

# **Module Manual**

Bachelor of Science (B.Sc.)

# General Engineering Science (German program, 7 semester)

Cohort: Winter Term 2021 Updated: 29th October 2021

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### Program description

#### Content

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

#### **Career prospects**

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

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

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

#### Learning target

#### Knowledge

Students can:

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

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

#### Skills

Graduates are able to

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

#### Social Competence

Graduates are able to

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

#### Autonomy

#### Graduates are able to

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

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

### **Program structure**

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

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

## Core Qualification

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

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

## Courses

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

Module M0743: Electrical Engineering I: Direct Current Networks and Electromagnetic Fields						
Courses						
Title				Тур	Hrs/wk	СР
Electrical Engineering I: Direct Curr				Lecture	3	5
Electrical Engineering I: Direct Curr	rent Networks and Elect	romagnetic Fields (L	0676)	Recitation Section (small)	2	1
Module Responsible	Prof. Matthias Kuhl					
Admission Requirements	None					
<b>Recommended Previous</b>						
Knowledge						
Educational Objectives	After taking part suc	cessfully, students	have reached the follow	ing learning results		
Professional Competence						
Knowledge						
Skills						
Personal Competence						
Social Competence						
Autonomy						
Workload in Hours	Independent Study T	ïme 110, Study Tir	me in Lecture 70			
Credit points	6					
Course achievement		Form	Description			
	No 10 %	Excercises				
Examination	Written exam					
Examination duration and	120 Minutes					
scale						
Assignment for the			-	ore Qualification: Compulsory		
Following Curricula			Engineering: Compulsory			
	Electrical Engineerin	-				
		5	g: Core Qualification: Cor	npulsory		
	Mechatronics: Core Qualification: Compulsory					
	Orientation Studies:	Core Qualification:	Elective Compulsory			

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

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

Course L1001: Mechanics I (S	Statics)	
Тур	re	
Hrs/wk	2	
СР	3	
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28	
Lecturer	Prof. Robert Seifried	
Language	DE	
Cycle	WiSe	
Content	<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).	

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

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

Module M0850: Mathe	ematics I				
Courses					
Title		Тур	Hrs/wk	СР	
Analysis I (L1010)		Lecture	2	2	
		Recitation Section (small)	1	1	
Analysis I (L1012)			1	1	
Analysis I (L1013)		Recitation Section (large)	1		
Linear Algebra I (L0912)		Lecture		2	
Linear Algebra I (L0913)		Recitation Section (small)	1	1	
Linear Algebra I (L0914)		Recitation Section (large)	1	1	
Module Responsible	Prof. Anusch Taraz				
Admission Requirements	None				
<b>Recommended Previous</b>	School mathematics				
Knowledge					
Educational Objectives	After taking part successfully, students have	e reached the following learning results			
Professional Competence					
Knowledge					
Kilomeuge	<ul> <li>Students can name the basic conce</li> </ul>	pts in analysis and linear algebra. They are at	ole to explain the	em using appropria	
	examples.				
	<ul> <li>Students can discuss logical connect</li> </ul>	ions between these concepts. They are capable	of illustrating th	nese connections w	
	the help of examples.		5		
	<ul> <li>They know proof strategies and can r</li> </ul>	correduce them			
		epioduce mem.			
Skills	Ctudents can madel problems in ana	lycic and linear algebra with the help of the con-	onto studiod in t	his course Moreov	
		lysis and linear algebra with the help of the cond	epts studied in t	This course. Moreov	
	they are capable of solving them by a				
	<ul> <li>Students are able to discover and ver</li> </ul>	ify further logical connections between the conce	epts studied in the	e course.	
	<ul> <li>For a given problem, the students of</li> </ul>	an develop and execute a suitable approach, a	and are able to c	critically evaluate t	
	results.				
Barrowal Commetance					
Personal Competence					
Social Competence	<ul> <li>Students are able to work together in</li> </ul>	teams. They are capable to use mathematics as	a common langu	1909	
	<ul> <li>In doing so, they can communicate new concepts according to the needs of their cooperating partners. Moreover, they can design examples to check and deepen the understanding of their peers.</li> </ul>				
	design examples to check and deepe	n the understanding of their peers.			
Autonomy					
, laterierity	<ul> <li>Students are capable of checking the</li> </ul>	eir understanding of complex concepts on their	own. They can sp	pecify open question	
	precisely and know where to get help	in solving them.			
	• Students have developed sufficient	persistence to be able to work for longer period	ds in a goal-orier	nted manner on ha	
	problems.		5		
	problemor				
	Independent Study Time 128, Study Time in	Lecture 112			
Credit points	8				
Course achievement	None				
Examination	Written exam				
Examination duration and	60 min (Analysis I) + 60 min (Linear Algebra	a I)			
scale					
	Gonoral Engineering Science (German prog	ram 7 somestor): Core Qualification: Compulson			
-		ram, 7 semester): Core Qualification: Compulsory			
Following Curricula	Civil- and Environmental Engineering: Core				
	Bioprocess Engineering: Core Qualification: Compulsory				
	Digital Mechanical Engineering: Core Qualification: Compulsory				
	Electrical Engineering: Core Qualification: Co	ompulsory			
	Green Technologies: Energy, Water, Climate	e: Core Qualification: Compulsory			
	Computational Science and Engineering: Co				
	Logistics and Mobility: Core Qualification: Co				
	Mechanical Engineering: Core Qualification:				
	Mechatronics: Core Qualification: Compulsor	-			
	Orientation Studies: Core Qualification: Elective Compulsory				
	Naval Architecture: Core Qualification: Compulsory				
	Process Engineering: Core Qualification: Cor	npulsory			
		jistics and Mobility: Core Qualification: Compulso	~		
	and handgement major in E0g	,	,		

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

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

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

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

Module M0687: Chem	istry					
Houdie Houor. Chem	istry					
Courses						
Title		Тур	Hrs/wk	СР		
Chemistry I+II (L0460)		Lecture	4	4		
Chemistry I+II (L0475)		Recitation Section (large)	2	2		
Module Responsible	Dr. Dorothea Rechtenbach					
Admission Requirements	None					
<b>Recommended Previous</b>	none					
Knowledge						
Educational Objectives	After taking part successfully, students have reac	hed the following learning results				
Professional Competence						
Knowledge	The students are able to name and to describe basic principles and applications of general chemistry (structure of matter, period table, chemical bonds), physical chemistry (aggregate states, separating processes, thermodynamics, kinetics), inorgan chemistry (acid/base, pH-value, salts, solubility, redox, metals) and organic chemistry (aliphatic hydrocarbons, functional group 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 bas they are capable of explaining, choosing and applying specific methods and various reaction mechanisms.					
Personal Competence						
Social Competence	Students are able to take part in discussions on c contribute to those discussion by their own stater	•	of an interdiscipli	nary team. They o		
Autonomy	After successful completion of this module stude approaches with arguments. They can also docun		ndependently by	defending propos		
Workload in Hours	Independent Study Time 96, Study Time in Lectur	e 84				
Credit points	6					
Course achievement	None					
Examination	Written exam					
Examination duration and	120 min					
scale						
Assignment for the	General Engineering Science (German program, 7	semester): Core Qualification: Compulsory				
Following Curricula						
		g Science: Elective Compulsory				

