h
	Diagnostics			
	The students can suggest solutions for repairs of imaging instrum	nentation after having	done error analyses	
				. Ale a les les accelerates a
	The students can classify results of imaging techniques accord anatomy, pathology and pathophysiology.	ing to different grou	ps of diseases based or	their knowledge
Personal Competence				
Social Competence	The students can assess the special social situation of tumor pati The students are aware of the special, often fear-dominated measures and can meet them appropriately.		·	-
Autonomy	The students can apply their new knowledge and skills to a concr The students can introduce younger students to the clinical daily			
	The students are able to access anatomical knowledge by them	iselves, can participa	te competently in conve	rsations on the to
	and acquire the relevant knowledge themselves.	ves, can participa	Jompetently in conven	
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28			
Credit points				
Course achievement	None			
Examination	Written exam			
Examination duration and				
scale Assignment for the		ecialisation Biomedic	al Engineering: Compulso	nrv
-				
Following Curricula	Compulsory			
Following Curricula	Data Science: Specialisation Medicine: Compulsory			
Following Curricula				
Following Curricula	Electrical Engineering: Specialisation Medical Technology: Electiv			
Following Curricula	Electrical Engineering: Specialisation Medical Technology: Electiv Engineering Science: Specialisation Biomedical Engineering: Com General Engineering Science (English program, 7 semester): Spec	npulsory	l Engineering: Compulsor	ry
Following Curricula	Engineering Science: Specialisation Biomedical Engineering: Com	npulsory cialisation Biomedica	l Engineering: Compulsor	у
Following Curricula	Engineering Science: Specialisation Biomedical Engineering: Com General Engineering Science (English program, 7 semester): Spec Mechanical Engineering: Specialisation Biomechanics: Compulsor Biomedical Engineering: Specialisation Medical Technology and C	npulsory cialisation Biomedica ry Control Theory: Electiv	ve Compulsory	у
Following Curricula	Engineering Science: Specialisation Biomedical Engineering: Com General Engineering Science (English program, 7 semester): Spec Mechanical Engineering: Specialisation Biomechanics: Compulsor	npulsory cialisation Biomedica ry Control Theory: Electiv ss Administration: Ele	ve Compulsory ctive Compulsory	у

Technomathematics: Specialisation III. Engineering Science: Elective Compulsory

Course L0383: Introduction t	to Radiology and Radiation Therapy
Тур	Lecture
Hrs/wk	2
СР	
	Independent Study Time 62, Study Time in Lecture 28
Language	Prof. Ulrich Carl, Prof. Thomas Vestring
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
	"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

Module M0662: Nume	erical Mathematics I
Courses	
Courses	The Market CD
Title Numerical Mathematics I (L0417)	Typ Hrs/wk CP Lecture 2 3
Numerical Mathematics I (L0418)	Recitation Section (small) 2 3
Module Responsible	Prof. Sabine Le Borne
Admission Requirements	None
Recommended Previous	Mathematik I + II for Engineering Students (german or english) or Analysis & Linear Algebra I + II for Technomathematicia
Knowledge	basic MATLAB/Python knowledge
Educational Objectives	After taking part successfully, students have reached the following learning results
Professional Competence	Students are able to
Knowledge	Students are able to
	name numerical methods for interpolation, integration, least squares problems, eigenvalue problems, nonlinear root finding.
	problems and to explain their core ideas,
	<ul> <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>
	explain aspects for the practical execution of numerical methods with respect to computational and storage complexity.
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 solution algorithm,</li> </ul>
	select and execute a suitable solution approach for a given problem.
Personal Competence	
Social Competence	Students are able to
	work together in heterogeneously composed teams (i.e., teams from different study programs and background knowledge
	explain theoretical foundations and support each other with practical aspects regarding the implementation of algorithms.
Autonomy	Students are capable
Ź	
	to assess whether the supporting theoretical and practical excercises are better solved individually or in a team,     to assess their individual process and if possessive to ask questions and sook holp.
	to assess their individual progess and, if necessary, to ask questions and seek help.
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56
Credit points	6
Course achievement	
Course achievement Examination	Written exam
Course achievement Examination Examination duration and	Written exam
Course achievement Examination Examination duration and scale	Written exam 90 minutes
Course achievement Examination Examination duration and scale Assignment for the	Written exam
Course achievement Examination Examination duration and scale Assignment for the	Written exam  90 minutes  General Engineering Science (German program, 7 semester): Specialisation Computer Science: Compulsory
Course achievement Examination Examination duration and scale Assignment for the	Written exam  90 minutes  General Engineering Science (German program, 7 semester): Specialisation Computer Science: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Materials
Course achievement Examination Examination duration and scale Assignment for the	Written exam  90 minutes  General Engineering Science (German program, 7 semester): Specialisation Computer Science: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Materials Engineering Sciences: Compulsory General Engineering Science (German program, 7 semester): Specialisation Biomedical Engineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Biomechanic
Course achievement Examination Examination duration and scale Assignment for the	Written exam  90 minutes  General Engineering Science (German program, 7 semester): Specialisation Computer Science: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Materials Engineering Sciences: Compulsory General Engineering Science (German program, 7 semester): Specialisation Biomedical Engineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Biomechanic Compulsory
Course achievement Examination Examination duration and scale Assignment for the	Written exam  90 minutes  General Engineering Science (German program, 7 semester): Specialisation Computer Science: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Materials Engineering Sciences: Compulsory General Engineering Science (German program, 7 semester): Specialisation Biomedical Engineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Biomechanic
Course achievement Examination Examination duration and scale Assignment for the	Written exam  90 minutes  General Engineering Science (German program, 7 semester): Specialisation Computer Science: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Materials Engineering Sciences: Compulsory General Engineering Science (German program, 7 semester): Specialisation Biomedical Engineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Biomechanic Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Theoretical Mechanical Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Theoretical Mechanical
Course achievement Examination Examination duration and scale Assignment for the	Written exam  90 minutes  General Engineering Science (German program, 7 semester): Specialisation Computer Science: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Materials Engineering Sciences: Compulsory General Engineering Science (German program, 7 semester): Specialisation Biomedical Engineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Biomechanic Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Theoretical Mechanic Engineering: Compulsory
Course achievement Examination Examination duration and scale Assignment for the	Written exam  90 minutes  General Engineering Science (German program, 7 semester): Specialisation Computer Science: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Materials Engineering Sciences: Compulsory General Engineering Science (German program, 7 semester): Specialisation Biomedical Engineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Biomechanic Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Theoretical Mechanic Engineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Aircraft System Engineering: Elective Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Mechatronics: Elective Compulsory
Course achievement Examination Examination duration and scale Assignment for the	Written exam  90 minutes  General Engineering Science (German program, 7 semester): Specialisation Computer Science: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Materials Engineering Sciences: Compulsory General Engineering Science (German program, 7 semester): Specialisation Biomedical Engineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Biomechanic Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Theoretical Mechanic Engineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Aircraft System Engineering: Elective Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Mechatronics: Elective Compulsory
Course achievement Examination Examination duration and scale Assignment for the	Written exam  90 minutes  General Engineering Science (German program, 7 semester): Specialisation Computer Science: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Materials Engineering Sciences: Compulsory General Engineering Science (German program, 7 semester): Specialisation Biomedical Engineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Biomechanic Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Theoretical Mechanic Engineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Aircraft System Engineering: Elective Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Mechatronics: Elective Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Mechatronics: Elective Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Mechatronics: Elective Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Mechatronics: Elective Compulsory
Course achievement Examination Examination duration and scale Assignment for the	Written exam  90 minutes  General Engineering Science (German program, 7 semester): Specialisation Computer Science: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Materials Engineering Sciences: Compulsory General Engineering Science (German program, 7 semester): Specialisation Biomedical Engineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Biomechanic Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Theoretical Mechanic Engineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Aircraft System Engineering: Elective Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Mechatronics: Electiv Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Mechatronics: Electiv Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Mechatronics: Electiv Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Mechatronics: Electiv Compulsory
Course achievement Examination Examination duration and scale Assignment for the	Written exam  90 minutes  General Engineering Science (German program, 7 semester): Specialisation Computer Science: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Materials Engineering Sciences: Compulsory General Engineering Science (German program, 7 semester): Specialisation Biomedical Engineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Biomechanic Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Theoretical Mechanic Engineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Aircraft System Engineering: Elective Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Mechatronics: Elective Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Mechatronics: Elective Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Mechatronics: Elective Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Mechatronics: Elective Compulsory
Course achievement Examination Examination duration and scale Assignment for the	Written exam  90 minutes  General Engineering Science (German program, 7 semester): Specialisation Computer Science: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Materials Engineering Sciences: Compulsory General Engineering Science (German program, 7 semester): Specialisation Biomedical Engineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Biomechanic Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Theoretical Mechanic Engineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Aircraft System Engineering: Elective Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Mechatronics: Elective Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Mechatronics: Elective Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Energy System Elective Compulsory Bioprocess Engineering: Specialisation A - General Bioprocess Engineering: Elective Compulsory
Course achievement Examination Examination duration and scale Assignment for the	Written exam  90 minutes  General Engineering Science (German program, 7 semester): Specialisation Computer Science: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Materials Engineering Sciences: Compulsory General Engineering Science (German program, 7 semester): Specialisation Biomedical Engineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Biomechanic Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Theoretical Mechanic Engineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Aircraft System Engineering: Elective Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Mechatronics: Elective Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Mechatronics: Elective Elective Compulsory Bioprocess Engineering: Specialisation A - General Bioprocess Engineering: Elective Compulsory Computer Science: Specialisation Computational Mathematics: Elective Compulsory Computer Science: Specialisation II. Mathematics and Engineering Science: Elective Compulsory Data Science: Core qualification: Compulsory
Course achievement Examination Examination duration and scale Assignment for the	Written exam  90 minutes  General Engineering Science (German program, 7 semester): Specialisation Computer Science: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Materials Engineering Sciences: Compulsory General Engineering Science (German program, 7 semester): Specialisation Biomedical Engineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Biomechanic Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Theoretical Mechanic Engineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Aircraft System Engineering: Elective Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Mechatronics: Elective Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Mechatronics: Elective Compulsory Bioprocess Engineering: Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Energy System Elective Compulsory Bioprocess Engineering: Specialisation A - General Bioprocess Engineering: Elective Compulsory Computer Science: Specialisation Computational Mathematics: Elective Compulsory Data Science: Core qualification: Compulsory Electrical Engineering: Core qualification: Elective Compulsory
Course achievement Examination Examination duration and scale Assignment for the	Written exam  90 minutes  General Engineering Science (German program, 7 semester): Specialisation Computer Science: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Materials Engineering Sciences: Compulsory General Engineering Science (German program, 7 semester): Specialisation Biomedical Engineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Biomechanic Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Theoretical Mechanic Engineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Aircraft System Engineering: Elective Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Mechatronics: Electiv Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Mechatronics: Electiv Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Energy System Elective Compulsory Bioprocess Engineering: Specialisation A - General Bioprocess Engineering: Elective Compulsory Computer Science: Specialisation Computational Mathematics: Elective Compulsory Data Science: Core qualification: Compulsory Electrical Engineering: Core qualification: Elective Compulsory Engineering Science: Core qualification: Compulsory
Course achievement Examination Examination duration and scale Assignment for the	Written exam  90 minutes  General Engineering Science (German program, 7 semester): Specialisation Computer Science: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Materials Engineering Sciences: Compulsory General Engineering Science (German program, 7 semester): Specialisation Biomedical Engineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Biomechanic Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Theoretical Mechanic Engineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Aircraft System Engineering: Elective Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Mechatronics: Elective Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Mechatronics: Elective Compulsory Bioprocess Engineering: Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Energy System Elective Compulsory Bioprocess Engineering: Specialisation A - General Bioprocess Engineering: Elective Compulsory Computer Science: Specialisation Computational Mathematics: Elective Compulsory Data Science: Core qualification: Compulsory Electrical Engineering: Core qualification: Elective Compulsory
Course achievement Examination Examination duration and scale Assignment for the	Written exam  90 minutes  General Engineering Science (German program, 7 semester): Specialisation Computer Science: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Materials Engineering Sciences: Compulsory General Engineering Science (German program, 7 semester): Specialisation Biomedical Engineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Biomechanic Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Theoretical Mechanic Engineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Aircraft System Engineering Elective Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Mechatronics: Elective Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Mechatronics: Elective Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Mechatronics: Elective Compulsory Bioprocess Engineering: Specialisation A - General Bioprocess Engineering: Elective Compulsory Computer Science: Specialisation Computational Mathematics: Elective Compulsory Computer 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
Course achievement Examination Examination duration and scale Assignment for the	Written exam  90 minutes  General Engineering Science (German program, 7 semester): Specialisation Computer Science: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Materials Engineering Sciences: Compulsory General Engineering Science (German program, 7 semester): Specialisation Biomedical Engineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Biomechanic Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Theoretical Mechanic Engineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Aircraft System Engineering: Elective Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Mechatronics: Elective Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Mechatronics: Elective Compulsory General Engineering: Specialisation A - General Bioprocess Engineering: Elective Compulsory Bioprocess Engineering: Specialisation A - General Bioprocess Engineering: Elective Compulsory Computer Science: Specialisation Computational Mathematics: Elective Compulsory Computer Science: Specialisation II. Mathematics and Engineering Science: Elective Compulsory Data Science: Core qualification: Compulsory Engineering Science: Core qualification: Elective Compulsory Engineering Science: Core qualification: Compulsory Engineering Science: Core qualification: Compulsory General Engineering Science (English program, 7 semester): Core qualification: Compulsory
Course achievement Examination Examination duration and scale Assignment for the	Written exam  90 minutes  General Engineering Science (German program, 7 semester): Specialisation Computer Science: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Materials Engineering Sciences: Compulsory General Engineering Science (German program, 7 semester): Specialisation Biomedical Engineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Biomechanic Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Theoretical Mechanic Engineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Aircraft Systen Engineering: Elective Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Mechatronics: Electiv Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Mechatronics: Electiv Compulsory Bioprocess Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Energy System Elective 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 General Engineering Science (English program, 7 semester): Specialisation Mechanical Engineering, Focus Biomechanic Compulsory
Course achievement Examination Examination duration and scale Assignment for the	Written exam  90 minutes  General Engineering Science (German program, 7 semester): Specialisation Computer Science: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Materials Engineering Sciences: Compulsory General Engineering Science (German program, 7 semester): Specialisation Biomedical Engineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Biomechanic Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Theoretical Mechanic Engineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Aircraft System Engineering: Elective Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Mechatronics: Elective Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Mechatronics: Elective Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Energy System Elective Compulsory Bioprocess Engineering: Specialisation A - General Bioprocess Engineering: Elective Compulsory Computer Science: Specialisation Computational Mathematics: Elective Compulsory Computer Science: Specialisation Computational Mathematics: Elective Compulsory Electrical Engineering: Core qualification: Compulsory Engineering Science: Core qualification: Elective Compulsory Engineering Science: Core qualification: Compulsory General Engineering Science (English program, 7 semester): Specialisation Computer Science: Compulsory General Engineering Science (English program, 7 semester): Specialisation Mechanical Engineering, Focus Biomechanic Compulsory General Engineering Science (English program, 7 semester): Specialisation Mechanical Engineering, Focus Materials in Engineering
Course achievement Examination Examination duration and scale Assignment for the	Written exam  90 minutes  General Engineering Science (German program, 7 semester): Specialisation Computer Science: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Materials Engineering Sciences: Compulsory General Engineering Science (German program, 7 semester): Specialisation Biomedical Engineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Biomechanica Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Theoretical Mechanic Engineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Aircraft System Engineering: Elective Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Mechatronics: Elective Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Mechatronics: Elective Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Energy System Elective Compulsory Bioprocess Engineering: Specialisation A - General Bioprocess Engineering: Elective Compulsory Computer Science: Specialisation Computational Mathematics: Elective Compulsory Computer Science: Specialisation II. Mathematics and Engineering Science: Elective Compulsory Data Science: Core qualification: Compulsory Engineering Science: Core qualification: Compulsory General Engineering Science (English program, 7 semester): Specialisation Computer Science: Compulsory General Engineering Science (English program, 7 semester): Specialisation Mechanical Engineering, Focus Biomechanic Compulsory General Engineering Science (English program, 7 semester): Specialisation Mechanical Engineering, Focus Materials in Engineerins Sciences: Compulsory
Course achievement Examination Examination duration and scale Assignment for the	Written exam  90 minutes  General Engineering Science (German program, 7 semester): Specialisation Computer Science: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Materials Engineering Sciences: Compulsory General Engineering Science (German program, 7 semester): Specialisation Biomedical Engineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Biomechanic Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Theoretical Mechanic Engineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Aircraft System Engineering: Elective Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Mechatronics: Elective Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Mechatronics: Elective Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Energy System Elective Compulsory Bioprocess Engineering: Specialisation A - General Bioprocess Engineering: Elective Compulsory Computer Science: Specialisation Computational Mathematics: Elective Compulsory Computer Science: Specialisation Computational Mathematics: Elective Compulsory Electrical Engineering: Core qualification: Compulsory Engineering Science: Core qualification: Elective Compulsory Engineering Science: Core qualification: Compulsory General Engineering Science (English program, 7 semester): Specialisation Computer Science: Compulsory General Engineering Science (English program, 7 semester): Specialisation Mechanical Engineering, Focus Biomechanic Compulsory General Engineering Science (English program, 7 semester): Specialisation Mechanical Engineering, Focus Materials in Engineering
Course achievement Examination Examination duration and scale Assignment for the	Written exam  90 minutes  General Engineering Science (German program, 7 semester): Specialisation Computer Science: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Materials Engineering Sciences: Compulsory General Engineering Science (German program, 7 semester): Specialisation Biomedical Engineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Biomechanic Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Theoretical Mechanic Engineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Aircraft Systen Engineering: Elective Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Mechatronics: Electiv Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Mechatronics: Electiv Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Energy System Elective Compulsory Bioprocess Engineering: Specialisation A - General Bioprocess Engineering: Elective Compulsory Computer Science: Specialisation Computational Mathematics: Elective Compulsory Computer Science: Specialisation II. Mathematics and Engineering Science: Elective Compulsory Electrical Engineering: Core qualification: Compulsory Engineering Science: Core qualification: Compulsory Engineering Science: Core qualification: Compulsory General Engineering Science (English program, 7 semester): Specialisation Mechanical Engineering, Focus Biomechanic Compulsory General Engineering Science (English program, 7 semester): Specialisation Mechanical Engineering, Focus Biomechanic Compulsory General Engineering Science (English program, 7 semester): Specialisation Mechanical Engineering, Focus Materials in Engineerin Sciences: Compulsor
Course achievement Examination Examination duration and scale Assignment for the	Written exam  90 minutes  General Engineering Science (German program, 7 semester): Specialisation Computer Science: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Materials Engineering Sciences: Compulsory General Engineering Science (German program, 7 semester): Specialisation Biomedical Engineering; Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Biomechanic Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Theoretical Mechanic Engineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Aircraft System Engineering: Elective Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Aircraft System Engineering: Elective Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Mechatronics: Elective Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Energy System Elective Compulsory Bioprocess Engineering: Specialisation A - General Bioprocess Engineering: Elective Compulsory Computer Science: Specialisation Computational Mathematics: Elective Compulsory Computer Science: Specialisation II. Mathematics and Engineering Science: Elective Compulsory Electrical Engineering: Core qualification: Compulsory Engineering Science: Core qualification: Compulsory Engineering Science: Core qualification: Compulsory General Engineering Science (English program, 7 semester): Specialisation Mechanical Engineering, Focus Materials in Engineering General Engineering Science (English program, 7 semester): Specialisation Mechanical Engineering, Focus Materials in Engineering General Engineering Science (English program, 7 semester): Specialisation Mechanical Engineering, Focus Materials in Engineeri
Course achievement Examination Examination duration and scale Assignment for the	Written exam  90 minutes  General Engineering Science (German program, 7 semester): Specialisation Computer Science: Compulsory  General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Materials Engineering Sciences: Compulsory  General Engineering Science (German program, 7 semester): Specialisation Biomedical Engineering; Compulsory  General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Biomechanic Compulsory  General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Theoretical Mechanic Engineering: Compulsory  General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Aircraft System Engineering: Elective Compulsory  General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Mechatronics: Elective Compulsory  General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Mechatronics: Elective Compulsory  General Engineering: Specialisation A - General Bioprocess Engineering: Elective 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  General Engineering Science (English program, 7 semester): Specialisation Compulsory  General Engineering Science (English program, 7 semester): Specialisation Mechanical Engineering, Focus Biomechanic Compulsory  General Engineering Science (English program, 7 semester): Specialisation Mechanical Engineering, Focus Biomechanic Compulsory  General Engineering Science (English program, 7 semester): Specialisation Mechanical Engineering, Focus Materials in Engineering Sciences: Compulsory  General Enginee