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

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

Courses							
Title				Тур	Hrs/wk	СР	
Computer Science for Engineers - Introduction and Overview (L2685)				Lecture	3	3	
	nce for Engineers - Introduction and Overview (L2686)				Recitation Section (small)	2	3
Module Responsible		nwin Fey					
Admission Requirements	None						
Recommended Previous							
Knowledge			f. II		in a la suela sues des		
Educational Objectives	After taking	g part suc	cessfully, students n	ave reached the follow	ing learning results		
Professional Competence Knowledge							
Skills							
Personal Competence							
Social Competence							
Autonomy							
· · · · · · · · · · · · · · · · · · ·	Independe	Independent Study Time 110, Study Time in Lecture 70					
Credit points		,	,,				
Course achievement	Compulsory	Bonus	Form	Description			
	No	10 %	Attestation	Testate finde	en semesterbegleitend statt.		
Examination	Written exa	am					
Examination duration and	90 min						
scale							
Assignment for the	General En	gineering	Science (German pr	ogram, 7 semester): Co	ore Qualification: Compulsory		
Following Curricula		-					
	Green Technologies: Energy, Water, Climate: Core Qualification: Compulsory						
	Logistics and Mobility: Core Qualification: Compulsory						
	Mechanical Engineering: Core Qualification: Compulsory						
	Mechatronics: Core Qualification: Compulsory Orientation Studies: Core Qualification: Elective Compulsory						
			Core Qualification: Co				
	Engineering and Management - Major in Logistics and Mobility: Core Qualification: Compulsory						

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

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

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

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

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

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ecture supported by activatin	ng methods.	
knowledge in exercises. o recapitulate poorly unders	stood content e.c	g. by using the vide
e Qualification: Compulsory		
ју Technology: Elective Com	npulsory	
rg		ore Qualification: Compulsory rgy Technology: Elective Compulsory ctive Compulsory

_	
	Lecture
	2
CP	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Prof. Dieter Krause, Prof. Josef Schlattmann, Prof. Otto von Estorff, Prof. Sören Ehlers
Language	DE
Cycle	SoSe
Content	Lecture
	Introduction to design
	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> </ul>
	<ul> <li>Maschinen- und Konstruktionselemente; Steinhilper, W., Röper, R., Springer Verlag, aktuelle Auflage.</li> </ul>
	Konstruktionslehre, Pahl, G.; Beitz, W., Springer-Verlag, aktuelle Auflage.
	Maschinenelemente 1-2; Schlecht, B., Pearson Verlag, aktuelle Auflage.
	<ul> <li>Maschinenelemente - Gestaltung, Berechnung, Anwendung; Haberhauer, H., Bodenstein, F., Springer-Verlag, aktuelle Auflage.</li> </ul>
	<ul> <li>Roloff/Matek Maschinenelemente; Wittel, H., Muhs, D., Jannasch, D., Voßiek, J., Springer Vieweg, aktuelle Auflage.</li> <li>Sowie weitere Bücher zu speziellen Themen</li> </ul>

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

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

Course L0493: Mechanics II	
Тур	Lecture
Hrs/wk	2
СР	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Prof. Christian Cyron
Language	DE
Cycle	SoSe
Content	stresses and strains
	Hooke's law
	tension and compression
	torsion
	bending
	stability
	buckling
	energy methods
Literature	<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
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Prof. Christian Cyron
Language	DE
Cycle	SoSe
Content	See interlocking course
Literature	See interlocking course

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

Courses				
Title		Тур	Hrs/wk	СР
Technical Thermodynamics I (L0437)		Lecture	2	4
Technical Thermodynamics I (L043		Recitation Section (large)	1	1
Technical Thermodynamics I (L044		Recitation Section (small)	1	1
	Prof. Dr. Arne Speerforck			
Admission Requirements				
	Elementary knowledge in Mathematics and Mechan	ics		
Knowledge				
	After taking part successfully, students have reache	ed the following learning results		
Professional Competence				
Knowledge	Students are familiar with the laws of Thermodyna	amics. They know the relation of the kind	ls of energy acc	ording to 1 <sup>st</sup> law
	distinguish between state variables and process variables and know the meaning of different state variables like temper enthalpy, entropy and also the meaning of exergy and anergy. They are able to draw the Carnot cycle in a Thermodyn related diagram. They know the physical difference between an ideal and a real gas and are able to use the related equati state. They know the meaning of a fundamental state of equation and know the basics of two phase Thermodynamics.			n a Thermodynam related equations
Skills	Students are able to calculate the internal energy, the enthalpy, the kinetic and the potential energy as well as work and he simple change of states and to use this calculations for the Carnot cycle. They are able to calculate state variables for an idea for a real gas from measured thermal state variables.			
Personal Competence Social Competence	The students are able to discuss in small groups an	d develop an approach.		
Autonomy	Students are able to define independently tasks, to knowledge in practice.	get new knowledge from existing knowledge	dge as well as to	o find ways to use t
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 s	emester): Core Qualification: Compulsory		
Following Curricula	Bioprocess Engineering: Core Qualification: Comput	sory		
	Digital Mechanical Engineering: Core Qualification:	Compulsory		
	Green Technologies: Energy, Water, Climate: Core (	Qualification: Compulsory		
	Logistics and Mobility: Specialisation Traffic Plannin	g and Systems: Elective Compulsory		
	Mechanical Engineering: Core Qualification: Compu	sory		
	Mechatronics: Core Qualification: Compulsory			
	Orientation Studies: Core Qualification: Elective Cor	npulsory		
	Naval Architecture: Core Qualification: Compulsory			
	Technomathematics: Specialisation III. Engineering	Science: Elective Compulsory		
	Process Engineering: Core Qualification: Compulsor	ý		
	Engineering and Management - Major in Logistics a			

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

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

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

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

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

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

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

rse L0915: Linear Algebr	a II
Тур	Lecture
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Prof. Anusch Taraz, Prof. Marko Lindner, 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			
CP	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	urse L0917: Linear Algebra II		
Тур	Recitation Section (large)		
Hrs/wk	1		
CP	1		
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14		
Lecturer	Prof. Anusch Taraz, Prof. Marko Lindner, Dr. Christian Seifert, Dr. Dennis Clemens		
Language	DE		
Cycle	SoSe		
Content	See interlocking course		
Literature	See interlocking course		

Courses				
Title		Тур	Hrs/wk	СР
Technical Thermodynamics II (L044		Lecture	2	4
Technical Thermodynamics II (L0450)		Recitation Section (large)	1	1
Technical Thermodynamics II (L045		Recitation Section (small)	1	1
	Prof. Dr. Arne Speerforck			
Admission Requirements	None			
Recommended Previous	Elementary knowledge in Mathematics, Mechanics and	Technical Thermodynamics I		
Knowledge				
Educational Objectives	After taking part successfully, students have reached the	ne following learning results		
Professional Competence	Students are familiar with different cycle processes like			
	derive energetic and exergetic efficiencies and know clockwise and clockwise cycles (heat-power cycle, cool draw the different cycles in Thermodynamics related processes and are able to perform simple combustion know the definition of the speed of sound and know ab	ing cycle). They have increased knowl diagrams. They know the laws of g calculations. They are provided with t	edge of steam c as mixtures, esp	ycles and are able pecially of humid
Skills	Students are able to use thermodynamic laws for the design of technical processes. Especially they are able to formulate exergy- and entropy balances and by this to optimise technical processes. They are able to perform simple safety calcu regard to an outflowing gas from a tank. They are able to transform a verbal formulated message into an abstract procedure.			safety calculations
	The students are able to discuss in small groups and de Students are able to define independently tasks, to get knowledge in practice.		dge as well as to	find ways to use t
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 seme	ester): Core Qualification: Compulsory		
Following Curricula	Bioprocess Engineering: Core Qualification: Compulsory			
	Energy and Environmental Engineering: Core Qualificat			
	Energy Systems: Technical Complementary Course Cor			
	Engineering Science: Specialisation Mechanical Engine	ering: Elective Compulsory		
	General Engineering Science (English program, 7 seme	ster): Specialisation Mechanical Engine	eering: Elective C	ompulsory
	Green Technologies: Energy, Water, Climate: Core Qua	ification: Compulsory		
	Mechanical Engineering: Core Qualification: Compulsor	4		
	Mechatronics: Core Qualification: Compulsory			
	Technomathematics: Specialisation III. Engineering Scie	ence: Elective Compulsory		
	Process Engineering: Core Qualification: Compulsory			

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

Course L0450: Technical The	urse L0450: Technical Thermodynamics II	
Тур	Recitation Section (large)	
Hrs/wk	1	
CP	1	
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14	
Lecturer	Prof. Dr. Arne Speerforck	
Language	DE	
Cycle	WiSe	
Content	See interlocking course	
Literature	See interlocking course	

Course L0451: Technical Thermodynamics II	
Тур	Recitation Section (small)
Hrs/wk	1
CP	1
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14
Lecturer	Prof. Dr. Arne Speerforck
Language	DE
Cycle	WiSe
Content	See interlocking course
Literature	See interlocking course

Courses				
Title		Тур	Hrs/wk	СР
Mechanics III (Dynamics) (L1134)		Lecture	3	3
Mechanics III (Dynamics) (L1135)		Recitation Section (small	) 2	2
Mechanics III (Dynamics) (L1136)		Recitation Section (large	) 1	1
Module Responsible	Prof. Robert Seifried			
Admission Requirements	None			
<b>Recommended Previous</b>	Mathematics I, II, Mechanics I (Statics)			
Knowledge				
Educational Objectives	After taking part successfully, students hav	e reached the following learning results		
Professional Competence				
Knowledge	The students can			
	<ul> <li>describe the axiomatic procedure us</li> </ul>	ad in machanical contaxts		
	<ul> <li>explain important steps in model des</li> </ul>			
	<ul> <li>present technical knowledge in stere</li> </ul>			
	present technical knowledge in stere	ostatics.		
Skills	The students can			
		nathematical / mechanical analysis and mode	el formation, and app	ily it to the context
	their own problems;			
		and kinetic methods to engineering problems		
	<ul> <li>estimate the reach and boundaries of</li> </ul>	f statical methods and extend them to be ap	plicable to wider prob	olem sets.
Personal Competence				
Social Competence	The students can work in groups and suppo	ort each other to overcome difficulties.		
Autonomy	Students are capable of determining their of	own strengths and weaknesses and to organiz	e their time and lear	ning based on those
Workload in Hours	Independent Study Time 96, Study Time in	Lecture 84		
Credit points	6			
Course achievement	None			
Examination	Written exam			
Examination duration and	120 min			
scale				
Assignment for the	General Engineering Science (German prog	ram, 7 semester): Core Qualification: Compu	sory	
Following Curricula	Data Science: Core Qualification: Elective C	ompulsory		
	Digital Mechanical Engineering: Core Qualif	ication: Compulsory		
	Energy and Environmental Engineering: Co	re Qualification: Elective Compulsory		
	Green Technologies: Energy, Water, Climat	e: Specialisation Energy Technology: Elective	Compulsory	
	Mechanical Engineering: Core Qualification:			
	Mechatronics: Core Qualification: Compulso	iry		
	Naval Architecture: Core Qualification: Com			
	Naval Alemeetale. core quameation. com	pulsory		

Course L1134: Mechanics III (Dynamics)		
Тур	Lecture	
Hrs/wk	3	
CP	3	
Workload in Hours	Independent Study Time 48, Study Time in Lecture 42	
Lecturer	Prof. Robert Seifried	
Language	DE	
Cycle	WiSe	
Content	Kinematics	
	<ul> <li>Kinematics of points and relative motion</li> <li>Planar and spatial motion of point systems and rigid bodies</li> <li>Dynamics <ul> <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> </li> <li>Vibrations <ul> <li>•</li> </ul> </li> </ul>	
Literature	K. Magnus, H.H. Müller-Slany: Grundlagen der Technischen Mechanik. 7. Auflage, Teubner (2009).	
	D. Gross, W. Hauger, J. Schröder, W. Wall: Technische Mechanik 3 und 4. 11. Auflage, Springer (2011).	

Typ       Recitation Section (small)         Hrs/wk       2         CP       2         Workload in Hours       Independent Study Time 32, Study Time in Lecture 28         Lecturer       Prof. Robert Seifried         Language       DE         Cycle       WiSe         Content       See interlocking course	
CP       2         Workload in Hours       Independent Study Time 32, Study Time in Lecture 28         Lecturer       Prof. Robert Seifried         Language       DE         Cycle       WiSe	
Workload in Hours     Independent Study Time 32, Study Time in Lecture 28       Lecturer     Prof. Robert Seifried       Language     DE       Cycle     WiSe	
Lecturer     Prof. Robert Seifried       Language     DE       Cycle     WiSe	
Language     DE       Cycle     WiSe	
Cycle WiSe	
Content Con interleating course	
Content See Interlocking course	
Literature See interlocking course	