Computational Science and Engineering: Core qualification: Compulsory

 ${\it Mechanical\ Engineering: Specialisation\ Theoretical\ Mechanical\ Engineering:\ Compulsory}$ 

Mechanical Engineering: Specialisation Energy Systems: Elective Compulsory

Mechanical Engineering: Specialisation Mechatronics: Elective Compulsory

Theoretical Mechanical Engineering: Technical Complementary Course Core Studies: Elective Compulsory

Process Engineering: Specialisation Process Engineering: Elective Compulsory

Course L0417: Numerical Mathematics I		
Тур	Lecture	
Hrs/wk	2	
СР	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 für Ingenieure und Naturwissenschaftler, Springer</li> </ul>	

ourse 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						
Title						
Heat Transfer (L0458) Heat Transfer (L0459)	<b>Typ</b> Lecture Recitation Section (la	Hrs/wk CP 3 4 arge) 2 2				
Module Responsible Dr	r. Andreas Moschallski					
	one					
	echnical Thermodynamics I, II and Fluid Dynamics					
Knowledge						
Educational Objectives Af	ter taking part successfully, students have reached the following learning results					
Professional Competence						
Knowledge Th	ne students are able to					
- c	describe the different physical mechanism of Heat Transfer,					
- e	explain the technical terms,					
	to analyse comlex heat transfer processes in a critical way.					
	ne students are able to					
	understand the physics of Heat Transfer, calculate and evaluate complex Heat Transfer processes,					
	solve excersises self-consistent and in small groups.					
	orre execusives sen considerin and in small groups.					
Personal Competence						
Social Competence Th	ne students are able to discuss in small groups and develop an approach.					
Autonomy Th	ne students are able to develop a complex problem self-consistent and analyse the	results in a critical way. A qualified exch				
wi	ith other students is given.					
Workload in Hours Inc	dependent Study Time 110, Study Time in Lecture 70					
Credit points 6						
Course achievement No	one					
<b>Examination</b> W	ritten exam					
Examination duration and 12	20 min					
scale						
-	eneral Engineering Science (German program, 7 semester): Specialisation Med	hanical Engineering, Focus Energy Syst				
-	ompulsory					
	eneral Engineering Science (German program, 7 semester): Specialisation Biomedi eneral Engineering Science (German program, 7 semester): Specialisation Mechan					
	ngineering: Compulsory	ical Engineering, Focus Theoretical Mech				
	nergy Systems: Technical Complementary Course Core Studies: Elective Compulsor	v				
	eneral Engineering Science (English program, 7 semester): Specialisation Med	•				
	ompulsory	5 5 5				
Ge	eneral Engineering Science (English program, 7 semester): Specialisation Biomedic	al Engineering: Compulsory				
Me	Mechanical Engineering: Specialisation Energy Systems: Compulsory					
Me	echanical 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					
Тур	itation Section (large)				
Hrs/wk	2				
СР	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 M0956: Meas	urement Technology for Mechanica	l Engineers					
Courses							
<b>Fitle</b> Practical Course: Measurement and Measurement Technology for Mech		<b>Typ</b> Practical Course Lecture	<b>Hrs/wk</b> 2 2	<b>CP</b> 2 3			
Measurement Technology for Mech							
Module Responsible	Prof. Thorsten Kern						
Admission Requirements	None						
Recommended Previous Knowledge	Basic knowledge of physics, chemistry and electrical	ll engineering					
<b>Educational Objectives</b>	After taking part successfully, students have reache	ed the following learning results					
Professional Competence  Knowledge	Students are able to name the most important fur Calibration, Static and Dynamic Properties of Senso		Technology (Quantities ar	d Units, Uncertainty			
	They can outline the most important measuring m Temperature, mechanical quantities, Flow, Time, Fl		antities to be maesured	(Electrical Quantities			
	They can describe important methods of chemical A	analysis (Gas Sensors, Spectrosco	ppy, Gas Chromatography	)			
Skills	Students can select suitable measuring methods to	given problems and can use refe	ering measurement device	es in practice.			
	The students are able to orally explain issues in the place the issues into the right context and application.	•	technology and solution a	approaches as well as			
Personal Competence Social Competence	Students can arrive at work results in groups and document them in a common report.						
Autonomy	Students are able to familiarize themselves with new measurement technologies.						
Workload in Hours	Independent Study Time 110, Study Time in Lecture	e 70					
Credit points	6						
Course achievement	Compulsory Bonus Form  Yes None Subject theoretical and practical work	Description					
Examination	Subject theoretical and practical work						
Examination duration and scale	105 minutes						
Assignment for the Following Curricula	General Engineering Science (German program, 7 s General Engineering Science (German program, 7 s General Engineering Science (German program, 7 s Digital Mechanical Engineering: Core qualification: G Energy and Environmental Engineering: Core qualifi Engineering Science: Specialisation Mechatronics: G Engineering Science: Specialisation Mechatronics G Engineering Science: Specialisation Biomedical Eng General Engineering Science (English program, 7 se Coencral Engineering Science (English program, 7 se Logistics and Mobility: Specialisation Production Ma Mechanical Engineering: Core qualification: Compul Mechatronics: Core qualification: Compulsory Engineering and Management - Major in Logistics Compulsory	emester): Specialisation Biomedicemester): Specialisation Energy at Compulsory cation: Compulsory computer	cal Engineering: Compulse and Enviromental Engineer and Enviromental Engineer al Engineering: Compulsor al Engineering: Elective Compulsory	ering: Compulsory  ring: Compulsory  ory  ory  compulsory			

Course L1119: Practical Cour	se: Measurement and Control Systems					
Тур	Practical Course					
Hrs/wk	2					
СР	2					
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28					
Lecturer	Prof. Thorsten Kern					
Language	DE					
Cycle	WiSe/SoSe					
Content	Experiment 1: Emission and immission measurement of gaseous pollutants: different technologies to determine different gaseous					
	pollutants in automotive exhaust are used.					
	Experiment 2: Simulation and measurement of asynchrone engine and rotary pump: the dynamic behaviour of e pump engine will					
	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 with					
	Michelson interferometer and optical fibers demonstrated.					
	The factor and optical motor demonstrated.					
	Experiment 4:Identification of the parameters of a control system and optimal control parameters					
Literature	Versuch 1:					
	Little W. Die Ausberg der Left und ihren Vermerieitung in der festen Aberganhöre und ern Arbeitstelete 2. Auf					
	<ul> <li>Leith, W.: Die Analyse der Luft und ihrer Verunreinigung in der freien Atmosphäre und am Arbeitsplatz. 2. Aufl.,</li> <li>Wissenschaftliche Verlagsgesellschaft, Stuttgart, 1974</li> </ul>					
	Birkle, M.: Meßtechnik für den Immissionsschutz, Messen der gas- und partikelförmigen Luftverunreinigungen. R. Oldenburg					
	Verlag, München-Wien, 1979					
	• Luftbericht 83/84, Freie und Hansestadt Hamburg, Behörde für Bezirksangelegenheiten, Naturschutz und Umweltgest					
	Gebrauchs- und Bedienungsanweisungen					
	VDI-Handbuch Reinhaltung der Luft, Band 5: VDI-Richtlinien 2450 Bl.1, 2451 Bl.4, 2453 Bl.5, 2455 Bl.1					
	Versuch 2:					
	Grundlagen über elektrische Maschinen, speziell: Asynchronmotoren					
	Simulationsmethoden, speziell: Verwendung von Blockschaltbildern					
	Betriebsverhalten von Kreispumpen, speziell: Kennlinien, Ähnlichkeitsgesetze					
	Versuch 3:					
	Unger, HG.: Optische Nachrichtentechnik, Teil 1: Optische Wellenleiter. Hüthing Verlag, Heidelberg, 1984					
	Dakin, J., Cushaw, B.: Optical Fibre Sensors: Principles and Components. Artech House Boston, 1988					
	Culshaw, B., Dakin, J.: Optical Fibre Sensors: Systems and Application. Artech House Boston, 1989					
	Versuch 4:					
	Leonhard: Einführung in die Regelungstechnik. Vieweg Verlag, Braunschweig-Wiesbaden					
	Jan Lunze: Systemtheoretische Grundlagen, Analyse und Entwurf einschleifiger Regelungen					

Course L1116: Measurement	Technology for Mechanical Engineering				
Тур	Lecture				
Hrs/wk					
СР					
	Independent Study Time 62, Study Time in Lecture 28				
	Prof. Thorsten Kern, Dennis Kähler				
Language					
Cycle	1 Fundamentals				
Content	1 rundamentals				
	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				
	mpedance				
	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				
СР	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				

Module M1279: MED I	I: Introduction to Biochemistry	and Molecular Biology		
Courses				
Title		Тур	Hrs/wk	СР
Introduction to Biochemistry and Mo	olecular Biology (L0386)	Lecture	2	3
Module Responsible	Prof. Hans-Jürgen Kreienkamp			
Admission Requirements	None			
Recommended Previous	None			
Knowledge				
Educational Objectives	After taking part successfully, students have re	ached the following learning results		
<b>Professional Competence</b>				
Knowledge	The students can			
	<ul> <li>describe basic biomolecules;</li> </ul>			
	<ul> <li>explain how genetic information is code</li> </ul>	d in the DNA;		
	<ul> <li>explain the connection between DNA an</li> </ul>			
CL:III-	The should also asso			
SKIIIS	The students can			
	recognize the importance of molecular parts.	arameters for the course of a disease;		
	<ul> <li>describe selected molecular-diagnostic</li> </ul>	procedures;		
	<ul> <li>explain the relevance of these procedur</li> </ul>	es for some diseases		
Personal Competence				
-	The students can participate in discussions in r	esearch and medicine on a technical level	I.	
Autonomy	The students can develop understanding of top	ics from the course, using technical litera	ture, by themselves.	
Workload in Hours	Independent Study Time 62, Study Time in Lec	ture 28		
Credit points	3			
Course achievement	None			
Examination	Written exam			
Examination duration and	60 minutes			
scale				
Assignment for the	General Engineering Science (German program	•		
Following Curricula	General Engineering Science (German prog	ram, 7 semester): Specialisation Mecha	anical Engineering, Foo	cus Biomechanics:
	Compulsory			
	Data Science: Specialisation Medicine: Compul Electrical Engineering: Specialisation Medical T			
	Engineering Science: Specialisation Biomedica			
	General Engineering Science (English program		naineerina: Compulsorv	
	General Engineering Science (English program	•		cus Biomechanics:
	Compulsory		3 3,	
	Mechanical Engineering: Specialisation Biomec	hanics: Compulsory		
	Biomedical Engineering: Specialisation Manage	ment and Business Administration: Electiv	ve Compulsory	
	Biomedical Engineering: Specialisation Artificia	l Organs and Regenerative Medicine: Elec	tive Compulsory	
	Biomedical Engineering: Specialisation Medical	Technology and Control Theory: Elective	Compulsory	
	Biomedical Engineering: Specialisation Implant	·	ry	
	Technomathematics: Specialisation III. Enginee	ring Science: Elective Compulsory		

ourse L0386: Introduction to Biochemistry and Molecular Biology				
Тур	Lecture			
Hrs/wk	2			
СР	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 Healing					
Courses						
Title		Тур	Hrs/wk	СР		
Implants and Fracture Healing (L03	876) Lecture 2 3					
Module Responsible	Prof. Michael Morlock					
Admission Requirements	None					
Recommended Previous	It is recommended to participate in "Introduction into ${\it A}$	Anatomie" before attending "Imp	lants and Fracture Heali	ng".		
Knowledge						
Educational Objectives	After taking part successfully, students have reached t	he following learning results				
Professional Competence						
Knowledge	The students can describe the different ways how bone	es heal, and the requirements fo	r their existence.			
	The students can name different treatments for the sp	ine and hollow bones under give	n fracture morphologies			
Skills	The students can determine the forces acting within th	e human body under guasi-stati	c situations under specif	ic assumptions.		
	· ·		·			
Personal Competence						
Social Competence	The students can, in groups, solve basic numerical mo-	deling tasks for the calculation o	f internal forces.			
Autonomy	The students can, in groups, solve basic numerical mo	deling tasks for the calculation o	f internal forces.			
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28					
Credit points	3					
Course achievement	None					
Examination	Written exam					
Examination duration and	90 min					
scale						
_	General Engineering Science (German program, 7	semester): Specialisation Med	hanical Engineering, Fo	ocus Biomechanics:		
Following Curricula						
	General Engineering Science (German program, 7 sem		l Engineering: Compulso	ry		
	Engineering Science: Specialisation Biomedical Engine					
	General Engineering Science (English program, 7 seme	•		-		
	General Engineering Science (English program, 7	semester): Specialisation Mec	hanical Engineering, Fo	ocus Biomechanics:		
	Compulsory	C				
	Mechanical Engineering: Specialisation Biomechanics:					
	Biomedical Engineering: Specialisation Implants and El Biomedical Engineering: Specialisation Artificial Organs		•			
	Biomedical Engineering: Specialisation Management at	-				
	Biomedical Engineering: Specialisation Medical Techno					
	Orientation Studies: Core qualification: Elective Compu		c compaisory			
	Technomathematics: Specialisation III. Engineering Sci	•				
	. cesaeg.ce.asadon III. Engineering Sci	ccc. E.ective Compulsory				