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		Тур	Hrs/wk	CP
Analysis III (L1028)		Lecture	2	2
Analysis III (L1029)		Recitation Section (small)	1	1
Analysis III (L1030)		Recitation Section (large)	1	1
Differential Equations 1 (Ordinary		Lecture	2	2
Differential Equations 1 (Ordinary		Recitation Section (small)	1	1
Differential Equations 1 (Ordinary	Differential Equations) (L1033)	Recitation Section (large)	1	1
Module Responsible	Prof. Anusch Taraz			
Admission Requirements	None			
•				
Recommended Previous	Mathematics I + II			
Knowledge				
Educational Objectives	After taking part successfully, students have reached t	he following learning results		
Professional Competence				
-				
Knowledge	• Students can name the basic concepts in the an	ea of analysis and differential equation	s. They are able	to explain them usir
	appropriate examples.	, , , , , , , , , , , , , , , , , , ,	2	
		an these concents. They are conchis	of illustration th	ana compositions with
	<ul> <li>Students can discuss logical connections between the students can discuss logical connections between the students and students are students and students are students are students.</li> </ul>	en these concepts. They are capable	or illustrating th	ese connections wi
	the help of examples.			
	<ul> <li>They know proof strategies and can reproduce t</li> </ul>	hem.		
<i>ci :</i> //				
Skills	Students can model problems in the area of and	alvsis and differential equations with th	e help of the co	ncepts studied in th
	course. Moreover, they are capable of solving th			
	<ul> <li>Students are able to discover and verify further</li> </ul>			
	<ul> <li>For a given problem, the students can develop</li> </ul>	p and execute a suitable approach, a	nd are able to c	ritically evaluate th
	results.			
Personal Competence				
Social Competence				
<i>p</i>	<ul> <li>Students are able to work together in teams. The</li> </ul>	ey are capable to use mathematics as	a common langu	age.
	<ul> <li>In doing so, they can communicate new conception</li> </ul>	ts according to the needs of their coor	perating partners	. Moreover, they ca
	design examples to check and deepen the unde			-
	design examples to check and deepen the unde	istanding of their peers.		
Autonomy				
	<ul> <li>Students are capable of checking their understand</li> </ul>	anding of complex concepts on their o	wn. They can sp	ecify open question
	precisely and know where to get help in solving	them.		
	Students have developed sufficient persistence	e to be able to work for longer period	ls in a goal-orien	ted manner on har
	problems.	5 1	5	
	problems.			
Workload in Hours	Independent Study Time 128, Study Time in Lecture 1	12		
Credit points				
Course achievement	None			
Examination	Written exam			
Examination duration and	60 min (Analysis III) + 60 min (Differential Equations 1	)		
scale				
Assignment for the	General Engineering Science (German program, 7 sem	ester): Core Qualification: Compulsory		
Following Curricula	Civil- and Environmental Engineering: Core Qualification	on: Compulsory		
	Bioprocess Engineering: Core Qualification: Compulsor	у		
	Digital Mechanical Engineering: Core Qualification: Cor			
	- guaincai Engineering. core quaincation. Cor			
	Flashing Frazing and Cons Overlifesting Conservation			
	Electrical Engineering: Core Qualification: Compulsory			
	Energy and Environmental Engineering: Core Qualification			
	Energy and Environmental Engineering: Core Qualification	lification: Compulsory		
	Energy and Environmental Engineering: Core Qualifica Green Technologies: Energy, Water, Climate: Core Qua Computational Science and Engineering: Core Qualifica	alification: Compulsory ation: Compulsory		
	Energy and Environmental Engineering: Core Qualifica Green Technologies: Energy, Water, Climate: Core Qua Computational Science and Engineering: Core Qualifica Logistics and Mobility: Specialisation Traffic Planning a	alification: Compulsory ation: Compulsory nd Systems: Elective Compulsory	leen.	
	Energy and Environmental Engineering: Core Qualifica Green Technologies: Energy, Water, Climate: Core Qua Computational Science and Engineering: Core Qualifica Logistics and Mobility: Specialisation Traffic Planning a Logistics and Mobility: Specialisation Production Manag	alification: Compulsory ation: Compulsory nd Systems: Elective Compulsory gement and Processes: Elective Compu	lsory	
	Energy and Environmental Engineering: Core Qualifica Green Technologies: Energy, Water, Climate: Core Qua Computational Science and Engineering: Core Qualifica Logistics and Mobility: Specialisation Traffic Planning a	alification: Compulsory ation: Compulsory nd Systems: Elective Compulsory gement and Processes: Elective Compu	lsory	
	Energy and Environmental Engineering: Core Qualifica Green Technologies: Energy, Water, Climate: Core Qua Computational Science and Engineering: Core Qualifica Logistics and Mobility: Specialisation Traffic Planning a Logistics and Mobility: Specialisation Production Manag	alification: Compulsory ation: Compulsory nd Systems: Elective Compulsory gement and Processes: Elective Compu nology: Compulsory	lsory	
	Energy and Environmental Engineering: Core Qualifica Green Technologies: Energy, Water, Climate: Core Qua Computational Science and Engineering: Core Qualifica Logistics and Mobility: Specialisation Traffic Planning a Logistics and Mobility: Specialisation Production Manag Logistics and Mobility: Specialisation Information Techn Mechanical Engineering: Core Qualification: Compulsor	alification: Compulsory ation: Compulsory nd Systems: Elective Compulsory gement and Processes: Elective Compu nology: Compulsory	lsory	
	Energy and Environmental Engineering: Core Qualifica Green Technologies: Energy, Water, Climate: Core Qua Computational Science and Engineering: Core Qualifica Logistics and Mobility: Specialisation Traffic Planning a Logistics and Mobility: Specialisation Production Manag Logistics and Mobility: Specialisation Information Techn Mechanical Engineering: Core Qualification: Compulson Mechatronics: Core Qualification: Compulsory	alification: Compulsory ation: Compulsory nd Systems: Elective Compulsory gement and Processes: Elective Compu nology: Compulsory	lsory	
	Energy and Environmental Engineering: Core Qualifica Green Technologies: Energy, Water, Climate: Core Qua Computational Science and Engineering: Core Qualifica Logistics and Mobility: Specialisation Traffic Planning a Logistics and Mobility: Specialisation Production Manage Logistics and Mobility: Specialisation Information Techn Mechanical Engineering: Core Qualification: Compulsory Mechatronics: Core Qualification: Compulsory Naval Architecture: Core Qualification: Compulsory	alification: Compulsory ation: Compulsory nd Systems: Elective Compulsory gement and Processes: Elective Compu nology: Compulsory	lsory	
	Energy and Environmental Engineering: Core Qualifica Green Technologies: Energy, Water, Climate: Core Qua Computational Science and Engineering: Core Qualifica Logistics and Mobility: Specialisation Traffic Planning a Logistics and Mobility: Specialisation Production Manag Logistics and Mobility: Specialisation Information Techn Mechanical Engineering: Core Qualification: Compulson Mechatronics: Core Qualification: Compulsory	alification: Compulsory ation: Compulsory nd Systems: Elective Compulsory gement and Processes: Elective Compu nology: Compulsory	lsory	
	Energy and Environmental Engineering: Core Qualifica Green Technologies: Energy, Water, Climate: Core Qua Computational Science and Engineering: Core Qualifica Logistics and Mobility: Specialisation Traffic Planning a Logistics and Mobility: Specialisation Production Manage Logistics and Mobility: Specialisation Information Techn Mechanical Engineering: Core Qualification: Compulsory Mechatronics: Core Qualification: Compulsory Naval Architecture: Core Qualification: Compulsory	alification: Compulsory ation: Compulsory nd Systems: Elective Compulsory gement and Processes: Elective Compu nology: Compulsory ry		ective Compulsory
	Energy and Environmental Engineering: Core Qualifica Green Technologies: Energy, Water, Climate: Core Qua Computational Science and Engineering: Core Qualifica Logistics and Mobility: Specialisation Traffic Planning a Logistics and Mobility: Specialisation Production Manage Logistics and Mobility: Specialisation Information Techn Mechanical Engineering: Core Qualification: Compulson Mechatronics: Core Qualification: Compulsory Naval Architecture: Core Qualification: Compulsory Process Engineering: Core Qualification: Compulsory Engineering and Management - Major in Logistics and	alification: Compulsory ation: Compulsory nd Systems: Elective Compulsory gement and Processes: Elective Compu nology: Compulsory ry Mobility: Specialisation Traffic Planning	and Systems: El	
	Energy and Environmental Engineering: Core Qualifica Green Technologies: Energy, Water, Climate: Core Qua Computational Science and Engineering: Core Qualifica Logistics and Mobility: Specialisation Traffic Planning a Logistics and Mobility: Specialisation Production Manage Logistics and Mobility: Specialisation Information Techn Mechanical Engineering: Core Qualification: Compulsory Mechatronics: Core Qualification: Compulsory Naval Architecture: Core Qualification: Compulsory Process Engineering: Core Qualification: Compulsory Engineering and Management - Major in Logistics and Engineering and Management - Major in Logistics and	alification: Compulsory ation: Compulsory nd Systems: Elective Compulsory gement and Processes: Elective Compu nology: Compulsory ry Mobility: Specialisation Traffic Planning	and Systems: El	
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Course L1028: Analysis III		
Тур	Lecture	
Hrs/wk	2	
СР	2	
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28	
Lecturer	Dozenten des Fachbereiches Mathematik der UHH	
Language	DE	
Cycle	WiSe	
Content	Main features of differential and integrational calculus of several variables	
Literature	<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	<ul> <li>http://www.math.uni-hamburg.de/teaching/export/tuhh/index.html</li> </ul>	

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

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

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

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

Content

Literature

See interlocking course

See interlocking course

Module M0672: Signa	Is and Systems			
Courses				
Title		Тур	Hrs/wk	СР
Signals and Systems (L0432)		Lecture	3	4
Signals and Systems (L0433)		Recitation Section (small)	2	2
Module Responsible	Prof. Gerhard Bauch			
Admission Requirements	None			
Recommended Previous	Mathematics 1-3			
Knowledge	The modul is an introduction to the theory of signals	and systems. Cool in pulledge in mathe		o moodulo Mothemetil
	The modul is an introduction to the theory of signals 1-3 is expected. Further experience with spectral tra		-	
	but not required.	ansionnations (rouner series, rouner tra	пізіонії, саріасе	transionn) is useful
	but not required.			
Educational Objectives	After taking part successfully, students have reached	the following learning results		
Professional Competence				
Knowledge	The students are able to classify and describe signal	Is and linear time-invariant (LTI) systems	using methods	of signal and system
	theory. They are able to apply the fundamental tran	nsformations of continuous-time and disc	rete-time signals	and systems. They
	can describe and analyse deterministic signals and	systems mathematically in both time an	nd image domai	n. In particular, they
	understand the effects in time domain and image	domain which are caused by the transit	ion of a continu	ous-time signal to a
	discrete-time signal.			
Skills	The students are able to describe and analyse deterministic signals and linear time-invariant systems using methods of signal an			
	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	e impact of LTI systems on the signal prop	perties in time ar	nd frequency domain.
Personal Competence				
Social Competence	The students can jointly solve specific problems.			
Autonomy	The students are able to acquire relevant inform	ation from appropriate literature sourc	es. They can c	ontrol their level of
	knowledge during the lecture period by solving tutori	ial problems, software tools, clicker syste	m.	
Workload in Hours	Independent Study Time 110, Study Time in Lecture	70		
Credit points	6			
Course achievement	None			
Examination	Written exam			
Examination duration and	90 min			
scale				
Assignment for the	General Engineering Science (German program, 7 se	mester): Core Qualification: Compulsory		
Following Curricula	Computer Science: Core Qualification: Compulsory			
	Computer Science: Specialisation II. Mathematics and Engineering Science: Elective Compulsory			
	Data Science: Core Qualification: Compulsory			
	Electrical Engineering: Core Qualification: Compulsor	У		
	Computational Science and Engineering: Core Qualifi			
	Mechanical Engineering: Specialisation Mechatronics	: Elective Compulsory		
	Mechatronics: Core Qualification: Compulsory			
	Technomathematics: Specialisation III. Engineering S	cience: Elective Compulsory		

Course L0432: Signals and S	ystems
Тур	Lecture
Hrs/wk	3
СР	4
Workload in Hours	Independent Study Time 78, Study Time in Lecture 42
Lecturer	Prof. Gerhard Bauch
Language	DE/EN
Cycle	SoSe
Content	Introduction to signal and system theory
	Signals
	Classification of signals
	<ul> <li>Continuous-time and discrete-time signals</li> </ul>
	<ul> <li>Analog and digital signals</li> </ul>
	<ul> <li>Deterministic and random signals</li> </ul>
	<ul> <li>Description of LTI systems by differential equations or difference equations, respectively</li> </ul>
	<ul> <li>Basic properties of signals and operations on signals</li> </ul>
	Elementary signals
	Distributions (Generalized Functions)
	<ul> <li>Power and energy of signals</li> </ul>
	<ul> <li>Correlation functions of deterministic signals</li> </ul>
	Autocorrelation function
	Crosscorrelation function
	Orthogonal signals
	<ul> <li>Applications of correlation</li> </ul>
	Linear time-invariant (LTI) systems
	• Linearity
	• Time-invariance
1	1

- Description of LTI systems by impulse response and frequency response
- Convolution
- Convolution and correlation
- Properties of LTI-systems
- Causal systems
- Stable systems
- Memoryless systems
- Fourier Series and Fourier Transform
  - Fourier transform of continuous-time signals, discrete-time signals, periodic signals, non-periodic signals
     Properties of the Fourier transform
  - Fourier transform of some basic signals
  - Parseval's theorem
- Analysis of LTI-systems and signals in the frequency domain
  - Frequency response, magnitude response and phase response
  - Transmission factor, attenuation, gain
  - Frequency-flat and frequency-selective LTI-systems
  - Bandwidth definitions
  - Basic types of systems (filters), lowpass, highpass, bandpass, bandstop systems
  - Phase delay and group delay
  - Linear-phase systems
  - Distortion-free systems
  - Spectrum analysis with limited observation window: Leakage effect
- Laplace Transform
  - Relation of Fourier transform and Laplace transform
  - Properties of the Laplace transform
  - Laplace transform of some basic signals
- Analysis of LTI-systems in the s-domain
  - Transfer function of LTI-systems
  - Relation of Laplace transform, magnitude response and phase response
  - Analysis of LTI-systems using pole-zero plots
  - Allpass filters
  - Minimum-phase, maximum-phase and mixed phase filters
  - Stable systems
- Sampling
  - Sampling theorem
  - Reconstruction of continuous-time signals in frequency domain and time domain
  - Oversampling
  - Aliasing
  - Sampling with pulses of finite duration, sample and hold
  - Decimation and interpolation
- Discrete-Time Fourier Transform (DTFT)
  - Relation of Fourier transform and DTFT
  - Properties of the DTFT
- Discrete Fourier Transform (DFT)
  - Relation of DTFT and DFT
  - Cyclic properties of the DFT
  - DFT matrix
  - Zero padding
  - Cyclic convolution
  - Fast Fourier Transform (FFT)
  - Application of the DFT: Orthogonal Frequency Division Multiplex (OFDM)
- Z-Transform
  - Relation of Laplace transform, DTFT, and z-transform
  - Properties of the z-transform
  - Z-transform of some basic discrete-time signals
- Discrete-time systems, digital filters
  - FIR and IIR filters
  - Z-transform of digital filters
  - Analysis of discrete-time systems using pole-zero plots in the z-domain
  - Stability

Literature

- Allpass filters
- Minimum-phase, maximum-phase and mixed-phase filters
- Linear phase filters
- T. Frey , M. Bossert , Signal- und Systemtheorie, B.G. Teubner Verlag 2004
  K. Kammeyer, K. Kroschel, Digitale Signalverarbeitung, Teubner Verlag.
  - K. Kannieyer, K. Kroscher, Digitale signaliverarbeitung, reublier 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.