Course L0376: Implants and	Fracture Healing						
Тур	Lecture						
Hrs/wk							
СР							
	Independent Study Time 62, Study Time in Lecture 28						
Language	Prof. Michael Morlock						
Cycle							
	Topics to be covered include:						
	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)						
	cture 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						

Module M0634: Introd	duction into	Medic	al Technology	and System	ıs		
Courses							
Title				Тур	Hrs/wk	СР	
Introduction into Medical Technology and Systems (L0342)					Lecture	2	3
Introduction into Medical Technolog	gy and Systems (L	0343)			Project Seminar	2	2
Introduction into Medical Technolog	gy and Systems (L	1876)			Recitation Section (large)	1	1
Module Responsible	Prof. Alexander	Schlaefer					
Admission Requirements	None						
Recommended Previous	principles of ma	th (algebr	a, analysis/calculus)				
Knowledge	principles of sto	ochastics					
	principles of pro	gramming	ı, R/Matlab				
Educational Objectives	After taking par	t successfi	ully, students have re	ached the followi	ng learning results		
Professional Competence	/ treer taking par	- 5466655.	any, stadents have re	acrica and ronorm	ng rearring results		
-	The students c	an explair	n principles of medic	al technology in	cluding imaging systems,	computer aided	surgery and medical
memeage					atory affairs and standards		
			,		,		- 55
Skills	The students ar	e able to e	evaluate systems and	medical devices	in the context of clinical ap	plications.	
Personal Competence							
•	The students de	scribe a p	roblem in medical tec	hnology as a proi	ect, and define tasks that a	are solved in a join	t effort.
Autonomy	The students ca	n reflect t	their knowledge and	document the res	sults of their work. They ca	n present the resu	ults in an appropriate
	manner.						
Workload in Hours	Independent Stu	udy Time 1	110, Study Time in Le	cture 70			
Credit points	6	-					
Course achievement	Compulsory Bonu	s For	m	Description			
	Yes 10 %	6 Wr	itten elaboration				
	Yes 10 %	6 Pre	esentation				
Examination	Written exam						
Examination duration and	90 minutes						
scale							
Assignment for the	General Engine	ering Scier	nce (German program	, 7 semester): Sp	ecialisation Biomedical Eng	ineering: Compuls	ory
Following Curricula					eering: Elective Compulsory		
				_	ig Science: Elective Compu	Isory	
			cation: Elective Comp	-			
	_	-	re qualification: Electi				
			cialisation Biomedical	-			
	_				cialisation Biomedical Engi		-
					matics & Engineering Scien		uisory
	-	-	•	-	enerative Medicine: Elective	e Compulsory	
	_	-		•	eses: Elective Compulsory	mpulcon	
	-	-	•		Control Theory: Elective Consist Administration: Elective (		
	-	-	cialisation III. Enginee			Compaison y	
	recimoniacilem	acics. Spec	Jansation III. Enginee	ing Science. Liec	Live compaisory		

Course L0342: Introduction into Medical Technology and Systems		
Тур	Lecture	
Hrs/wk	2	
СР	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	Wird in der Veranstaltung bekannt gegeben.	

Course L0343: Introduction i	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 i	ourse L1876: Introduction into Medical Technology and Systems	
Тур	Recitation Section (large)	
Hrs/wk	1	
СР	1	
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14	
Lecturer	Prof. Alexander Schlaefer	
Language	DE	
Cycle	Se	
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	Wird in der Veranstaltung bekannt gegeben.	

Module M1280: MED I	II: Introduction to Physiology
Courses	
Title	Typ Hrs/wk CP
Introduction to Physiology (L0385)	Lecture 2 3
Module Responsible	Dr. Roger Zimmermann
Admission Requirements	None
Recommended Previous	None
Knowledge	
Educational Objectives	After taking part successfully, students have reached the following learning results
Professional Competence	
Knowledge	The students can
	describe the basics of the energy metabolism;
	<ul> <li>describe physiological relations in selected fields of muscle, heart/circulation, neuro- and sensory physiology.</li> </ul>
	1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1
Skills	The students can describe the effects of basic bodily functions (sensory, transmission and processing of information, development
	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, by
	themselves.
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Credit points	3
Course achievement	None
Examination	Written exam
Examination duration and	60 minutes
scale	
Assignment for the	General Engineering Science (German program, 7 semester): Specialisation Biomedical Engineering: Compulsory
Following Curricula	General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Biomechanics
	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 Mechanical Engineering, Focus Biomechanics
	Compulsory General Engineering Science (English program, 7 semester): Specialisation Biomedical Engineering: Compulsory
	General Engineering Science (English program, 7 semester): Specialisation Biomedical Engineering: 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
	L

Course L0385: Introduction t	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	

Module M1332: BIO I:	Experimental Methods in Biomechanics		
Courses			
<b>Title</b> Experimental Methods in Biomecha	Typ         Hrs/wk         CP           anics (L0377)         Lecture         2         3		
Module Responsible	Prof. Michael Morlock		
Admission Requirements	None		
Recommended Previous Knowledge	It is recommended to participate in "Implantate und Frakturheilung" before attending "Experimentelle Methoden".		
Educational Objectives	After taking part successfully, students have reached the following learning results		
Professional Competence			
Knowledge	The students can describe the different ways how bones heal, and the requirements for their existence.  The students can name different treatments 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		
Skills	given task.  The students can describe the basic handling of several experimental techniques used in biomechanics.		
Personal Competence Social Competence	The students can, in groups, solve basic experimental tasks.		
Autonomy	The students can, in groups, solve basic experimental tasks.		
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 Following Curricula	General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Biomechanics 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 Mechanical Engineering, Focus Biomechanics Compulsory General Engineering Science (English program, 7 semester): Specialisation Biomedical Engineering: Compulsory General Engineering Science (English program, 7 semester): Specialisation Biomedical Engineering: 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	ourse L0377: Experimental Methods in Biomechanics	
Тур	Lecture	
Hrs/wk	2	
СР	3	
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28	
Lecturer	Prof. Michael Morlock	
Language	DE	
Cycle	SoSe	
Content		
Literature	Wird in der Veranstaltung bekannt gegeben	

		-			
rogramming Concepts, Da			Typ Lecture Recitation Section (small)	<b>Hrs/wk</b> 3 2	<b>CP</b> 3 3
Prof. Sibylle Fröschle					
None					
After taking part succes	ssfully, students have	e reached the follow	ving learning results		
Independent Study Tim	ne 110. Study Time in	Lecture 70			
	ic 110, Study Time iii	. Ecctare 70			
	Form	Description			
No 10 %	Attestation	Testate find	len semesterbegleitend statt.		
Written exam					
120 min					
General Engineering	Science (German pr	rogram, 7 semeste	er): Specialisation Mechanic	al Engineering, F	ocus Biomechanic
Compulsory					
Compulsory General Engineering S Engineering: Compulsory General Engineering S Engineering: Compulso General Engineering Engineering Sciences: G General Engineering Compulsory General Engineering Sc Engineering: Compulso General Engineering Sc and Production: Electiv General Engineering Sc Bioprocess Engineering Electrical Engineering: Energy and Environment General Engineering Sc General Engineering Sc General Engineering Sc General Engineering Sc Compulsory	Science (German pro Science (German pro Science (German pro Compulsory Science (German prog Science (English progra Science (English progra Science (English progra Science (English progra Science (English progra	ogram, 7 semester orgram, 7 semester orgram, 7 semest orgram, 7 semest orgram, 7 semest orgram, 7 semester): S oram, 7 semester): S Compulsory ompulsory omp	c): Specialisation Mechanical colors of the process and process are process and process and process and process are process and process and process are process and process and process are process and process and process and process are process and process and process are process and process are process and process and process are process and process ar	Engineering, Food Engineering, Food Engineering, Food Engineering, Focus The Engineering, Focus Food Engineering: Elective Committee Engineering: Elective Committee Engineering Engineering Elective Committee Engineering En	us Energy Systems  cus Aircraft System  Focus Materials i  Focus Mechatronics  neoretical Mechanica  Product Developmen  mpulsory
	Independent Study Time  After taking part success  After taking part succes	Independent Study Time 110, Study Time in 6  Compulsory Bonus Form No 10 % Attestation  Written exam  120 min  General Engineering Science (German programeral Enginee	Independent Study Time 110, Study Time in Lecture 70  After taking part successfully, students have reached the follow for taking part successfully, students have reached the follow for taking part successfully, students have reached the follow for taking part successfully, students have reached the follow for taking part successfully, students have reached the follow for taking for the follow follow for the follow follow for the follow fol	Prof. Sibylle Fröschle  None  After taking part successfully, students have reached the following learning results  Independent Study Time 110, Study Time in Lecture 70 6 Compulsory Bonus Form Description No 10 % Attestation Testate finden semesterbegleitend statt.  Written exam 120 min  General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering Science (German program, 7 semester): Specialisation Green Technolog Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Compulsory 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 General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering Sciences: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Dechanical Engineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Process Engineering Engineering Science (German program, 7 semester): Specialisation Electrical Engineering Engineering Science (German program, 7 semester): Specialisation Electrical Engineering Engineering Science (German program, 7 semester): Specialisation Electrical Engineering Engineering Science (Germa	Independent Study Time 110, Study Time in Lecture 70  After taking part successfully, students have reached the following learning results  Independent Study Time 110, Study Time in Lecture 70  After taking part successfully, students have reached the following learning results  Independent Study Time 110, Study Time in Lecture 70  After taking part successfully, students have reached the following learning results  Independent Study Time 110, Study Time in Lecture 70  After taking part successfully, students have reached the following learning results  Independent Study Time 110, Study Time in Lecture 70  After taking part successfully, students have reached the following learning results  Independent Study Time 110, Study Time in Lecture 70  After taking part successfully, students have reached the following learning results  Independent Study Time 110, Study Time in Lecture 70  Becompliated the summary of the seminary of the

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

Course L2690: Computer Science for Engineers - Programming Concepts, Data Handling & Communication	
Тур	Recitation Section (small)
Hrs/wk	2
СР	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

## **Specialization Naval Architecture**

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

Module M1118: Hydro	ostatics and Body Plan			
Courses				
Title		Тур	Hrs/wk	СР
Hydrostatics (L1260)		Lecture	2	3
Hydrostatics (L1261)		Recitation Section (large)	2	1
Body Plan (L1452)		Project Seminar	2	2
Module Responsible	Prof. Stefan Krüger			
Admission Requirements	None			
Recommended Previous	Good knowledge in Mathemathics I-III and Mechanics I-I	II.		
Knowledge	It is recommended that the students are familiar with typical design relevant drawings, e.g. Body Plan, GA- Plan, Tank Plan etc.			n, Tank Plan etc.
<b>Educational Objectives</b>	After taking part successfully, students have reached the following learning results			
Professional Competence				
Knowledge	The lecture enables the student to carry out all necessary theoretical calculations for ship design on a scientific level. The lecture			
	is basic requirement for all following lectures in the subjects shipo design and safety of ships.			
Chille	The shudget is able to some out budgestatic calculation	as to ansure that the ship has sufficien	ot stability I la is	a a la a da a da a la a la a la a la a
SKIIIS	Skills The student is able to carry out hydrostatic calculations to ensure that the ship has sufficient stability. He is able to		s able to design null	
	forms that are safe against capsizing or sinking.			
Personal Competence				
Social Competence	The student gets access to hydrostatical problems.			
Autonomy				
	Independent Study Time 96, Study Time in Lecture 84			
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	Naval Architecture: Core qualification: Compulsory			

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

- Balance of Heeling and Righting Moments acc. to BV 1030
- Intact Stability Code (General Critaria)
- 4. Linearization of Stability Problems
- Linearization of Restoring Forces and Moments
- Correlation between Metacentric Height and Righting Lever at small heeling angles
- Computation of Path of Metacentric Height for Modern Hull Forms
- Correlation between Righting Lever and Path of Metacentric Height
- Hydrostatic Stiffness Matrix
- Definition of MCT
- Computation of Equilibrum Floating Conditions from Hydrostatic Tables
- Effect of Free Surfaces on Initial GM
- Roll Motions at Small Roll Angles
- 6. Stability in Waves
- Roll Motions at Large Amplitudes
- Pure Loss of Stability on the Wave Crest
- Principle of Parametric Excitation
- Principle of Direct Wave Moments
- Grim's Equivalent Wave Concept
- 6 Longitudinal Strength
- Longitudinal Mass Distribution, Shear Forces, Bending Moments
- Longitudinal Strength in Stability Booklet
- 7. Deadweight Survey and Inclining Experiment
- Deplacement Computations from Draft mark Readings
- Weights to go on /come from board  $% \left( 1\right) =\left( 1\right) \left( 1\right) \left($
- 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	
СР	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
СР	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	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.

Module M0933: Funda	mentals of Materials Science			
Courses				
<b>Title</b> Fundamentals of Materials Science I (L1085) Fundamentals of Materials Science II (Advanced Ceramic Materials, Polymers and Composites) (L0506)		Typ Lecture Lecture Lecture	<b>Hrs/wk</b> 2 2 2	<b>CP</b> 2 2 2
Physical and Chemical Basics of Mat		Lecture	2	Z
Module Responsible				
	None			
Kecommended Previous Knowledge	Highschool-level physics, chemistry und mathematics			
<b>Educational Objectives</b>	After taking part successfully, students have reached the follow	ing learning results		
Professional Competence				
	The students have acquired a fundamental knowledge on r comprehensively. Fundamental knowledge here means specific phase transformations, corrosion and mechanical properties. The for materials and can identify relevant approaches for chaphenomena back to the underlying physical and chemical laws	ally the issues of atom ne students know abou aracterizing specific pr	ic structure, microstructure the key aspects of characters.	ire, phase diagrams, acterization methods
	The students are able to trace materials phenomena back to the underlying physical and chemical laws of nature. Materials phenomena here refers to mechanical properties such as strength, ductility, and stiffness, chemical properties such as corrosion 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.			
Porsonal Competence				
Personal Competence Social Competence	_			
Autonomy				
-	Independent Childy Time Of Childy Time in Lecture Of			
	Independent Study Time 96, Study Time in Lecture 84			
Credit points				
Course achievement				
Examination				
Examination duration and	180 min			
scale Assignment for the	General Engineering Science (German program, 7 semester): S			
Following Curricula	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 Technomathematics: Specialisation III. Engineering Science: Ele Engineering and Management - Major in Logistics and Mobilit Compulsory	pecialisation Biomedica pecialisation Naval Arc pecialisation Energy an apulsory ergy Technology: Electi tive Compulsory and Processes: Elective	al Engineering: Compulso hitecture: Compulsory nd Enviromental Engineer ve Compulsory Compulsory	ry ing: Compulsory

Course L1085: Fundamentals	s of Materials Science I
Тур	Lecture
Hrs/wk	2
СР	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Prof. Jörg Weißmüller
Language	DE
Cycle	WiSe
Content	
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

•	Chemical Basics of Materials Science
Тур	Lecture
Hrs/wk	
СР	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Prof. Stefan 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	Für den Elektromagnetismus:  • Bergmann-Schäfer: "Lehrbuch der Experimentalphysik", Band 2: "Elektromagnetismus", de Gruyter  Für die Atomphysik:  • Haken, Wolf: "Atom- und Quantenphysik", Springer  Für die Materialphysik und Elastizität:  • Hornbogen, Warlimont: "Metallkunde", Springer

Module M0960: Mech	anics IV (Oscillations, Analytical Mecha	nics, Multibody Systems	s, Numerical	Mechanics)
Courses				
<b>Title</b> Mechanics IV (Oscillations, Analytic	<b>Typ</b> Lecture	Hrs/wk	<b>CP</b> 3	
Mechanics IV (Oscillations, Analytic	Recitation Section (small)	2	2	
-	al Mechanics, Numerical Mechanics) (L1139)	Recitation Section (large)	1	1
Module Responsible				
Admission Requirements	None			
Recommended Previous	Mathematics I-III and Mechanics I-III			
Knowledge				
-	After taking part successfully, students have reached the	following learning results		
Professional Competence				
Knowledge	The students can			
	<ul> <li>describe the axiomatic procedure used in mechan</li> </ul>	ical contexts;		
	<ul> <li>explain important steps in model design;</li> </ul>			
	<ul> <li>present technical knowledge.</li> </ul>			
Chille	The students can			
SKIIIS	The students can			
	<ul> <li>explain the important elements of mathematical in</li> </ul>	mechanical analysis and model for	mation, and apply	y it to the context of
	their own problems;			
	<ul> <li>apply basic methods to engineering problems;</li> </ul>			
	<ul> <li>estimate the reach and boundaries of the methods</li> </ul>	and extend them to be applicable t	o wider problem s	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 strengths	and weaknesses and to organize the	eir time and learn	ing based on those.
Workload in Hours	Independent Study Time 96, Study Time in 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 semes	ter): Specialisation Mechanical Engir	eering: Compulso	ory
Following Curricula	General Engineering Science (German program, 7 semester): Specialisation Biomedical Engineering: Compulsory			ory
	General Engineering Science (German program, 7 semes	ter): Specialisation Naval Architectur	re: Compulsory	
	Energy Systems: Technical Complementary Course Core	Studies: Elective Compulsory		
	Mechanical Engineering: Core qualification: Compulsory			
	Mechatronics: Core qualification: Compulsory			
	Naval Architecture: Core qualification: Compulsory			
	Technomathematics: Specialisation III. Engineering Scien	, ,		
	Theoretical Mechanical Engineering: Technical Complement	entary Course Core Studies: 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	Elements of vibration theory Vibration of Multi-degree of freedom systems Analytical Mechanics Multibody Systems Numerical methods for time integration Introduction to Matlab
Literature	K. Magnus, H.H. Müller-Slany: Grundlagen der Technischen Mechanik. 7. Auflage, Teubner (2009).  D. Gross, W. Hauger, J. Schröder, W. Wall: Technische Mechanik 1-4. 11. Auflage, Springer (2011).  W. Schiehlen, P. Eberhard: Technische Dynamik, Springer (2012).