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

Courses				
Fitle		Тур	Hrs/wk	СР
ntroduction to Control Systems (L	0654)	Lecture	2	4
ntroduction to Control Systems (L	0655)	Recitation Section (small)	2	2
Module Responsible	Prof. Herbert Werner			
Admission Requirements	None			
Recommended Previous Knowledge	Representation of signals and systems in time	and frequency domain, Laplace transform		
Educational Objectives	After taking part successfully, students have r	eached the following learning results		
Professional Competence				
Knowledge	<ul> <li>Students can represent dynamic system first and second order systems</li> <li>They can explain the dynamics of simp root locus</li> <li>They can explain the Nyquist stability c</li> <li>They can explain the role of the phase</li> </ul>	n behavior in time and frequency domain, an le control loops and interpret dynamic propert riterion and the stability margins derived from margin in analysis and synthesis of control loo er affects a control loop in terms of its frequen	ties in terms of fre n it. ops	
	<ul> <li>They can explain issues arising when compared to the second second</li></ul>	ontrollers designed in continuous time domain	are implemented	digitally
Skills	<ul> <li>Students can transform models of linea</li> <li>They can simulate and assess the beha</li> <li>They can design PID controllers with th</li> <li>They can analyze and synthesize simple</li> <li>They can calculate discrete-time ap implementation</li> </ul>	r dynamic systems from time to frequency do vior of systems and control loops e help of heuristic (Ziegler-Nichols) tuning rule e control loops with the help of root locus and proximations of controllers designed in co Matlab Control Toolbox, Simulink) for carrying	es frequency respons ontinuous-time an	se techniques
Personal Competence				
Autonomy		ed sources (lecture notes, software docume	ntation, experimer	nt guides) and use
	when solving given problems. They can assess their knowledge in weekly on	-line tests and thereby control their learning p	progress.	
	They can assess their knowledge in weekly on		progress.	
	They can assess their knowledge in weekly on Independent Study Time 124, Study Time in L		progress.	
Credit points	They can assess their knowledge in weekly on Independent Study Time 124, Study Time in L 6		progress.	
Credit points Course achievement	They can assess their knowledge in weekly on Independent Study Time 124, Study Time in L 6 None		progress.	
Credit points Course achievement Examination	They can assess their knowledge in weekly on Independent Study Time 124, Study Time in L 6 None Written exam		progress.	
Credit points Course achievement	They can assess their knowledge in weekly on Independent Study Time 124, Study Time in L 6 None Written exam		progress.	
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Credit points Course achievement Examination Examination duration and scale Assignment for the	They can assess their knowledge in weekly on Independent Study Time 124, Study Time in L 6 None Written exam 120 min General Engineering Science (German program Bioprocess Engineering: Core Qualification: Cor Computer Science: Specialisation Computation Data Science: Core Qualification: Elective Con Electrical Engineering: Core Qualification: Core General Engineering: Core Qualification: Core General Engineering Science (English program General Engineering Science (English program Compulsory General Engineering Science (English program Sciences: Compulsory General Engineering Science (English program S	ecture 56 m, 7 semester): Core Qualification: Compulsor ompulsory nal Mathematics: Elective Compulsory opulsory Qualification: Compulsory n, 7 semester): Specialisation Electrical Engine n, 7 semester): Specialisation Electrical Engine n, 7 semester): Specialisation Energy and Envi n, 7 semester): Specialisation Energy and Envi n, 7 semester): Specialisation Computer Science ram, 7 semester): Specialisation Mechanical am, 7 semester): Specialisation Mechanical Engi aram, 7 semester): Specialisation Mechanical Engi	y y seering: Compulsory neering: Compulsory romental Engineer ce: Compulsory cal Engineering, Foc l Engineering, Foc l Engineering, Foc ineering, Focus Ma cal Engineering,	ry ing: Compulsory Focus Biomechanic us Energy System cus Aircraft Syster terials in Engineeri Focus Mechatronic
Credit points Course achievement Examination Examination duration and scale Assignment for the	They can assess their knowledge in weekly on Independent Study Time 124, Study Time in L 6 None Written exam 120 min General Engineering Science (German program Bioprocess Engineering: Core Qualification: Cor Computer Science: Specialisation Computation Data Science: Core Qualification: Elective Com Electrical Engineering: Core Qualification: Core General Engineering: Core Qualification: Core General Engineering Science (English program General Engineering Science (English program Compulsory General Engineering Science (English program Sciences: Compulsory General Engineering Science (English program and Production: Compulsory General Engineering Science (English program and Production: Compulsory	ecture 56 m, 7 semester): Core Qualification: Compulsor ompulsory nal Mathematics: Elective Compulsory opulsory Qualification: Compulsory n, 7 semester): Specialisation Electrical Engine n, 7 semester): Specialisation Electrical Engine n, 7 semester): Specialisation Bioprocess Engin n, 7 semester): Specialisation Energy and Envi n, 7 semester): Specialisation Computer Science ram, 7 semester): Specialisation Mechanical am, 7 semester): Specialisation Mechanical am, 7 semester): Specialisation Mechanical am, 7 semester): Specialisation Mechanical am, 7 semester): Specialisation Mechanical Engin n, 7 semester): Specialisation Mechanical Engin (ram, 7 semester): Specialis	y y cering: Compulsory g: Compulsory neering: Compulsory cal Engineering, Foc l Engineering, Foc l Engineering, Foc ineering, Focus Ma cal Engineering, gineering, Focus F	ry ing: Compulsory Focus Biomechanie us Energy Systen cus Aircraft Syster terials in Engineeri Focus Mechatronie Product Developme
Credit points Course achievement Examination Examination duration and scale Assignment for the	They can assess their knowledge in weekly on Independent Study Time 124, Study Time in L 6 None Written exam 120 min General Engineering Science (German program Bioprocess Engineering: Core Qualification: Cor Computer Science: Specialisation Computation Data Science: Core Qualification: Elective Com Electrical Engineering: Core Qualification: Core General Engineering: Core Qualification: Core General Engineering Science (English program General Engineering Science (English program Compulsory General Engineering Science (English program Sciences: Compulsory General Engineering Science (English program S	ecture 56 m, 7 semester): Core Qualification: Compulsor ompulsory nal Mathematics: Elective Compulsory opulsory Qualification: Compulsory n, 7 semester): Specialisation Electrical Engine n, 7 semester): Specialisation Electrical Engine n, 7 semester): Specialisation Energy and Envi n, 7 semester): Specialisation Computer Science ram, 7 semester): Specialisation Mechanical am, 7 semester): Specialisation Mechanical am, 7 semester): Specialisation Mechanical am, 7 semester): Specialisation Mechanical am, 7 semester): Specialisation Mechanical Engi n, 7 semester): Specialisation Mechanical Engi	y y compulsory neering: Compulsory neering: Compulsory romental Engineer ce: Compulsory cal Engineering, Foc l Engineering, Focus Ma cal Engineering, Focus Ma cal Engineering, Focus Ma cal Engineering, Focus Th gineering, Focus Th gineering, Focus Th	ry ing: Compulsory Focus Biomechanic us Energy System cus Aircraft Syster terials in Engineerii Focus Mechatronic Product Developme

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
CP	4
Workload in Hours	Independent Study Time 92, Study Time in Lecture 28
Lecturer	Prof. Herbert Werner
Language	DE
Cycle	WiSe
Content	Signals and systems
	<ul> <li>Linear systems, differential equations and transfer functions</li> <li>First and second order systems, poles and zeros, impulse and step response</li> <li>Stability</li> <li>Feedback systems</li> <li>Principle of feedback, open-loop versus closed-loop control</li> <li>Reference tracking and disturbance rejection</li> </ul>
	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
	<ul> <li>Bode diagram</li> <li>Minimum and non-minimum phase systems</li> <li>Nyquist plot, Nyquist stability criterion, phase and gain margin</li> <li>Loop shaping, lead lag compensation</li> <li>Frequency response interpretation of PID control</li> </ul>
	Time delay systems
	<ul><li>Root locus and frequency response of time delay systems</li><li>Smith predictor</li></ul>
	Digital control
	<ul> <li>Sampled-data systems, difference equations</li> <li>Tustin approximation, digital implementation of PID controllers</li> </ul>
	Software tools
	<ul> <li>Introduction to Matlab, Simulink, Control toolbox</li> <li>Computer-based exercises throughout the course</li> </ul>
Literature	<ul> <li>Werner, H., Lecture Notes "Introduction to Control Systems"</li> <li>G.F. Franklin, J.D. Powell and A. Emami-Naeini "Feedback Control of Dynamic Systems", Addison Wesley, Reading, MA, 2009</li> <li>K. Ogata "Modern Control Engineering", Fourth Edition, Prentice Hall, Upper Saddle River, NJ, 2010</li> <li>R.C. Dorf and R.H. Bishop, "Modern Control Systems", Addison Wesley, Reading, MA 2010</li> </ul>

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

	Тур	Hrs/wk	СР
	Recitation Section (small)	2	3
0)	Lecture	3	3
Prof. Christoph Ihl			
None			
Basic Knowledge of Mathematics and Business			
After taking part successfully, students have reache	ed the following learning results		
<ul> <li>important definitions from the field of Manage</li> <li>explain the most important aspects of and projects</li> <li>describe and explain basic business funct organization and human ressource managen</li> <li>explain the relevance of planning and de uncertainty, and explain some basic method</li> <li>state basics from accounting and costing and</li> <li>Students are able to analyse business units with re out an Entrepreneurship project in a team. In partice</li> <li>analyse Management goals and structure the</li> <li>analyse organisational and staff structures or</li> </ul>	gement goals in Management and name the most tions as production, procurement and so nent, information management, innovation cision making in Business, esp. in situa s from mathematical Finance d selected controlling methods. espect to different criteria (organization, ot cular, they are able to em appropriately f companies	t important aspe burcing, supply management ar tions under mul	cts of entreprneur chain manageme nd marketing tiple objectives a
<ul> <li>analyse production and procurement system</li> <li>analyse and apply basic methods of marketin</li> <li>select and apply basic methods from mather</li> </ul>	is and Business information systems ng matical finance to predefined problems	nder risk	
<ul> <li>to communicate appropriately and</li> <li>to cooperate respectfully with their fellow stu</li> <li>Students are able to</li> </ul>	udents.	pherent report on	the project
Independent Study Time 110, Study Time in Lectur	e 70		
6			
None			
Subject theoretical and practical work			
several written exams during the semester			
Civil- and Environmental Engineering: Specialisation Civil- and Environmental Engineering: Specialisation Civil- and Environmental Engineering: Specialisation Bioprocess Engineering: Core Qualification: Compulsory Data Science: Core Qualification: Compulsory Data Science: Core Qualification: Compulsory Electrical Engineering: Core Qualification: Compulsor Energy and Environmental Engineering: Core Qualifi General Engineering Science (English program, 7 se General Engineering Science (English program, 7 se	n Civil Engineering: Elective Compulsory n Water and Environment: Elective Compul n Traffic and Mobility: Elective Compulsory lsory fication: Compulsory emester): Specialisation Electrical Engineer emester): Specialisation Civil Engineering: emester): Specialisation Bioprocess Engine	ing: Compulsory Compulsory ering: Compulson mental Engineer	ſy
	Prof. Christoph Ihl         None         Basic Knowledge of Mathematics and Business         After taking part successfully, students have reacher         After taking this module, students know the import         and Organisation to Marketing and Innovation, and         • explain the differences between Economic         important definitions from the field of Manage         • explain the most important aspects of and         projects         • describe and explain basic business function         organization and human ressource manager         • explain the relevance of planning and de         uncertainty, and explain some basic method         • state basics from accounting and costing and         Students are able to analyse business units with re         out an Entrepreneurship project in a team. In partice         • analyse Management goals and structure the         • analyse organisational and staff structures to         • analyse and apply basic methods of marketi         • select and apply basic methods from mather         • apply their knowledge from the lecture to         • to communicate appropriately and         • to cooperate respectfully with their fellow str         Students are able to         • work in a team and to organize the team the         • to wirk a report on their project.      <	p)         Leture           Prof. Christoph III         None           Basic Knowledge of Mathematics and Business         After taking part successfully, students have reached the following learning results           After taking this module, students know the important basics of many different areas in Busin and Organisation to Marketing and Innovation, and also to Investment and Controlling. In part • explain the differences between Economics and Management and name the sub-discip important definitions from the field of Management information procurement and su organization and human ressource management, information management, innovation • explain the relevance of planning and decision making in Busines, esp. in situa uncertainty, and explain some basic methods from mathematical Finance • state basics from accounting and costing and selected controlling methods.           Students are able to analyse business units with respect to different criteria (organization, ot out an Entrepreneurship project in a team. In particular, they are able to • analyse organisational and staff structures of companies • apply methods for decision making under multiple objectives, under uncertainty and ur • analyse production and procurement systems and Business information systems • analyse and apply basic methods of marketing • select and apply basic methods form mathematical finance to predefined problems • apply thesic methods from the lecture to an entrepreneurship project and write a cor • to communicate appropriately and • to comparise eraptically and • to cooperate respectfully with their fellow students.           Students are able to         • work in a team and to organize the team themselves • to write a report on their project.           Independent Study Time 110, Study Time in Lecture 70	b)         Lecture         3           Prof. Christigh Inl         None           Basic Knowledge of Mathematics and Business         After taking part successfully, students have reached the following learning results           After taking part successfully, students have reached the following learning results         After taking this module, students know the important basics of many different areas in Business and Manage and Organisation to Marketing and Innovation, and also to Investment and Controlling, In particular they are al explain the differences between Economics and Management and the sub-disciplines in Manage important definitions from the field of Management.           explain the differences between Economics and Management and name the most important aspep projects         describe and explain basic business functions as production, procurement and sourcing, supply organization and human reasource management, information management, innovation management are explain the relevance of planning and decision making in Business, esp. in situations under multi uncertainty, and explain some basic methods from mathematical Finance           state basics from accounting and costing and selected controlling methods.           Students are able to analyse business units with respect to different criteria (organization, objectives, strateg out an Entrepreneurship project in a team. In particular, they are able to           analyse Management goals and structure them appropriately           analyse and apply basic methods from mathematical finance to predefined problems           analyse and apply basic methods from mathematical finance to predefined problems           analy

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

-	L selevas
Тур	Lecture
Hrs/wk	3
CP	3
	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. Corneli
	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, Innovat Management, Marketing and Sales</li> <li>Cross-sectional Functions, e.g. Organisation, Human Ressource Management, Supply Chain Management, Informati 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. A Stuttgart 2005.
	Weber, J., Schäffer, U. : Einführung in das Controlling, 12. Auflage, Stuttgart 2008. Weber, J./Weißenberger, B.: Einführung in das Rechnungswesen, 7. Auflage, Stuttgart 2006.

Courses				
Title		Тур	Hrs/wk	СР
	ship-accompanying Seminar (L2687)	Seminar	1	0
Advanced Internship AIW/ ES: Prep		Seminar	1	0
Module Responsible	Prof. Robert Seifried			
Admission Requirements	None			
<b>Recommended Previous</b>	150 Creditpoints in General Engineering Sci	ence		
Knowledge				
Educational Objectives	After taking part successfully, students have	e reached the following learning results		
Professional Competence				
Knowledge	Students of the different specialisations get	experiences in typical scope of duties of e	engineers, who are worki	ing in a developm
	division, planning division or in the mana	agement of a company. In the framewor	k of this environment	the knowledge fr
	university can used a first time for real eng	ineering tasks.		
Chille	Chudonte of the different encodeligations of	and be interveted in tunical day/a wark	Du this they are leave	ing trutical tasks
SKIIIS	Students of the different specialisations should be integrated in typical day's work. By this they are learning typical tasks are functions of engineers. They are able to structure and organize their working day and to finish tasks in a certain time.			
	functions of engineers. They are able to stit		to ministr tasks in a certa	ini time.
Personal Competence				
Social Competence	Students are able to cooperate with co-work	kers in a company and to understand the la	anguage 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				
Assignment for the	General Engineering Science (German prog	ram, 7 semester): Core Qualification: Com	pulsory	
Following Curricula	Engineering Science: Core Qualification: Cor	mpulsory		
	General Engineering Science (English progra			

Course L2687: Advanced Inte	enship AIW/ ES: Internship-accompanying Seminar
Тур	Seminar
Hrs/wk	1
CP	0
Workload in Hours	Independent Study Time -14, Study Time in Lecture 14
Lecturer	Prof. Robert Seifried, Eilika Schwenke
Language	DE/EN
Cycle	WiSe/SoSe
Content	The aim of the internship-accompanying seminar is the acquisition and consolidation of competences relevant for successfully doing the advanced internship in the 7th semester. The target group is students who already have found an internship placement. The focus is on strengthening personal competences to support the successful development of professional competences. In the seminar, students reflect on current challenges in relation to the internship. They discuss current topics with fellow students and teachers with the method of collegial counselling (peer-to-peer approach); in this way they gain (additional) self-confidence and increase their chances of successfully contributing in the internship, recognising and expressing their own wishes and needs in order to optimally use the internship for their own theory-practice transfer. The selection of topics is process-oriented and controlled by the group; the teachers provide impulses for reflection on certain topics. Topics that are dealt with are, for example: Negotiating the employment contract, Successful start into the internship - how do I behave in the first few days, How do I get interesting tasks, How do I deal with difficult situations (e.g. conflicts, sexism, racism), How do I note my progress/write the internship report? Through the intensive exchange with fellow students, the students also gain insights into the internships of their peers. This gives them an impression of their professional opportunities far beyond their own internship. The concrete application example of the advanced internship thus promotes the acquisition and consolidation of competences in career management skills that can be transferred to later career steps.
Literature	
Literature	

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

## **Specialization Civil Engineering**

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

Courses				
Title		Тур	Hrs/wk	СР
Building Physics (L0217)		Lecture	2	2
Building Physics (L0219)		Recitation Section (large)	1	1
Building Physics (L0247)		Recitation Section (small)	1	1
Principles of Building Materials (L02		Lecture	2	2
Module Responsible	Prof. Frank Schmidt-Döhl			
Admission Requirements				
Recommended Previous	Knowledge of physics, chemistry and mathematics from school			
Knowledge				
Educational Objectives	After taking part successfully, students	have reached the following learning results		
Professional Competence				
Skills	behaviour, to describe the structure of building materials and the correlations between structure and other properties, show methods of joining and of corrosion processes and to describe the most important regularities and properties of buildi materials and structures and their measurement in the field of protection against moisture, coldness, fire and noise. The students are able to work with the most important standardized methods and regularities in the field of moisture protectio the German regulation for energy saving, fire protection and noise protection in the case of a small building.			
Personal Competence				
Social Competence	The students are able to support each other to 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 Tim	e in Lecture 84		
Credit points	6			
Course achievement	None			
Examination	Written exam			
Examination duration and	2 h written exam			
scale				
-		program, 7 semester): Specialisation Civil Engineering	: Compulsory	
Following Curricula	Civil- and Environmental Engineering: 0			
	Orientation Studies: Core Qualification:	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	ics
Тур	Recitation Section (large)
Hrs/wk	1
СР	1
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14
Lecturer	Prof. Frank Schmidt-Döhl
Language	DE
Cycle	WiSe
Content	See interlocking course
Literature	See interlocking course