Course 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	
СР	1	
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14	
Lecturer	Prof. Robert Seifried	
Language	DE	
Cycle	SoSe	
Content	See interlocking course	
Literature	See interlocking course	

Module M0854: Math	ematics IV			
Courses				
Title		Тур	Hrs/wk	СР
Differential Equations 2 (Partial Dif Differential Equations 2 (Partial Dif		Lecture Recitation Section	2 (small) 1	1
Differential Equations 2 (Partial Dif	•	Recitation Section		1
Complex Functions (L1038)		Lecture	2	1
Complex Functions (L1041)		Recitation Section		1
Complex Functions (L1042)	Prof. Anusch Taraz	Recitation Section	(large) I	1
Module Responsible  Admission Requirements				
Recommended Previous				
Knowledge				
<b>Educational Objectives</b>	After taking part successfully, students have reached	the following learning results	i	
<b>Professional Competence</b>				
Knowledge	Students can name the basic concepts in Mather	amatics IV. Thou are able to	avalain thom using appro	priato ovamplos
	Students can fisher the basic concepts in Matrix     Students can discuss logical connections betw			•
	the help of examples.	,		
	They know proof strategies and can reproduce	them.		
Skills	Students can model problems in Mathematics	IV with the help of the cond	rents studied in this cour	rse Moreover they are
	capable of solving them by applying establishe		cepts studied in this coul	se. Moreover, they are
	Students are able to discover and verify further	logical connections between	the concepts studied in	the course.
	For a given problem, the students can develop	p and execute a suitable a	pproach, and are able to	critically evaluate the
	results.			
Personal Competence				
Social Competence	Students are able to work together in teams. The students are able to work together.	ney are capable to use mathe	ematics as a common lan	guage.
	In doing so, they can communicate new conce			
	design examples to check and deepen the und	erstanding of their peers.		
Autonomy	Students are capable of checking their unders	tanding of complex concepts	on their own. They can	specify open questions
	precisely and know where to get help in solving	them.		
	Students have developed sufficient persistence	e to be able to work for lor	iger periods in a goal-ori	ented manner on hard
	problems.			
Workload in Hours  Credit points		.2		
Course achievement				
Examination				
Examination duration and		uations 2)		
scale				
Assignment for the	General Engineering Science (German program, 7 ser	nester): Specialisation Electri	cal Engineering: Compuls	sory
Following Curricula	General Engineering Science (German program, 7	semester): Specialisation	Mechanical Engineering	, Focus Mechatronics:
	Compulsory			
	General Engineering Science (German program, 7 ser General Engineering Science (German program, 7 ser			
		nester): Specialisation Mecha	anicai Engineering, Focus	meoreticai Mechanicai
	Engineering: Elective Compulsory  Computer Science: Specialisation Computational Mathematics: Elective Compulsory			
	Electrical Engineering: Core qualification: Compulsory	·	•	
	General Engineering Science (English program, 7 semester): Specialisation Electrical Engineering: 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 Theoretical Mechanical			
	Engineering: Compulsory  Computational Science and Engineering: Specialization II. Mathematics S. Engineering Science: Elective Compulsory			
	Computational Science and Engineering: Specialisation II. Mathematics & Engineering Science: Elective Compulsory  Mechanical Engineering: Specialisation Mechatronics: Compulsory			
	Mechanical Engineering: Specialisation Mechatronics: Compulsory  Mechanical Engineering: Specialisation Theoretical Mechanical Engineering: Elective Compulsory			
	Mechatronics: Core qualification: Compulsory			
	Naval Architecture: Core qualification: Compulsory			
	Theoretical Mechanical Engineering: Technical Comple	ementary Course Core Studie	s: Elective Compulsory	

Course L1043: Differential Equations 2 (Partial Differential Equations)		
Тур	Lecture	
Hrs/wk	2	
СР	1	
Workload in Hours	Independent Study Time 2, Study Time in Lecture 28	
Lecturer	Dozenten des Fachbereiches Mathematik der UHH	
Language	DE	
Cycle	SoSe	
Content	Main features of the theory and numerical treatment of partial differential equations	
Literature	<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> </ul>	
Literature	http://www.math.uni-hamburg.de/teaching/export/tuhh/index.html	

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

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

Course L1038: Complex Fund	tions
Тур	Lecture
Hrs/wk	2
СР	1
Workload in Hours	Independent Study Time 2, Study Time in Lecture 28
Lecturer	Dozenten des Fachbereiches Mathematik der UHH
Language	DE
Cycle	SoSe
Content	Main features of 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> <li>http://www.math.uni-hamburg.de/teaching/export/tuhh/index.html</li> </ul>

Course L1041: Complex Functions	
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 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

Module M0680: Fluid	Dynamics			
Courses				
Title		Тур	Hrs/wk	СР
Fluid Mechanics (L0454)		Lecture	3	4
Fluid Mechanics (L0455)		Recitation Section (large)	2	2
Module Responsible	Prof. Thomas Rung			
Admission Requirements	None			
Recommended Previous	Sound knowledge of engineering mathematics, engineer	ring mechanics and thermodynamics.		
Knowledge				
<b>Educational Objectives</b>	After taking part successfully, students have reached the	ne following learning results		
<b>Professional Competence</b>				
Knowledge	Students will have the required sound knowledge to	explain the general principles of flui	d engineering a	nd physics of fluids.
	Students can scientifically outline the rationale of flow	physics using mathematical models a	nd are familiar v	with methods for the
	performance analysis and the prediciton of fluid engine	ering devices.		
Chille	Charles to a ship to a such fluid as air a single single single	and flavoring and date for the condi-		
SKIIIS	Students are able to apply fluid-engineering principles enables the student to carry out all necessary theore			*
	scientific level.	cical calculations for the huld dynamic	. design of engli	leering devices on a
	scientific level.			
Personal Competence				
Social Competence	The students are able to discuss problems and jointly d	evelop 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	180 min			
scale				
Assignment for the	General Engineering Science (German program, 7 seme	ester): Specialisation Mechanical Engine	eering: Compulso	ory
Following Curricula	General Engineering Science (German program, 7 seme	ester): Specialisation Biomedical Engine	eering: Compulso	ory
	General Engineering Science (German program, 7 seme	ester): Specialisation Naval Architecture	e: Compulsory	
	Mechanical Engineering: Core qualification: Compulsory	,		
	Naval Architecture: Core qualification: Compulsory			
	Technomathematics: Specialisation III. Engineering Scientific Scie	ence: Elective Compulsory		

Course L0454: Fluid Mechani	ics
Тур	Lecture
Hrs/wk	3
СР	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> <li>the course primarily refers to / das Modul stütz sich bevorzugt auf:         <ul> <li>Munson, B.R.; Rothmayer, A.P.; Okiishi, T.H.; Huebsch, W.W.: Fundamentals of Fluid Mechanics, John Wiley &amp; Sons.</li> </ul> </li> </ul>
	<ul> <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

Module M0640: Stoch	astics and Ship Dynamics			
Courses				
Title Ship Dynamics (L0352) Ship Dynamics (L1620) Statistics and Stochastic Processes	in Naval Architecure and Ocean Engineering (L0364)	Typ Lecture Recitation Section (small) Lecture	<b>Hrs/wk</b> 2 1 2	CP 3 1 3
Module Responsible	Prof. Moustafa Abdel-Maksoud			-
Admission Requirements				
Recommended Previous Knowledge	Technical mechanics Linear algebra, analysis, complex numbers Fluid mechanics			
<b>Educational Objectives</b>	After taking part successfully, students have reached the fo	ollowing learning results		
Professional Competence				<u> </u>
Knowledge	<ul> <li>The students are able to give an overview over various memoredure of the manoeuvres.</li> <li>The students are able to give an overview over varius rud</li> </ul>			
	- The students can name computation methods which are u	used to determine forces and moti	ons in waves.	
Skills	- The students can come up with the equations of motions - The students are able to determine hydrodynamic coeffic	ients and they can explain their ph	nysical meaning.	e and linearise them.
	<ul> <li>The students can explain how a rudder works and they ca</li> <li>The students can mathematically describe waves.</li> <li>The students can explain the mathematically description</li> </ul>			mine them.
Personal Competence				
Social Competence	- The students can arrive at work results in groups and doc	ument them.		
,	- The students can discuss in groups and explain their poin			
Autonomy	- The students can assess their own strengthes and weakne	esses and the define further work	steps on this basi	S.
Workload in Hours	Independent Study Time 140, Study Time in Lecture 70			
Credit points	7			
Course achievement	None			
Examination	Written exam			
Examination duration and scale	180 min			
Assignment for the Following Curricula				

Course L0352: Ship Dynamic	s
Тур	Lecture
Hrs/wk	2
СР	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Prof. Moustafa Abdel-Maksoud
Language	DE
Cycle	SoSe
Content	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 Universität Hamburg-Harburg, 2014</li> <li>Abdel-Maksoud, M., Ship Dynamics, Lecture notes, Institute for Fluid Dynamic and Ship Theory, Hamburg University of Technology, 2014</li> <li>Bertram, V., Practical Ship Design Hydrodynamics, Butterworth-Heinemann, Linacre House - Jordan Hill, Oxford, United 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 and 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 Dynamics	
Тур	Recitation Section (small)
Hrs/wk	1
СР	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

Course L0364: Statistics and	Stochastic Processes in Naval Architecure and Ocean Engineering
Тур	Lecture
Hrs/wk	2
СР	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Dr. Sven Wassermann
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	V. Müller, Statistik und Stochastik in der Schiffs- und Meerestechnik, Vorlesungsskript, Institut für Fluiddynamik und Schiffstheorie, Technische Universität Hamburg-Harburg, 2014  W. Blendermann "Grundlagen der Wahrscheinlichkeitsrechnung", Vorlesungsskript, Arbeitsbereich Fluiddynamik und Schiffstheorie, Technische Universität Hamburg-Harburg, 2001  H. W. Coleman, W. G. Steele, Experimentation and Uncertainty Analysis for Engineers, 3 <sup>rd</sup> Edition, John Wiley & Sons, Inc., New York, NY, 2009  ITTC Recommended Procedures and Guidelines, In: Quality Systems Manual, International Towing Tank Conference (ITTC), 2011  F.M. Dekking, C. Kraaikamp, H.P. Lopuhaä, L.E. Meester, A Modern Introduction To Probability and Statistics, Springer, 2005  Springer Handbook of Engineering Statistics, H. Pham (Hrsg.), Springer, 2006  A. Klenke, Wahrscheinlichkeitstheorie, Springer, 2013

Courses				
Title		Тур	Hrs/wk	СР
Ship Structural Design (L0412)		Lecture	2	3
Ship Structural Design (L0415)		Recitation Section (sm	all) 2	3
Welding Technology (L1123)		Lecture	3	3
Module Responsible P	Prof. Sören Ehlers			
Admission Requirements N	lone			
Recommended Previous M	Mechanics I - III			
Knowledge F	undamentals of Materials Science I - III			
W	Velding Technology I			
F	undamentals of Mechanical Design I - III			
Educational Objectives A	after taking part successfully, students have reac	ned the following learning results		
Professional Competence				
Knowledge S	students can reproduce design and sizing as well	as fabrication of the different areas	of ship structures and	of different ship types
(i	incl. detail design); they can describe calculation	models for complex structures.		
	students are capable to specify the requirement components, to select suitable calculation models		of the hull, to define	design criteria for the
Personal Competence				
Social Competence S	tudents are capable to present their structural d	esign and discuss their decisions con	structively in a group.	
-	students are capable to design independently deppropriate fabrication methods.	ifferent structural areas of the ship	hull and different shi	p types and to define
Workload in Hours In	ndependent Study Time 172, Study Time in Lectu	ire 98		
Credit points 9	)			
Course achievement N	lone			
Examination W	Vritten exam			
Examination duration and 3	hours			
scale				
Assignment for the G	General Engineering Science (German program, 7	semester): Specialisation Naval Arch	nitecture: Compulsory	
Following Curricula G	General Engineering Science (English program, 7	semester): Specialisation Naval Arch	itecture: Compulsory	
_	laval Architecture: Core qualification: Compulsor			

Course L0412: Ship Structura	al Design
Тур	Lecture
Hrs/wk	2
СР	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Prof. Sören Ehlers
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 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	
Cycle	
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.

Module M0659: Fundamentals of Ship Structural Design and Analysis				
Courses				
Title		Тур	Hrs/wk	СР
Fundamentals of Ship Structural De	esign (L0411)	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				
Admission Requirements				
Recommended Previous				
Knowledge	Fundamentals of Materials Science I - III			
	Welding Technology I			
	Fundamentals of Mechanical Design I - III			
Educational Objectives	After taking part successfully, students have reached	the following learning results		
Professional Competence				
Knowledge	Students can reproduce the basic contents of the stru		y can explain the	theory and methods
	for the calculation of deformations and stresses in bea	am-like structures.		
	Furthermore, they can reproduce the basis contents	of codes (rules), materials, semi-finish	ed products, join	ing and principles of
	structural design of components in the ship structure.			3
Skills	Students are capable of applying the methods and	tools for the calculation of linear def	ormations and s	tresses in the above
	mentioned structures; they can choose calculation mo			
	,,			
	Furthermore, they are capable to apply the methods	of drawing and sizing the ship structur	e; they can sele	ct suitable materials,
	semi-finished products and joints.			
Personal Competence				
Social Competence	·	te in a professional environment in the	e shipbuilding ar	d component supply
	industry.			
Autonomy	The students are capable to independently idealize i	real ship structures and to select suital	ole methods for	analysis of beam-like
,	structures; they are capable to assess the results of s			Í
	Furthermore, they are capable to assess drawing	s of complex ship structures and to	design ship st	ructures for various
	requirements and boundary conditions.			
Workload in Hours	Independent Study Time 156, Study Time in Lecture 8	34		
Credit points	8			
Course achievement	None			
Examination	Written exam			
Examination duration and	3 hours			
scale	3			
Assignment for the	General Engineering Science (German program, 7 ser	mester): Specialisation Naval Architectur	re: Compulsory	
Following Curricula	General Engineering Science (German program, 7 ser General Engineering Science (English program, 7 sem	•		
i onowing curricula	Naval Architecture: Core qualification: Compulsory	iester). Specialisadori Navai Arciillecturi	Compulsory	
	Traval Architecture. Core qualification. Compulsory			

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

Course L0413: Fundamentals	s of Ship Structural Design
Тур	Recitation Section (small)
Hrs/wk	1
СР	2
Workload in Hours	Independent Study Time 46, Study Time in Lecture 14
Lecturer	Prof. Sören Ehlers
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
	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	s of Ship Structural Analysis
Тур	Lecture
Hrs/wk	2
СР	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
	Finite element method (f.e. method) by the example of trussworks
	3. Force methods for frameworks
	4. F.e. method for frameworks
	5. Shear and torsion in thin-walled beams
	6. Beams subjected to longitudinal forces
Literature	Vorlesungsskript mit weiteren Literaturangaben; div. Bücher über die Methode der finiten Elemente

Course L0414: Fundamentals of Ship Structural Analysis		
Тур	Recitation Section (small)	
Hrs/wk	1	
СР	2	
Workload in Hours	Independent Study Time 46, Study Time in Lecture 14	
Lecturer	Prof. Sören Ehlers	
Language	DE	
Cycle	WiSe	
Content	Contents:	
	1. Introduction	
	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	

Module M1109: Resis	tance and Propulsion			
Courses				
Title		Тур	Hrs/wk	СР
Resistance and Propulsion (L1265)		Lecture	2	3
Resistance and Propulsion (L1266)		Recitation Section (large)	2	3
Module Responsible	-			
Admission Requirements	None			
Recommended Previous Knowledge	Mechanics     Fluid Dynamics for Naval Architects     Hydrostratics			
<b>Educational Objectives</b>	After taking part successfully, students have reached th	e following learning results		
Professional Competence				
	The hydrodynamic basics that are relevant for resistance and propulsion of ships are discussed. The different resistance phenomena and their practical applications to hullform design as well as numerical and empirical prediction methods are subject of the course. Furthermore, environmental additional resistances are dealt with. The course includes model test techniques and their application to full scale ships. This hold also for propulsion and hullefficiency elements, mainly thrust deduction and wake. Main Focus is how hull forms can be optimized for minimum and sustainable fuel consumption. The following topics are dealt with:  - Stillwater/added resistance, Wave resistance, Minimization of wave resistance, numerical prediction methods, friction laws, laminar/turbulent flow separation, Hull form design for redcude flow separation, Appendage Design and resistance, Froude's resistance law, form factor method, thrust deduction, wake, model scaling laws, resistance tests, free running propeller tests and propeller basics, propulsion tests, full scale speed power predictions, additional resistances (wind, steering, current, sea state), EEDI, speed trials, contractual matters concerning speed/power, bunker claims  The student shall learn to design competitive hull forms with respect to fuel consumption by applying numreical techniques and to evaluate these hulls by several progosis methods. Furtermore, the course will enable the student to clearl determine and minimize the required power including environmental influences.			
Personal Competence				
•	The student learns to prepare technical matters in such	a way that he can compte with his bu	ilding suvervisio	n team.
Autonomy	The student learns to prepare technical matters in such	a way that he can compte with his bu	ilding suvervisio	n 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	180 min		<u> </u>	
scale				
Assignment for the	General Engineering Science (German program, 7 seme	ster): Specialisation Naval Architectur	e: Compulsory	
Following Curricula	General Engineering Science (English program, 7 semes	ter): Specialisation Naval Architecture	e: Compulsory	
	Naval Architecture: Core qualification: Compulsory			

Course L1265: Resistance and Propulsion	
Тур	Lecture
Hrs/wk	2
СР	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Prof. Stefan Krüger
Language	DE
Cycle	WiSe
Content	
Literature	

Course L1266: Resistance and Propulsion		
Тур	Recitation Section (large)	
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	See interlocking course	
Literature	See interlocking course	

Module M0655: Computational Fluid Dynamics I						
Courses						
litle little		Тур	Hrs/wk	СР		
Computational Fluid Dynamics I (L0235)		Lecture	2	3		
Computational Fluid Dynamics I (L0419)		Recitation Section (large)	2	3		
Module Responsible	Prof. Thomas Rung					
Admission Requirements	None					
Recommended Previous	Mathematical Methods for Engineers					
Knowledge	Fundamentals of Differential/integral calculus	and series expansions				
Educational Objectives	After taking part successfully, students have reache	d the following learning results				
Professional Competence						
Knowledge	The students are able to list the basic numerics of p	artial differential equations.				
Skills	The students are able develop appropriate numerical integration in space and time for the governing partial differential equation					
	They can code computational algorithms in a structi	ured way.				
Personal Competence						
Social Competence	The students can arrive at work results in groups an	d document them.				
Autonomy	The students can independently analyse approache.	s to solving specific problems.				
Workload in Hours	Independent Study Time 124, Study Time in Lecture	2 56				
Credit points	6					
Course achievement	None					
Examination	Written exam					
Examination duration and	2h					
scale						
Assignment for the	General Engineering Science (German program, 7 s	emester): Specialisation Mechanical Engi	neering, Focus Th	neoretical Mechanica		
Following Curricula	Engineering: Elective Compulsory					
General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, I						
	Engineering: Elective Compulsory	7	<b>.</b>	5 6 :		
	General Engineering Science (German program,	r semester): Specialisation Mechanical	Engineering, Foo	tus Energy Systems		
	Elective Compulsory  General Engineering Science (Gorman program, 7 science)	omostor): Specialisation Naval Architectur	o. Compulson:			
	General Engineering Science (German program, 7 s General Engineering Science (German program, 7 s			ring: Compulsory		
	Energy Systems: Technical Complementary Course		omeniai Enginee	ing. Compulsory		
	General Engineering Science (English program, 7 se	, ,	mental Engineer	ing: Compulsory		
	General Engineering Science (English program, 7		_			
	Elective Compulsory	, , , , , , , , , , , , , , , , , , , ,	J 52g, 100	5, 5,500.115		
	General Engineering Science (English program, 7 se	mester): Specialisation Naval Architecture	e: Compulsory			
	General Engineering Science (English program, 7	•		cus Aircraft Systems		
	Engineering: Elective Compulsory	•				
	Mechanical Engineering: Specialisation Energy Syste	ems: Elective Compulsory				
	Mechanical Engineering: Specialisation Aircraft Syst	ems Engineering: Elective Compulsory				
	Naval Architecture: Core qualification: Compulsory					
	Technomathematics: Specialisation III. Engineering	Science: Elective Compulsory				

Course L0235: Computationa	al Fluid Dynamics I
Тур	Lecture
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	Fundamentals of computational modelling of thermofluid dynamic problems. Development of numerical algorithms.
	<ol> <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

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

Module M1110: Ship	Design			
Courses				
Title		Тур	Hrs/wk	СР
Ship Design (L1262)		Lecture	2	3
Ship Design (L1264)		Recitation Section (large)	2	3
Module Responsible	Prof. Stefan Krüger			
Admission Requirements	None			
Recommended Previous				
Knowledge	Fluid Dynamics for Naval Architects, Resistance and  Provided to the description  Provided to the	Propulsion		
	Resistance and Propulsion, Hydrostatics			
<b>Educational Objectives</b>	After taking part successfully, students have reached the f	ollowing learning results		
Professional Competence				
Knowledge	The lecture starts with an overview about the importance	and requirements of the aerly de	esign phase. Com	petitive Elements of
	Ship Designs are thoroughly discussed. Typical bulding cor	tracts and the related technical ris	sk are introduced.	The most important
	main parameters of a ship are introduced and their influ	ence on the competitiveness of a	design. The lect	ure focusses on the
	influence of alternated main parameters on the total perfe		•	
	lecture, the design changes are dealt with by simple m		shall further learr	n to model complex
	systems properly so that the relavent technical conclusions	s can be drawn.		
	The lecture continues with an introduction into the difference	ent phases of design project, from	the initial design	phase to a building
	contract. Further, methods are introduced to generate bu	ding specfication relevant informa	ation at different l	evens of granularity
	during the different design stages. In detail, the following t	opics are adressed:		
	- Structure of a building specification			
	- Determination of Light Ship Weight and Deadweight			
	Components			
	- Design of main section and hull form			
	- Design of aftbody lines and manoevering devices			
	- Design of main propulsion plant - Design of subdivision			
	- Design of Subdivision - Determination of limiting GMrequ- Curves			
	- Scantlings of most improtant structural members			
	- Longitudinal strength			
	- Outfitting Components			
	- Relevant rules and regulations			
CL III				
Skills	The student is made familiar with the basic design prince			
	student shall be able to carry out a concept design based the Marine Environment. The lecture deals with the basic			
	of a ship design with respect to fulfillment procedures of t			
	relevant methods to determine and judge uopn the perform			or one beorgin and
	,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,	, ,		
Personal Competence				
Social Competence	The students learns to prepare technical matters in s	uch a way the he can persuade	his potantial c	ustomer against his
	competitors.	under a communities de	his and the	
Autonomy	The students learns to prepare technical matters in s	ucn a way the he can persuade	nis potantial ci	ustomer against his
	competitors.			
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56			
Credit points	6			
Course achievement	None			
Examination	Written exam			
Examination duration and	180 min			
scale				
Assignment for the	General Engineering Science (German program, 7 semeste	r): Specialisation Naval Architectur	e: Compulsory	
Following Curricula	General Engineering Science (English program, 7 semester	): Specialisation Naval Architecture	e: Compulsory	
	Naval Architecture: Core qualification: Compulsory			

Course L1262: Ship Design	
Тур	Lecture
Hrs/wk	2
СР	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Prof. Stefan Krüger
Language	DE
Cycle	SoSe
Content	
Literature	

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

## **Specialization Process Engineering**

Process engineering is the engineering discipline that conducts research into, develops, and realizes material change processes. It deals as a cross-sectional 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.

Title Introduction into Process Engineering/Bioprocess Engineering (L0829) Lecture  Introduction into Process Engineering (L0830) Lecture  Independent of Material engineering (L0830) Lecture  Independent of Locative (Locative (L0830)) Independent of Material engineering (L0830) Independent of Material engineering (L0	
introduction into Process Engineering (Bioprocess Engineering (L0829)  Lecture 2 2  Module Responsible Admission Requirements None  Recommended Previous Knowledge  Educational Objectives After taking part successfully, students have reached the following learning results  Professional Competence Knowledge  After passing this module the students have the ability to:  • give an overview of the most important fields on process engineering.  • explain some working methods for different fields in process engineering,  • name the most important working approaches or methods of the different fields of process engineering,  • read and prepare an engineering drawing,  • explain the most important technologies for wastewater and exhaust air treatment  • scheme typical chemical and biotechnological processes independently with the aid of pointers.	
Fundamentals of material engineering (L0830)  Module Responsible Prof. Michael Schlüter  Admission Requirements None  Recommended Previous Knowledge Educational Objectives After taking part successfully, students have reached the following learning results  Professional Competence Knowledge After passing this module the students have the ability to:  • give an overview of the most important fields on process and bioprocess engineering, • explain some working methods for different fields in process engineering.   **After passing this module the students should have the ability to:  • list and outline the most important fields of process engineering, • name the most important working approaches or methods of the different fields of process engineering, • read and prepare an engineering drawing, • explain the most important technologies for wastewater and exhaust air treatment • scheme typical chemical and biotechnological processes independently with the aid of pointers.	
Module Responsible         Prof. Michael Schlüter           Admission Requirements         None           Recommended Previous Knowledge         none           Educational Objectives         After taking part successfully, students have reached the following learning results           Professional Competence         Knowledge           Knowledge         After passing this module the students have the ability to: <ul> <li>give an overview of the most important fields on process and bioprocess engineering,</li> <li>explain some working methods for different fields in process engineering.</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></ul>	
Admission Requirements Recommended Previous Knowledge  Educational Objectives Professional Competence  Knowledge  After passing this module the students have the ability to:  • give an overview of the most important fields on process and bioprocess engineering, • explain some working methods for different fields in process engineering.  Skills  After passing this module the students should have the ability to:  • list and outline the most important fields of process engineering, • name the most important working approaches or methods of the different fields of process engineering, • read and prepare an engineering drawing, • explain the most important technologies for wastewater and exhaust air treatment • scheme typical chemical and biotechnological processes independently with the aid of pointers.	
Recommended Previous Knowledge  Educational Objectives After taking part successfully, students have reached the following learning results  Professional Competence Knowledge After passing this module the students have the ability to:  • give an overview of the most important fields on process and bioprocess engineering, • explain some working methods for different fields in process engineering.  Skills After passing this module the students should have the ability to:  • list and outline the most important fields of process engineering, • name the most important working approaches or methods of the different fields of process engineering, • read and prepare an engineering drawing, • explain the most important technologies for wastewater and exhaust air treatment • scheme typical chemical and biotechnological processes independently with the aid of pointers.	
Educational Objectives After taking part successfully, students have reached the following learning results  Professional Competence  Knowledge After passing this module the students have the ability to:  • give an overview of the most important fields on process and bioprocess engineering,  • explain some working methods for different fields in process engineering.  Skills After passing this module the students should have the ability to:  • list and outline the most important fields of process engineering,  • name the most important working approaches or methods of the different fields of process engineering,  • read and prepare an engineering drawing,  • explain the most important technologies for wastewater and exhaust air treatment  • scheme typical chemical and biotechnological processes independently with the aid of pointers.	
Educational Objectives  After taking part successfully, students have reached the following learning results  Professional Competence  Knowledge  After passing this module the students have the ability to:  • give an overview of the most important fields on process and bioprocess engineering,  • explain some working methods for different fields in process engineering.   Skills  After passing this module the students should have the ability to:  • list and outline the most important fields of process engineering,  • name the most important working approaches or methods of the different fields of process engineering,  • read and prepare an engineering drawing,  • explain the most important technologies for wastewater and exhaust air treatment  • scheme typical chemical and biotechnological processes independently with the aid of pointers.	
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<ul> <li>explain some working methods for different fields in process engineering.</li> <li>Skills</li> <li>After passing this module the students should have the ability to: <ul> <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> </li></ul>	
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<ul> <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>	
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<ul> <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>	
scheme typical chemical and biotechnological processes independently with the aid of pointers.	
Personal Competence	
Personal Competence	
Social Competence The students are able to	
a work out regults in groups and document them	
<ul> <li>work out results in groups and document them,</li> <li>provide appropriate feedback and handle feedback on their own performance constructively.</li> </ul>	
provide appropriate regulack and findule regulack of their own performance constructively.	
Autonomy The students are able to estimate their progress of learning by themselves and to deliberate their lack of knowledge in Pr	ocess
Engineering and Bioprocess Engineering.	
Workload in Hours Independent Study Time 34, Study Time in Lecture 56	
Credit points 3	
Course achievement Compulsory Bonus Form Description	$\overline{}$
No 5 % Written elaboration	
Examination Written exam	
Examination duration and 90 min	
scale	
Assignment for the General Engineering Science (German program, 7 semester): Specialisation Process Engineering: Compulsory	
Following Curricula General Engineering Science (German program, 7 semester): Specialisation Bioprocess Engineering: Compulsory	
Bioprocess Engineering: Core qualification: Compulsory	
Orientation Studies: Core qualification: Elective Compulsory	
Process Engineering: Core qualification: Compulsory	

Course L0829: Introduction into Process Engineering/Bioprocess Engineering		
Тур	Lecture	
Hrs/wk	2	
СР	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.	
	G. UD	
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>

Module M1497: Meas	urement Technol	ogy for VT/ BVT			
Courses					
Title			Тур	Hrs/wk	СР
Practical Course Measurement Tech	nnology (L2270)		Practical Course	2	2
Measurement Technology (L2268)			Lecture	2	2
Physical Fundamentals of Measurer	ment Technology (L2269)		Lecture	2	2
Module Responsible	Prof. Alexander Penn				
Admission Requirements	None				
Recommended Previous	Technical interest, logic	al skills, integral- and d	fferential calculus, basic physical conce	pts such as tempera	ture, mass, velocity,
Knowledge	etc				
Educational Objectives	After taking part succes	sfully, students have rea	ched the following learning results		
Professional Competence	3 1 3 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1	7,	<u> </u>		
Knowledge	Physical basics: kinem	atics and dynamics (th	eory of motion), rotation of rigid boo	lies, energy and mo	mentum, electricity.
		drodynamics, temperatu		, ,	,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,
		,	-		
			ement uncertainty, basics of sensor tec		nciples, temperature
	measurement, pressure	measurement, level me	asurement, flow measurement. Usage of	Matlab scripts.	
	Practical course: Pressu	re drop in piping, calorin	netry, image data acquisition, flow meas	urement, concentration	on measurement and
	mass transfer, capacitiv	e measurements of solid	concentrations, spectroscopy, error calc	ulation, chromatogra	phy
61.71					
Skills			I topics, analysis of an experimental tes		
	calculations.	iab, use oi reievant iat	poratory measurement technology, pre	paration of a test pr	otocoi, execution of
	calculations.				
Personal Competence					
Social Competence	Arrangement and divisi	on of work in practical t	raining and learning groups, assessmen	t of own level of kno	wledge, work on the
	experimental stand in	groups, consultation v	ith persons responsible for teaching,	presentation of the	preparation of the
	experiment, tolerance o	f frustration			
Autonomy	Time management of th	ne workload independer	nt development of the thematic basics,	nersonal responsibility	v for the provision of
, ideanomy	_		ctice of presentation in front of a gro		· ·
		detailed questions by us			,
Workload in Hours	Independent Study Time	e 96, Study Time in Lectu	ire 84		
Credit points	6				
Course achievement		Form	Description		
Examination	Written exam	Excercises	Popup-Quizzes währen der Vorlesung		
Examination duration and scale	120 min				
	Conoral Engineering Sci	onco (Cormon program	7 competer), Specialisation Process Engi	nooring, Compulsory	
Assignment for the Following Curricula		· -	<ul><li>7 semester): Specialisation Process Engi</li><li>7 semester): Specialisation Process Engi</li></ul>		
i onowing curricula			7 semester): Specialisation Bioprocess E		orv
			7 semester): Specialisation Green Techn		,
		Core qualification: Com			
	'		7 semester): Specialisation Process Engir	neering: Compulsory	
			re qualification: Compulsory	- , ,	
		e qualification: Elective (			
	Process Engineering: Co	re qualification: Compuls	sory		

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

Course L2269: Physical 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					
itle		Тур	Hrs/wk	СР	
undamentals of Fluid Mechanics (I		Lecture Recitation Section (large)	2	4 2	
luid Mechanics for Process Engine		Recitation Section (large)	2	2	
Module Responsible					
Admission Requirements Recommended Previous	None				
Knowledge	Mathematics I+II+III				
	Technical Mechanics I+II				
	Technical Thermodynamics I+II				
	Working with force balances     Cimplification and solving of partial differences.	reptiel equations			
	<ul><li>Simplification and solving of partial diffe</li><li>Integration</li></ul>	rential equations			
	• Integration				
<b>Educational Objectives</b>	After taking part successfully, students have re	eached the following learning results			
<b>Professional Competence</b>					
Knowledge	Students are able to:				
	explain the difference between different types of flow				
		ns of the Reynolds Transport-Theorem in proce	ess engineering		
	<ul> <li>explain simplifications of the Continuity-</li> </ul>	and Navier-Stokes-Equation by using physica	boundary condit	ions	
Ckilla	The students are able to				
SKIIIS	The students are able to				
	<ul> <li>describe and model incompressible flows</li> </ul>	s mathematically			
	• reduce the governing equations of fluid mechanics by simplifications to archive quantitative solutions e.g. by integration				
	notice the dependency between theory and technical applications				
	<ul> <li>use the learned basics for fluid dynamical</li> </ul>	al applications in fields of process engineering			
Personal Competence					
Social Competence	The students				
	are capable to gather information from	subject related professional publications and	relate that inform	nation to the cont	
	<ul> <li>are capable to gather information from subject related, professional publications and relate that information to the context of the lecture and</li> </ul>				
		d tasks in small groups. They are able to pre	ent their results	effectively in Eng	
	(e.g. during small group exercises)				
	<ul> <li>are able to work out solutions for exercise</li> </ul>	ses by themselves, to discuss the solutions or	ally and to presen	t the results.	
Autonomy	The students are able to				
Autonomy	The students are able to				
	search further literature for each topic a	nd to expand their knowledge with this literate	ıre,		
	<ul> <li>work on their exercises by their own and</li> </ul>	I to evaluate their actual knowledge with the f	eedback.		
Workload in Hours	Independent Study Time 124, Study Time in Le	ecture 56			
Credit points	6				
Course achievement	Compulsory Bonus Form	Description			
	Yes 5 % Midterm				
Examination					
Examination duration and	3 hours				
scale					
Assignment for the	General Engineering Science (German program			an.	
rollowing curricula	General Engineering Science (German program General Engineering Science (German program			лу	
	General Engineering Science (German program			rina: Compulsory	
	Bioprocess Engineering: Core qualification: Con		2.19.100	gpa.551 y	
	Energy and Environmental Engineering: Core q				
	Green Technologies: Energy, Water, Climate: C				
	Logistics and Mobility: Specialisation Traffic Pla	nning and Systems: Elective Compulsory			
	Technomathematics: Specialisation III. Enginee	ring Science: Elective Compulsory			
	Process Engineering: Core qualification: Compu	•			
	Engineering and Management - Major in Logisti	ics and Mobility: Specialisation Traffic Planning	and Systems: Ele	ective Compulsory	

Course L0091: Fundamentals	of Fluid Mechanics
Тур	Lecture
Hrs/wk	2
СР	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	Crowe, C. T.: Engineering fluid mechanics. Wiley, New York, 2009.     Durst, F.: Strömungsmechanik: Einführung in die Theorie der Strömungen von Fluiden. Springer-Verlag, Berlin, Heidelberg, 2006.
	<ol> <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> </ol>
	<ol> <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-</li> </ol>
	Verlag, Berlin, Heidelberg, 2008  10. Schlichting, H.: Grenzschicht-Theorie. Springer-Verlag, Berlin, 2006  11. van Dyke, M.: An Album of Fluid Motion. The Parabolic Press, Stanford California, 1882.  12. White, F.: Fluid Mechanics, Mcgraw-Hill, ISBN-10: 0071311211, ISBN-13: 978-0071311212, 2011

Тур	Recitation Section (large)
Hrs/wk	
СР	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Prof. Michael Schlüter
Language	DE
Cycle	SoSe 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>

Module M0544: Phase	e Equilibria Thermodynamics			
Courses				
<b>Title</b> Phase Equilibria Thermodynamics (	(L0114)	<b>Typ</b> Lecture	Hrs/wk	<b>CP</b> 2
Phase Equilibria Thermodynamics (		Recitation Section (small)	1	2
Phase Equilibria Thermodynamics (		Recitation Section (large)	1	2
Module Responsible				
Admission Requirements		and and the		
Kecommended Previous Knowledge	Mathematics, Physical Chemistry, Thermodyna	imics i and ii		
Educational Objectives	After taking part successfully, students have re	eached the following learning results		
Professional Competence Knowledge	·			
Skills	<ul> <li>Applying their knowledge, the students are able to identify the correct equation for the determination of the equilibrius 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 the 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 well 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 ma separation and reaction processes in chemical engineering.</li> </ul>			
Personal Competence Social Competence Autonomy	The students are able to find necessary	information self-reliantly in literature sources a able to check their learning progress con-	and to judge their	quality.
Workload in Hours	Independent Study Time 124, Study Time in Le	ecture 56		
Credit points				
Course achievement	None			
Examination	Written exam			
Examination duration and scale	120 minutes; theoretical questions and calcula	ations		
	General Engineering Science (German progran	n. 7 semester): Specialisation Process Enginee	ring: Compulsory	
Following Curricula				ory
<b>3</b>	General Engineering Science (German progran Compulsory Bioprocess Engineering: Core qualification: Coi	n, 7 semester): Specialisation Green Technolog		•
	Green Technologies: Energy, Water, Climate: S	Specialisation Bioresource Technology: Elective	Compulsory	
		•		

Course L0114: Phase Equilib	ria Thermodynamics
Тур	Lecture
Hrs/wk	2
СР	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Prof. Irina Smirnova
Language	DE
Cycle	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. Osmotic pressure
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 Equilibri					
,,	Recitation Section (small)				
Hrs/wk					
CP 2					
	Independent Study Time 46, Study Time in Lecture 14				
	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> <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 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> </ol>				

Course L0142: Phase Equilib	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: 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>

Module M0938: Biopr	ocess Engineering - Fundame	ntals			
Courses					
Title Bioprocess Engineering - Fundamen	ntals (L0841)	<b>Typ</b> Lectu		Hrs/wk	<b>CP</b> 3
Bioprocess Engineering - Fundamen Bioprocess Engineering - Fundamen			tation Section (large) tical Course	2	1 2
Module Responsible	Prof. Andreas Liese				
Admission Requirements	None				
Recommended Previous	none, module "organic chemistry", module	"fundamentals for process	engineering"		
Knowledge					
Educational Objectives	After taking part successfully, students have	e reached the following lea	arning results		
Professional Competence					
Knowledge	Students are able to describe the basic con enzymes and microorganisms, as well as rheology can be named and mass transp fundamental bioprocess management, steri	to differentiate different ort processes in bioreacto	types of inhibition. Tors can be explained.	The parameters of The students are	of stoichiometry and
Skills	After successful completion of this module, students should be able to  describe different kinetic approaches for growth and substrate-uptake and to calculate the corresponding parameters  predict qualitatively the influence of energy generation, regeneration of redox equivalents and growth inhibition on fermentation process  analyze bioprocesses on basis of stoichiometry and to set up / solve metabolic flux equations  distinguish between scale-up criteria for different bioreactors and bioprocesses (anaerobic, aerobic as well as microaero to compare them as well as to apply them to current biotechnical problem  propose solutions to complicated biotechnological problems and to deduce the corresponding models  to explore new knowledge resources and to apply the newly gained contents  identify scientific problems with concrete industrial use and to formulate solutions.  to document and discuss their procedures as well as results in a scientific manner			vth inhibition on the	
	After completion of this module participants take position to their own opinions and increase.  After completion of this module participants workflow and to present their results in a p	ease their capacity for tears s will be able to solve a te	mwork in engineering a	and scientific envir	onments.
Workload in Hours	Independent Study Time 96, Study Time in	Lecture 84			
Credit points	6 Compulsory Bonus Form	Description			
Course achievement	Yes 5 % Subject theoretical practical work				
Examination	Written exam				
Examination duration and scale	90 min				
Assignment for the	General Engineering Science (German progr	ram, 7 semester): Specialis	sation Process Enginee	ring: Compulsory	
Following Curricula	General Engineering Science (German progr		sation Bioprocess Engir	neering: Compulso	ory
	Bioprocess Engineering: Core qualification:				
	Green Technologies: Energy, Water, Climate	•			
	Biomedical Engineering: Specialisation Artifi		•	sory	
	Biomedical Engineering: Specialisation Impl	•	. ,		
	Biomedical Engineering: Specialisation Medi		-		
	Biomedical Engineering: Specialisation Mana Technomathematics: Specialisation III. Engin Process Engineering: Core qualification: Cor	neering Science: Elective C		ompuisory	

Course L0841: Bioprocess En	gineering - Fundamentals
Тур	Lecture
Hrs/wk	2
СР	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>Technology of sterilization (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: Bioprozeßtechnik, 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 En	
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)
	<ul> <li>6. Mass transfer in bioprocess (Prof. Zeng)</li> <li>7. Continuous culture (Chemostat) (Prof. Zeng)</li> <li>8. Sterilisation (Prof. Zeng)</li> <li>9. Downstream processing (Prof. Liese)</li> <li>10. Repetition (Reserve) (Prof. Liese, Prof. Zeng)</li> </ul>
Literature	siehe Vorlesung

Course L0843: Bioprocess Engineering - 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		

Module M0618: Rene	wables Energy Systems			
Courses				
Title Power Industry (L0316) Energy Systems and Energy Industry (L0315) Renewable Energy (L0313)		<b>Typ</b> Lecture Lecture Lecture	Hrs/wk 1 2 2	CP 1 2 2
Renewable Energy (L1434)	Duef Markin Kalbach with	Recitation Section (small)	1	1
Admission Requirements	Prof. Martin Kaltschmitt  None			
Recommended Previous				
Knowledge	Tione			
Educational Objectives	After taking part successfully, students have reac	hed the following learning results		
Professional Competence				
Knowledge	With completion of this module, the students ca efficiency. They can explain the issues occurring i distribution and power trading wih regard to applicable to many energy systems in general, of the students can explain the environmental benef	n this context. Furthermore, they can expla subject-related contexts. The students ca especially for renewable energy systems ar	in details of pov an explain thes	ver generation, power e aspects, which are
Skills	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 tunder 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 of and to put them them into the right context.			
Personal Competence Social Competence	The students are able to analyze suitable techn criteria under sustainability aspects. This allows the			
Autonomy	Students can independently exploit sources , ac questions.	equire the particular knowledge about the	subject area an	d transform it to new
Workload in Hours	Independent Study Time 96, Study Time in Lectur	e 84		
Credit points	6			
Course achievement	None			
Examination	Written exam			
Examination duration and scale	3 hours written exam			
Assignment for the Following Curricula	General Engineering Science (German program, 7 General Engineering Science (German program, 7 General Engineering Science (German program, 7 General Engineering Science (German program Elective Compulsory Civil- and Environmental Engineering: Specialisati Civil- and Environmental Engineering: Specialisati Civil- and Environmental Engineering: Specialisati Energy and Environmental Engineering: Core qua General Engineering Science (English program, Elective Compulsory Process Engineering: Core qualification: Compulsor	semester): Specialisation Process Engineer semester): Specialisation Energy and Envir , 7 semester): Specialisation Mechanical on Civil Engineering: Elective Compulsory on Traffic and Mobility: Elective Compulsory on Water and Environment: Elective Compulification: Compulsory 7 semester): Specialisation Mechanical	ring: Compulsory romental Engine Engineering, Fo / / ulsory	y ering: Compulsory ocus Energy Systems

Course L0316: Power Industr	у	
Тур	Lecture	
Hrs/wk	1	
СР	1	
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14	
Lecturer	Prof. Martin Kaltschmitt, Prof. Andreas Wiese	
Language	DE	
Cycle	SoSe 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	Folien der Vorlesung	

Course L0315: Energy Systems and Energy Industry		
Тур	ecture	
Hrs/wk	2	
СР	2	
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28	
Lecturer	Prof. Martin Kaltschmitt	
Language	DE	
Cycle	SoSe	
Content	<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 En	nergy	
Тур	ecture	
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 Energy		
Тур	Recitation Section (small)	
Hrs/wk	1	
СР	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>	

Module M0538: Heat	and Mass Transfer			
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)	Duck Ising Conius and	Recitation Section (large)	1	2
Module Responsible  Admission Requirements	Prof. Irina Smirnova None			
-	Basic knowledge: Technical Thermodynamics			
Knowledge	basic knowledge. reclinical memodynamics			
Educational Objectives	After taking part successfully, students have reached th	e following learning results		
Professional Competence			-	
Knowledge				
	The students are capable of explaining qualitative     heat exchanges, chamical reactors)	e and determining quantitative heat	transfer in proced	iurai apparatus (e. g.
	heat exchanger, chemical reactors).  They are capable of distinguish and characterize	different kinds of heat transfer med	hanisms namely h	eat conduction, heat
	transfer and thermal radiation.	amerene amas er nede aransier mee	assae.y	cut conduction, near
	The students have the ability to explain the p	hysical basis for mass transfer in	detail and to des	scribe mass transfer
	qualitative and quantitative by using suitable ma	ss transfer theories.		
	They are able to depict the analogy between hear	t- and mass transfer and to describe	complex linked pr	ocesses in detail.
Skills	The students are able to set reasonable system	houndaries for a given transport or	ohlam by using th	anhelwowledge
	and to balance the corresponding energy and ma		oblem by using ti	ie gairieu kilowieuge
	They are capable to solve specific heat transfer		ctors, temperatur	e alteration in fluids)
	and to calculate the corresponding heat flows.	,		
	Using dimensionless quantities, the students can	execute scaling up of technical proc	esses or apparatu	5.
	They are able to distinguish between diffusion, colors	onvective mass transition and mass	transfer. They car	use this knowledge
	for the description and design of apparatus (e.g.			
	In this context, the students are capable to choose	-	neat and mass exc	changer for a specific
	<ul> <li>application considering their advantages and disa</li> <li>In addition, they can calculate both, steady-state</li> </ul>		rocedural annarat	IIC
	The students are capable to connect their kr			
	particular the courses thermodynamics, fluid m			
	problems.			
Personal Competence				
Social Competence	The students are capable to work on subject-spe	cific challenges in teams and to pre	sent the results o	rally in a reasonable
	manner to tutors and other students.			
Autonomy				
Autonomy	The students are able to find and evaluate necess	sary information from suitable source	es	
	They are able to prove their level of knowledg			continuously (clicker-
	system, exam-like assignments) and on this basis	they can control their learning proc	esses.	
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56			
Credit points				
Course achievement				
Examination	Written exam			
Examination duration and	120 minutes; theoretical questions and calculations			
scale				
Assignment for the	General Engineering Science (German program, 7 seme	ster): Specialisation Process Enginee	ring: Compulsory	
Following Curricula		· · ·		ory
	General Engineering Science (German program, 7 seme			de Consti
	General Engineering Science (German program, 7 seme	ster): Specialisation Energy and Env	romental Enginee	ring: Compulsory
	Bioprocess Engineering: Core qualification: Compulsory Energy and Environmental Engineering: Core qualification	on: Compulsory		
	General Engineering Science (English program, 7 semes		eering: Compulso	ry
	General Engineering Science (English program, 7 semes			
	General Engineering Science (English program, 7 semes			
	Green Technologies: Energy, Water, Climate: Core quali	fication: Compulsory		
	Technomathematics: Specialisation III. Engineering Scie	nce: Elective Compulsory		
	Process Engineering: Core qualification: Compulsory			

Course L0101: Heat and Mass Transfer		
Тур	Lecture	
Hrs/wk	2	
СР	2	
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28	
Lecturer	Prof. Irina Smirnova	
Language	DE	
Cycle	WiSe	
Content	1. Heat transfer  Introduction, one-dimensional heat conduction  Convective heat transfer  Multidimensional heat conduction  Non-steady heat conduction  Thermal radiation  2. Mass transfer  one-way diffusion, equimolar countercurrent diffusion  boundary layer theory, non-steady mass transfer	
	Heat and mass transfer single particle/ fixed bed     Mass transfer and chemical reactions	
Literature	H.D. Baehr und K. Stephan: Wärme- und Stoffübertragung, Springer     VDI-Wärmeatlas	

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

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

Module M0546: Therr	mal Separation Processes			
Courses				
Title		Тур	Hrs/wk	СР
Thermal Separation Processes (L01	118)	Lecture	2	2
Thermal Separation Processes (L01		Recitation Section (small)	2	2
Thermal Separation Processes (L01 Separation Processes (L1159)	141)	Recitation Section (large) Practical Course	1	1
Module Responsible	Prof Irina Smirnova	Tractical Course		1
Admission Requirements				
	Recommended requirements: Thermodynamics III			
Knowledge				
Educational Objectives	After taking north accessfully, attached backs are also	d the fellowing learning requite		
Professional Competence	After taking part successfully, students have reached	a the following learning results		
Knowledge				
Knowieuge	The students can distinguish and describe	different types of separation processes	s such as distilla	tion, extraction, and
	adsorption			
	The students develop an understanding for t			
	energy demand of a process, the possibilities  They have good knowledge of designing meth			
	They have good knowledge of designing metr	ious for separation processes and device		
G1.77				
Skills	Using the gained knowledge the students car	select a reasonable system boundary f	or a given separa	tion process and can
	close the associated energy and material bala	nces		
	The students can use different graphical me	ethods for the designing of a separation	on process and d	efine the amount of
	theoretical stages required	Ab		Mar do
	<ul> <li>They can select and design a basic type of disadvantages of the process</li> </ul>	thermal separation process for a give	n case based on	the advantages and
	The students are capable to obtain independ	ently the needed material properties fro	om appropriate so	ources (diagrams and
	tables)	,		(
	They can calculate continuous and discontinu	ous processes		
	The students are able to prove their theoretic	al knowledge in the experimental lab wo	ork.	
	The students are able to discuss the theoretic	cal background and the content of the e	experimental work	with the teachers in
	colloquium.			
	The students are capable of linking their gained known	wledge with the content of other lecture	s and use it toget	ner for the solution of
	technical problems. Other lectures such as thermody	ynamics, fluid mechanics and chemical e	engineering.	
Bayaanal Campahanaa				
Personal Competence Social Competence				
Social Competence	The students can work technical assignments	in small groups and present the combin	ed results in the t	utorial
	The students are able to carry out practical	- · · · -		ion of labor between
	them. They are able to discuss their results ar	nd to document them scientifically in a r	eport.	
Autonomy				
	The students are capable to obtain the neede     The students can proof the state of their let			
	<ul> <li>The students can proof the state of their k learning process</li> </ul>	nowledge with exam resembling assig	illilents and ill ti	iis way control their
	Francis Process			
Workload in Hours	Independent Study Time 96, Study Time in Lecture 8	34		
Credit points	6			
Course achievement	None			
Examination	Written exam			
	120 minutes; theoretical questions and calculations			
scale				
Following Curricula	General Engineering Science (German program, 7 se General Engineering Science (German program, 7 se			ory
Following Curricula	General Engineering Science (German program, 7 se			-
	Compulsory	. , . ,	,	. 5,5,12,000,70
	General Engineering Science (German program, 7 se	emester): Specialisation Energy and Envi	romental Enginee	ring: Compulsory
	Bioprocess Engineering: Core qualification: Compuls	ory		
	Energy and Environmental Engineering: Core qualific	• •		
	General Engineering Science (English program, 7 set			
	General Engineering Science (English program, 7 sei		_	ing: Compulsory
	General Engineering Science (English program, 7 sei Green Technologies: Energy, Water, Climate: Specia	· ·		
	Green Technologies: Energy, Water, Climate: Specia			
	Process Engineering: Core qualification: Compulsory		V 3	

Course L0118: Thermal Sepa	ration Processes		
Тур	Lecture		
Hrs/wk	2		
СР	2		
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28		
Lecturer	Prof. Irina Smirnova		
Language	DE		
Cycle	WiSe		
Content	<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>		

Course L0119: Thermal Sepa	ration Processes	
Тур	Recitation Section (small)	
Hrs/wk	2	
СР	2	
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28	
Lecturer	Prof. Irina Smirnova	
Language	DE	
Cycle	WiSe	
Content	<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> The students work on tasks in small groups and present their results in front of all students.	
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		
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 1984 Ullmann"s Enzyklopädie der Technischen Chemie</li> </ul>		

Course L1159: Separation Pr	rocesses
Тур	Practical Course
Hrs/wk	1
СР	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:
	<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>

Module M0892: Chem	ical Reaction Engineering					
Courses						
Title		Тур	Hrs/wk	СР		
Chemical Reaction Engineering (Fu	ndamentals) (L0204)	Lecture	2	2		
Chemical Reaction Engineering (Fu	ndamentals) (L0244)	Recitation Section (large)	2	2		
Experimental Course Chemical Eng	ineering (Fundamentals) (L0221)	Practical Course	2	2		
Module Responsible	Prof. Raimund Horn					
Admission Requirements	None					
Recommended Previous	Contents of the previous modules mathematics I-III	, physical chemistry, technical thermody	namics I+II as w	ell as computational		
Knowledge	methods for engineers.					
Educational Objectives	After taking part successfully, students have reache	d the following learning results				
Professional Competence						
Knowledge	The students are able to explain basic concepts of o	chemical reaction engineering. They are	able to point out	differences between		
	thermodynamical and kinetical processes. The stud	dents have a strong ability to outline pa	irts of isotherma	l and non-isothermal		
	ideal reactors and to describe their properties.					
Skills	After successful completion of the module, students	are able to:				
	- apply different computational methods to dimension	- 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	d document these according to scientific	guidelines.			
Personal Competence						
Social Competence	After successful completition of the lab-course the	students have a strong ability to organiz	e themselfes in s	small groups to solve		
	issues in chemical reaction engineering. The stude	ents can discuss their subject related kn	owledge among	each other and with		
	their teachers.					
Autonomy	The students are able to obtain further informa-	ation and assess their relevance auto	nomously. Stude	nts can apply their		
	knowldege discretely to plan, prepare and conduct of	experiments.				
Workload in Hours	Independent Study Time 96, Study Time in Lecture 8	34				
Credit points	6					
Course achievement		Description				
	Yes None Subject theoretical and					
	practical work					
	Written exam					
Examination duration and .	120 min					
scale						
Assignment for the	General Engineering Science (German program, 7 se	- · ·				
Following Curricula	General Engineering Science (German program, 7 se		eering: Compulso	ory		
	Bioprocess Engineering: Core qualification: Compuls General Engineering Science (English program, 7 se		ering: Compulso	rv.		
	General Engineering Science (English program, 7 sei General Engineering Science (English program, 7 sei			у		
	Green Technologies: Energy, Water, Climate: Specia					
	Process Engineering: Core qualification: Compulsory	**	20pui30i y			
	. Tocass Engineering, core quantication, compulsory					

Тур	Lecture
Hrs/wk	2
СР	2
Vorkload 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, exten reaction, reactor throughput, reactor load, conversion, selectivity, yield, concentration calculations in stationary and flow multicomponent-mixtures)  Stoichiometry and stoichiometric calculations (simple reactions, complex reactions, key reactions, key species, matrix stoichiometric coefficients, linear dependent and independent reactions, element-species-matrix, row reduced form of a mat rank of a matrix, Gauss Jordan elimination, relation between stoichiometry and kinetics, calculating the extent of reaction from lenumber changes in complex reactions)  Thermodynamics (What is thermodynamics?, importance of thermodynamics in chemical reaction engineering, zeroth law thermodynamics, temperature scales, temperature measurements in praxis, first law of thermodynamics, internal ener enthalpy, calorimeter, heat of reaction, standard heat of formation, Hess law, heat capacity, Kirchhoff law, standard heat reaction, pressure dependence of the heat of reaction, second law of thermodynamics, reversible and irreversible process entropy, Clausius inequality, free energy, Gibbs Energy, chemical potential, chemical equilibrium, activity, van't Hoff I calculation of chemical equilibrium, principle of Le Chatelier and Braun, equilibrium calculations in multiple reaction syste 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 reactors, gas-liquid-reactors, multi-phase reactors)

Isothermal ideal reactors (mole-balance of a chemical reactor, mole balance of a batch reactor, integration of the batch reactor mole balance for various kinetics, partial fraction decomposition, mole balance of the semi-batch reactor, mole balance of the plug flow reactor, analogy batch reactor - plug flow reactor, design of plug flow reactors for reactions with volume change and complex reactions, mole balance of a fixed bed reactor, design of a membrane reactor, mole balance of a continuously stirred tank reactor, comparison of CSTR and PFR with respect to conversion and selectivity, mole-balance of a cascade of tank reactors, numerical-interative calculation of a cascade of tank reactors, Newton-Raphson method, graphical analysis of a cascade of tank reactors)

non-isothermal ideal reactors (energy balance of a reactor, adiabatic reactor, adiabatic temperature rise, staged reactor for adiabatic exothermic reactions limited by chemical equilibrium, design of an adiabatic plug flow reactor, Levenspiel-plots, heat transfer through a reactor wall, heat transfer by convection, heat conduction, heat transfer through a cylindrical wall, design of a plug flow reactor in parallel and counter flow, heat balance of the cooling fluid, CSTR with heat exchange, multiple stationary states, ignition-extinction behavior, stability of a CSTR, complex reactions in non-isothermal reactors, optimum temperature profile of a reactor)

## Literature

lecture notes Raimund Horn

skript Frerich Keil

Books:

- M. Baerns, A. Behr, A. Brehm, J. Gmehling, H. Hofmann, U. Onken, A. Renken, Technische Chemie, Wiley-VCH
- G. Emig, E. Klemm, Technische Chemie, Springer
- A. Behr, D. W. Agar, J. Jörissen, Einführung in die Technische Chemie
- E. Müller-Erlwein, Chemische Reaktionstechnik 2012, 2. Auflage, Teubner Verlag
- J. Hagen, Chemiereaktoren: Auslegung und Simulation, 2004, Wiley-VCH
- H. S. Fogler, Elements of Chemical Reaction Engineering, Prentice Hall B
- H. S. Fogler, Essentials of Chemical Reaction Engineering, Prentice Hall
- O. Levenspiel, Chemical Reaction Engineering, John Wiley & Sons, 1998
- L. D. Schmidt, The Engineering of Chemical Reactions, Oxford Univ. Press, 2009
- J. B. Butt, Reaction Kinetics and Reactor Design, 2000, Marcel Dekker
- R. Aris, Elementary Chemical Reactor Analysis, Dover Pubn. Inc., 2000
- 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 Reaction 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, irreversible reaction with pre-equilibrium, reduction of reaction mechanisms, quasi-stationarity principle of Bodenstein, rate limiting step, Michaelis-Menten kinetics, analytical integration of first order differential equations - integrating factor, numerical integration of complex kinetics)

Types of chemical Reaktors (chemical reactors in industry and laboratory, ideal vs. real reaktors, discontinuous, half continuous and continuous reactors, single phase - biphasic- and multiphase reactors, batch-reactor, semi-batch reactor, CSTR, Plug Flow reactor, fixed bed reactor, adiabatic staged reactors, rotating furnaces, fluidized bed reactors, gas-liquid-reactors, multi-phase reactors)

Isothermal ideal reactors (mole-balance of a chemical reactor, mole balance of a batch reactor, integration of the batch reactor mole balance for various kinetics, partial fraction decomposition, mole balance of the semi-batch reactor, mole balance of the plug flow reactor, analogy batch reactor - plug flow reactor, design of plug flow reactors for reactions with volume change and complex reactions, mole balance of a fixed bed reactor, design of a membrane reactor, mole balance of a continuously stirred tank reactor, comparison of CSTR and PFR with respect to conversion and selectivity, mole-balance of a cascade of tank reactors, numerical-interative calculation of a cascade of tank reactors, Newton-Raphson method, graphical analysis of a cascade of tank reactors)

non-isothermal ideal reactors (energy balance of a reactor, adiabatic reactor, adiabatic temperature rise, staged reactor for adiabatic exothermic reactions limited by chemical equilibrium, design of an adiabatic plug flow reactor, Levenspiel-plots, heat transfer through a reactor wall, heat transfer by convection, heat conduction, heat transfer through a cylindrical wall, design of a plug flow reactor in parallel and counter flow, heat balance of the cooling fluid, CSTR with heat exchange, multiple stationary states, ignition-extinction behavior, stability of a CSTR, complex reactions in non-isothermal reactors, optimum temperature profile of a reactor)

## Literature

lecture notes Raimund Horn

skript Frerich Keil

Books

- M. Baerns, A. Behr, A. Brehm, J. Gmehling, H. Hofmann, U. Onken, A. Renken, Technische Chemie, Wiley-VCH
- G. Emig, E. Klemm, Technische Chemie, Springer
- A. Behr, D. W. Agar, J. Jörissen, Einführung in die Technische Chemie
- E. Müller-Erlwein, Chemische Reaktionstechnik 2012, 2. Auflage, Teubner Verlag
- J. Hagen, Chemiereaktoren: Auslegung und Simulation, 2004, Wiley-VCH
- H. S. Fogler, Elements of Chemical Reaction Engineering, Prentice Hall B
- $\hbox{H. S. Fogler, Essentials of Chemical Reaction Engineering, Prentice Hall}\\$
- 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				
СР	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 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						
Courses								
Title Practical Exercise Environmental Technology (L1387) Environmental Technologie (L0326)				<b>Typ</b> Practical Course Lecture		Hrs/wk 1 2	<b>CP</b> 1 2	
Module Responsible	Prof. Martin Kaltschmi	tt						
Admission Requirements	None							
Recommended Previous Knowledge	Fundamentals of inorg	ganic/organ	ic chemistry	and biology				
Educational Objectives	After taking part succe	essfully, stu	idents have	reached the follow	ing learning results			
Professional Competence		-						
Knowledge	·	nicals in th	e environme		knowledge of environmotive an overview of scier			
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 opinions in front of and against the group.							
Personal Competence								
Social Competence	The students are able	to discuss	the various t	echnical and scien	tific tasks, both subject-	specific ar	nd multidiscij	olinary. They are able
	to develop different ap	pproaches t	to the task as	s a group as well a	s to discuss their theore	tical or pra	actical imple	mentation.
Autonomy	Students can independ	dently expl	oit sources a	bout of the subjec	t, acquire the particular	knowledge	e and tranfer	it to new problems.
Workload in Hours	Independent Study Tir	ne 48, Stud	dy Time in Le	cture 42				
Credit points	3							
Course achievement	Compulsory Bonus Yes None	Form Subject practical	theoretical work	<b>Description</b> and				
Examination	Written exam							
Examination duration and	1 hour							
scale								
Assignment for the					pecialisation Process Eng	-		
Following Curricula		Science (Ge	rman progra	m, 7 semester): Sp	pecialisation Bioprocess pecialisation Energy and	-	-	
	Energy and Environme	ental Engin	eering: Core	qualification: Com	pulsory			
					ecialisation Bioprocess E	-	-	
					ecialisation Energy and E		-	
					ecialisation Process Engi	neering: E	lective Com	oulsory
	Process Engineering: (	core qualifi	cation: Elect	ive Compulsory				

Turn	Practical Course
Hrs/wk	
CP	
	Independent Study Time 16, Study Time in Lecture 14
	Prof. Martin Kaltschmitt, Dr. Isabel Höfer
Language	
Cycle	
	The practical course Environmental Engineering currently consists of 6 experiments, which deal with the different focal points of environmental engineering in the areas of air, water, soil, environment, biomass and noise. The following experiments are carried out for this purpose:  Determination of the calorific value of biomass, soil purification, waste water treatment, noise emissions, plastic waste, biowaste.  Translated with www.DeepL.com/Translator (free version)  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	

Course L0326: Environmenta	ıl Technologie
Тур	Lecture
Hrs/wk	2
СР	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Prof. Martin Kaltschmitt, Dr. Isabel Höfer
Language	DE
Cycle	WiSe
Content	1. Introductory seminar on environmental science: 2. Environmental impact and adverse effects 3. Wastewater technology 4. Air pollution control 5. Noise protection 6. Waste and recycling management 7. Soil and ground water protection 8. Renewable energies 9. Resource conservation and energy efficiency
Literature	Förster, U.: Umweltschutztechnik; 2012; Springer Berlin (Verlag) 8., Aufl. 2012; 978-3-642-22972-5 (ISBN)

Module M1274: Enviro	onmental Technology			
Courses				
Title		Тур	Hrs/wk	СР
Environmental Assessment (L0860)		Lecture	2	2
Environmental Assessment (L1054)		Recitation Section (small)	1	1
Module Responsible	Prof. Martin Kaltschmitt			
Admission Requirements	None			
Recommended Previous	Fundamentals of inorganic/organic chemistry and biolog	у		
Knowledge				
<b>Educational Objectives</b>	After taking part successfully, students have reached the	e following learning results		
Professional Competence				
Skills	With the completion of this module the students ac environmental problems which might occur from produ about the methodological diversity and are competent i impacts. Besides the students are able to estimate the difficulties with their measurement.  The students are able to select a suitable method for the can develop suitable solutions for managing and mitigate out Life Cycle Impact Assessments independently and After finishing the course the students have the content of the cont	ction processes, projects or construct n dealing with different methods and complexity of these environmental p ne respective case from the variety of ting environmental problems in a bust can apply the software programs O	tion measures. The instruments to a strocesses as well for assessment me siness context. The penLCA and the strong transfer in the strong	ney have knowledge ssess environmental as uncertainties and thods. Thereby they ney are able to carry database Ecolnvent.
Personal Competence				
	The students are able to discuss the various technical art o develop jointly different solutions and to discuss the topics, the students receive insights into the multi-layer. Their sensitivity and consciousness towards these subsocial responsibilities in their role as engineers.  The students learn to research, process and present a scientific work. They can solve an environmental problem	neir theoretical or practical implemented issues of the environment protect jects are raised and which helps to a scientific topic independently. The	ntation. Due to	the selected lecture ept of sustainability. eness of their future try out independent
Workload in Hours	Independent Study Time 48, Study Time in Lecture 42			
Credit points				
Course achievement				
Examination				
Examination duration and				
scale	2 Hour Miles Chair			
	General Engineering Science (German program, 7 seme	ster): Specialisation Process Engineer	ina: Elective Com	pulsory
_	General Engineering Science (German program, 7 seme	· ·	-	
	General Engineering Science (German program, 7 seme			
	Bioprocess Engineering: Core qualification: Elective Com	pulsory		
	Energy and Environmental Engineering: Core qualification	n: Compulsory		
	General Engineering Science (English program, 7 semes	ter): Specialisation Bioprocess Engine	ering: Elective Co	ompulsory
	General Engineering Science (English program, 7 semes	ter): Specialisation Process Engineeri	ng: Elective Comp	oulsory
	General Engineering Science (English program, 7 semes	ter): Specialisation Energy and Enviro	mental Engineeri	ng: Compulsory
	Process Engineering: Core qualification: Elective Compul	sory		

Course L0860: Environmental 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					
	nergy consumption: Cumulated energy demand (CED), cost analysis  fe cycle concept Life cycle assessment (LCA)  ustainability: 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)					

Course L1054: Environmenta	I Assessment
Тур	Recitation Section (small)
Hrs/wk	1
СР	1
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14
Lecturer	Prof. Martin Kaltschmitt, Dr. Anne Rödl
Language	DE
Cycle	WiSe
Content	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.
Literature	Power point Präsentationen

Module M0539: Proce	ss and Plant Engineering I				
Courses					
Title		Тур	Hrs/wk	СР	
Process and Plant Engineering I (L0	Lecture	2	2		
Process and Plant Engineering I (L0	096)	Recitation Section (large)	1	2	
Process and Plant Engineering I (L1	214)	Recitation Section (small)	1	2	
Module Responsible	Prof. Mirko Skiborowski				
Admission Requirements	None				
Recommended Previous	unit operation of thermal an dmechanical separation pr	ocesses			
Knowledge	chemical reactor eingineering				
	chemical reactor enigmeeting				
Educational Objectives	After taking part successfully, students have reached the	ne following learning results			
Professional Competence					
Knowledge	students can:				
	classify and formulate blobal balance equations of cher	nical processes			
	specify linear component equations of complex chemic	al processes			
	explain linear regression and data reconcilliation proble	ems			
	explain pfd-diagrams				
Skills	students are capable of				
	- formulation of mass and energy balance equations an				
	- estimation of component streams of chemical plants using linear component balance models				
	- solution of data reconcilliation 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 Time 124, Study Time in Lecture 56	i e			
Credit points	6				
Course achievement		ription			
	Yes 10 % Subject theoretical and practical work				
Examination	·				
	120 Min. lectures notes and books				
scale	120 Mill. lectures flotes and books				
	General Engineering Science (German program, 7 seme	ester): Specialisation Process Engineeri	na: Compulsory		
	General Engineering Science (German program, 7 seme			orv	
. oog carricala	Bioprocess Engineering: Core qualification: Compulsory		sering. compaise	,	
	General Engineering Science (English program, 7 seme		ering: Compulsor	y	
	General Engineering Science (English program, 7 s			-	
	Compulsory	-		-	
	General Engineering Science (English program, 7 seme	ster): Specialisation Process Engineerin	ng: Compulsory		
	Green Technologies: Energy, Water, Climate: Specialisa	tion Bioresource Technology: Elective	Compulsory		
	Process Engineering: Core qualification: Compulsory				

Course L0095: Process and Plant Engineering I		
Тур	Lecture	
Hrs/wk	2	
СР	2	
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28	
Lecturer	Prof. Mirko Skiborowski	
Language	DE	
Cycle	SoSe	
Content	1. Introduction Structure and operation of production plants Operational business process Technical process design Motivation and targets of process development Life cycle of production plants	
	2. Engineering methods and tools  Mass and energy balances  Strategies of process synthesis  Graphical representation of processes  Multidimensional regression	

	Data reconciliation and data validation  3. Process Synthesis
	Decision levels
	Experimental process development
	Reactor synthesis  Synthesis of congration processes (process alternatives and criteria for selection)
	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	
Literature	S.D. Barnicki, J.R. Fair, Ind. End. Chem., 29(1990), S. 421, Ind. End. Chem., 31(1992), S. 1679
	H. Becker, S. Godorr, H. Kreis, Chemical Engineering, January 2001, S. 68-74
	Behr, W. Ebbers, N. Wiese, ChemIngTech. 72(2000)Nr. 10, S.1157
	E. Blass, Entwicklung verfahrenstechnischer Prozesse, Springer-Verlag, 2. Auflage 1997
	M. H. Bauer, J. Stichlmair, ChemIngTech., 68(1996), Nr. 8, 911-916
	R. Dittmeyer, W. Keim, G. Kreysa, A. Oberholz, Chemische Technik. Prozesse und Produkte,
	Band 2, Neue Technologien, 5. Auflage, Wiley-VCH GmbH&Co.KGaA, Weinheim, 2004
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	G. Fieg, Inz. Chem. Proc., 5(1979), S.15-19
	G. Fieg, G. Wozny, L. Jeromin, Chem. Eng. Technol. 17(1994),5, 301-306
	G. Fieg, Heat and Mass Transfer 32(1996), S. 205-213
	G. Fieg, Chem. Eng. Processing, Vol. 41/2(2001), S. 123-133
	U.H. Felcht, Chemie eine reife Industrie oder weiterhin Innovationsmotor, Universitätsbuchhandlung Blazek und Bergamann, Frankfurt, 2000
	J.P. van Gigch, Systems Design, Modeling and Metamodeling, Plenum Press, New York, 1991
	T.F. Edgar, D.M. Himmelblau, L.S. Lasdon, Optimization of Chemical Processes, McGraw-Hill, 2001
	G. Gruhn, Vorlesungsmanuskript "Prozess- und Anlagentechnik, TU Hamburg-Harburg
	D. Hairston, Chemical Engineering, October 2001, S. 31-37
	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 Plant Engineering I		
Тур	Recitation Section (large)	
Hrs/wk	1	
СР	2	
Workload in Hours	Independent Study Time 46, 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 Plant Engineering I	
Тур	Recitation Section (small)
Hrs/wk	1
СР	2
Workload in Hours	Independent Study Time 46, Study Time in Lecture 14
Lecturer	Prof. Mirko Skiborowski, Dr. Thomas Waluga
Language	DE
Cycle	SoSe
Content	See interlocking course
Literature	See interlocking course

Module M0670: Partic	cle Technology and	Solids Proces	s Engineeri	ng		
Courses						
Fitle Particle Technology I (L0434) Particle Technology I (L0435) Particle Technology I (L0440)				Typ Lecture Recitation Section (small) Practical Course	Hrs/wk 2 1 2	<b>CP</b> 3 1 2
Module Responsible	Prof. Stefan Heinrich			Tractical Course	2	2
Admission Requirements	None					
Recommended Previous  Knowledge						
<b>Educational Objectives</b>	After taking part successfull	y, students have rea	ached the following	ng learning results		
<b>Professional Competence</b>						
Knowledge	After successful completion	of the module stude	ents are able to			
	name and explain pr     characterize particles	•				
Skills	Students are able to  choose and design ap asses solids with resp document their work	ect to their behavio		rocessing according to the or sing steps	desired solids prop	erties of the produc
Personal Competence						
Social Competence	The students are able to d	iscuss scientific top	oics orally with o	ther students or scientific	personal and to o	levelop solutions for
	technical-scientific issues in	a group.				
Autonomy	Students are able to analyze	and solve question	ns regarding solid	particles independently.		
Workload in Hours	Independent Study Time 11	) Study Time in Lea	rture 70			
Credit points	6	o, ocaaye 200				
Course achievement	Compulsory Bonus Form		Description			
	Yes None Writt	en elaboration	sechs Bericht	e (pro Versuch ein Bericht)	à 5-10 Seiten	
Examination	Written exam					
Examination duration and	90 minutes					
scale						
Assignment for the	General Engineering Science	(German program	, 7 semester): Sp	ecialisation Process Enginee	ering: Compulsory	
Following Curricula	General Engineering Science	(German program	, 7 semester): Sp	ecialisation Bioprocess Engi	neering: Compulso	ry
	General Engineering Science	(German program	, 7 semester): Sp	ecialisation Energy and Envi	iromental Enginee	ing: Compulsory
	General Engineering Science		, 7 semester): S	pecialisation Green Technolo	ogies, Focus Water	and Environmental
	Engineering: Elective Compu					
	Bioprocess Engineering: Cor					
	Energy and Environmental E					
	General Engineering Science					-
	General Engineering Science					ng: Compulsory
	General Engineering Science			-	ring: Compulsory	
	Green Technologies: Energy			er: Elective Compulsory		
	Process Engineering: Core q	ualification: Compu	lsory			

Course L0434: Particle Techr	nology I
Тур	Lecture
Hrs/wk	2
СР	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 Techn	ourse L0435: Particle Technology I		
Тур	Recitation Section (small)		
Hrs/wk	1		
СР	1		
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14		
Lecturer	Prof. Stefan Heinrich		
Language	DE		
Cycle	SoSe		
Content	See interlocking course		
Literature	See interlocking course		

Course L0440: Particle Techn	nology I
Тур	Practical Course
Hrs/wk	2
СР	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Prof. Stefan Heinrich
Language	DE/EN
Cycle	SoSe
Content	<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.

	3		9 & 66	nmunication
Courses				
	Programming Concepts, Data Handling & Communication (L2689) Programming Concepts, Data Handling & Communication (L2690)	Typ Lecture Recitation Section (small)	<b>Hrs/wk</b> 3 2	<b>CP</b> 3 3
Module Responsible	Prof. Sibylle Fröschle			
Admission Requirements	None			
Recommended Previous				
Knowledge				
Educational Objectives	After taking part successfully, students have reached the fo	llowing learning results		
<b>Professional Competence</b>				
Knowledge				
Skills				
Davisanal Campatanas				
Personal Competence				
Social Competence				
Autonomy Workland in Hours	Independent Study Time 110 Study Time in Leature 70			
Workload in Hours				
Credit points	Compulsory Bonus Form Description	nn .		
Course achievement		finden semesterbegleitend statt.		
Examination				
Examination duration and				
scale				
Assignment for the	General Engineering Science (German program, 7 sem	ester): Specialisation Mechanical	Engineering, I	ocus Biomechanics
Following Curricula			3 3.	
	General Engineering Science (German program, 7 semester General Engineering Science (German program, 7 semester Compulsory General Engineering Science (German program, 7 semester Compulsory General Engineering Science (German program, 7 semester Engineering: Compulsory General Engineering Science (German program, 7 semester Engineering Sciences: Compulsory General Engineering Science (German program, 7 semester Compulsory General Engineering Science (German program, 7 semester Engineering: Compulsory General Engineering Science (German program, 7 semester Engineering: Compulsory General Engineering Science (German program, 7 semester Engineering: Compulsory	c): Specialisation Green Technologic ster): Specialisation Mechanical E ster): Specialisation Mechanical E mester): Specialisation Mechanical mester): Specialisation Mechanical	es, Focus Renew ingineering, Foc Engineering, Foc al Engineering, I Engineering,	us Energy: Electiv us Energy Systems cus Aircraft System Focus Materials i Focus Mechatronics

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

Course L2690: Computer Science for Engineers - Programming Concepts, Data Handling & Communication		
Тур	Recitation Section (small)	
Hrs/wk	2	
СР	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	

## **Thesis**

Module M-001: Bache	lor Thesis
Courses	
Title	Typ Hrs/wk CP
Module Responsible	
Admission Requirements	
	According to General Regulations §21 (1):
	At least 126 ECTS credit points have to be achieved in study programme. The examinations board decides on exceptions.
Recommended Previous	
Knowledge	
Educational Objectives	After taking part successfully, students have reached the following learning results
Professional Competence	
Knowledge	The students can select, outline and, if need be, critically discuss the most important scientific fundamentals of their course
	of study (facts, theories, and methods).
	On the basis of their fundamental knowledge of their subject the students are capable in relation to a specific issue of
	opening up and establishing links with extended specialized expertise.
	The students are able to outline the state of research on a selected issue in their subject area.
Skills	
	<ul> <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> </ul>
	<ul> <li>With the aid of the methods they have learnt during their studies the students can analyze problems, make decisions on</li> </ul>
	technical issues, and develop solutions.
	The students can take up a critical position on the findings of their own research work from a specialized perspective.
Personal Competence	
Social Competence	Both in writing and orally the students can outline a scientific issue for an expert audience accurately, understandably and
	in a structured way.
	• The students can deal with issues in an expert discussion and answer them in a manner that is appropriate to the
	addressees. In doing so they can uphold their own assessments and viewpoints convincingly.
Autonomy	
Platonomy	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.
	<ul> <li>The students are able to identify, open up, and connect knowledge and material necessary for working on a scientific problem.</li> </ul>
	The students can apply the essential techniques of scientific work to research of their own.
	Independent Study Time 360, Study Time in Lecture 0
Credit points  Course achievement	
Examination	
	According to General Regulations
scale	
Assignment for the	General Engineering Science (German program): Thesis: Compulsory
Following Curricula	General Engineering Science (German program, 7 semester): Thesis: Compulsory
	Civil- and Environmental Engineering: Thesis: Compulsory
	Bioprocess Engineering: Thesis: Compulsory  Computer Science: Thesis: Compulsory
	Data Science: Thesis: Compulsory
	Digital Mechanical Engineering: Thesis: Compulsory
	Electrical Engineering: Thesis: Compulsory
	Energy and Environmental Engineering: Thesis: Compulsory
	Engineering Science: Thesis: Compulsory  Congral Engineering Science (English program, 7 computer): Thesis: Compulsory
	General Engineering Science (English program, 7 semester): Thesis: Compulsory Green Technologies: Energy, Water, Climate: Thesis: Compulsory
	Computational Science and Engineering: Thesis: Compulsory
	Logistics and Mobility: Thesis: Compulsory
	Mechanical Engineering: Thesis: Compulsory
	Mechatronics: Thesis: Compulsory
	Naval Architecture: Thesis: Compulsory  Technomethomatics: Thesis: Compulsory
	Technomathematics: Thesis: Compulsory Teilstudiengang Lehramt Elektrotechnik-Informationstechnik: Thesis: Compulsory
	Teilstudiengang Lehramt Metalltechnik: Thesis: Compulsory  Teilstudiengang Lehramt Metalltechnik: Thesis: Compulsory
	Process Engineering: Thesis: Compulsory
	Engineering and Management - Major in Logistics and Mobility: Thesis: Compulsory