Course L0247: Building 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 I	Building Materials
Тур	Lecture
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Prof. Frank Schmidt-Döhl
Language	DE
Cycle	WiSe
Content	Structure of building materials
	Effects of action
	Fundamentals of mechanical behaviour
	Material testing
	Principles of metals
	Joining methods
Literature	Wendehorst, R.: Baustoffkunde. ISBN 3-8351-0132-3
	Scholz, W.:Baustoffkenntnis. ISBN 3-8041-4197-8

Courses					
Title			Тур	Hrs/wk	СР
Structural Analysis I (L0666)			Lecture	2	3
Structural Analysis I (L0667)	Recitation Section (large) 2 3				
Module Responsible	Prof. Uwe Starossek				
Admission Requirements	None				
<b>Recommended Previous</b>	Mechanics I, Mathematics I				
Knowledge					
Educational Objectives	After taking part suc	cessfully, students have r	eached the following learning results		
Professional Competence					
Knowledge	After successfully co	mpleting this module, stu	dents can express the basic aspects of linear fr	ame analysis of s	tatically determina
	systems.				
Skills	After successful com	unletion of this module th	e students are able to distinguish between sta	tically determinat	e and indetermina
Skiils			ariables and to construct influence lines of sta	-	
	frame and truss strue				ce plane and space
Personal Competence					
	Students can				
Social Competence	Students can				
	participate in	subject-specific and interc			
	<ul><li> participate in :</li><li> defend their o</li></ul>	wn work results in front o	fothers		
	<ul> <li>participate in s</li> <li>defend their o</li> <li>promote the s</li> </ul>	wn work results in front o	f others colleagues		
	<ul> <li>participate in s</li> <li>defend their o</li> <li>promote the s</li> </ul>	wn work results in front o	fothers		
	<ul> <li>participate in :</li> <li>defend their o</li> <li>promote the s</li> <li>Furthermore, 1</li> </ul>	wn work results in front o cientific development of c they can give and accept	f others colleagues	they are enabled	l to self-assess the
Social Competence	<ul> <li>participate in :</li> <li>defend their o</li> <li>promote the s</li> <li>Furthermore, 1</li> </ul>	wn work results in front o cientific development of c they can give and accept	f others colleagues professional constructive criticism rk assignments. Due to the in-term feedback,	they are enabled	to self-assess the
Social Competence Autonomy	<ul> <li>participate in :</li> <li>defend their o</li> <li>promote the s</li> <li>Furthermore, 1</li> </ul> The students are ab learning progress du	wn work results in front o ccientific development of c they can give and accept le work in-term homewor ring the lecture period, al	f others colleagues professional constructive criticism rk assignments. Due to the in-term feedback, ready.	they are enabled	l to self-assess the
Social Competence Autonomy Workload in Hours	<ul> <li>participate in :</li> <li>defend their o</li> <li>promote the s</li> <li>Furthermore, 1</li> </ul> The students are ab learning progress du Independent Study T	wn work results in front o ccientific development of c they can give and accept le work in-term homewor	f others colleagues professional constructive criticism rk assignments. Due to the in-term feedback, ready.	they are enabled	l to self-assess the
Social Competence Autonomy Workload in Hours Credit points	<ul> <li>participate in :</li> <li>defend their o</li> <li>promote the s</li> <li>Furthermore, 1</li> </ul> The students are ab learning progress du	wn work results in front o ccientific development of c they can give and accept le work in-term homewor ring the lecture period, al	f others colleagues professional constructive criticism rk assignments. Due to the in-term feedback, ready.	they are enabled	I to self-assess the
Social Competence Autonomy Workload in Hours	<ul> <li>participate in :</li> <li>defend their o</li> <li>promote the s</li> <li>Furthermore, I</li> </ul> The students are ab learning progress du Independent Study T	wn work results in front o ccientific development of c they can give and accept le work in-term homewor ring the lecture period, al ime 124, Study Time in Lo	f others colleagues professional constructive criticism rk assignments. Due to the in-term feedback, ready. ecture 56		
Social Competence Autonomy Workload in Hours Credit points	<ul> <li>participate in :</li> <li>defend their o</li> <li>promote the s</li> <li>Furthermore, I</li> </ul> The students are ab learning progress du Independent Study T 6 Compulsory Bonus	wn work results in front o ccientific development of c they can give and accept de work in-term homewor ring the lecture period, al ime 124, Study Time in Lo Form	f others colleagues professional constructive criticism rk assignments. Due to the in-term feedback, ready. ecture 56 Description		
Social Competence Autonomy Workload in Hours Credit points Course achievement	<ul> <li>participate in :</li> <li>defend their o</li> <li>promote the s</li> <li>Furthermore, I</li> </ul> The students are ab learning progress du Independent Study T 6 Compulsory Bonus No 10 % Written exam	wn work results in front o ccientific development of c they can give and accept de work in-term homewor ring the lecture period, al ime 124, Study Time in Lo Form	f others colleagues professional constructive criticism rk assignments. Due to the in-term feedback, ready. ecture 56 Description		
Social Competence Autonomy Workload in Hours Credit points Course achievement Examination	<ul> <li>participate in :</li> <li>defend their o</li> <li>promote the s</li> <li>Furthermore, I</li> </ul> The students are ab learning progress du Independent Study T 6 Compulsory Bonus No 10 % Written exam	wn work results in front o ccientific development of c they can give and accept de work in-term homewor ring the lecture period, al ime 124, Study Time in Lo Form	f others colleagues professional constructive criticism rk assignments. Due to the in-term feedback, ready. ecture 56 Description		
Social Competence Autonomy Workload in Hours Credit points Course achievement Examination Examination duration and	<ul> <li>participate in :</li> <li>defend their o</li> <li>promote the s</li> <li>Furthermore, I</li> </ul> The students are ab learning progress du Independent Study T 6 Compulsory Bonus No 10 % Written exam 90 Minuten	wn work results in front o ccientific development of c they can give and accept ele work in-term homewor ring the lecture period, al Time 124, Study Time in Lu Form Written elaboration	f others colleagues professional constructive criticism rk assignments. Due to the in-term feedback, ready. ecture 56 Description	tudentische Tutor	
Social Competence Autonomy Workload in Hours Credit points Course achievement Examination Examination duration and scale	<ul> <li>participate in :</li> <li>defend their o</li> <li>promote the s</li> <li>Furthermore, I</li> </ul> The students are ab learning progress du Independent Study T 6 Compulsory Bonus No 10 % Written exam 90 Minuten General Engineering	wn work results in front o ccientific development of c they can give and accept ele work in-term homewor ring the lecture period, al Time 124, Study Time in Lu Form Written elaboration	f others colleagues professional constructive criticism rk assignments. Due to the in-term feedback, ready. ecture 56 Description Hausübungen mit Testat, betreut durch Si n, 7 semester): Specialisation Civil Engineering	tudentische Tutor	
Social Competence Autonomy Workload in Hours Credit points Course achievement Examination Examination duration and scale Assignment for the	participate in :         defend their o         promote the s         Furthermore, I  The students are ab learning progress du Independent Study T 6 Compulsory Bonus No 10 % Written exam 90 Minuten General Engineering Civil- and Environme	wn work results in front o ccientific development of c they can give and accept de work in-term homewor ring the lecture period, al Time 124, Study Time in Lu Form Written elaboration Science (German program intal Engineering: Core Qu	f others colleagues professional constructive criticism rk assignments. Due to the in-term feedback, ready. ecture 56 Description Hausübungen mit Testat, betreut durch Si n, 7 semester): Specialisation Civil Engineering	tudentische Tutor	
Social Competence Autonomy Workload in Hours Credit points Course achievement Examination Examination duration and scale Assignment for the	participate in :         defend their o         promote the s         Furthermore, I      The students are ab     learning progress du     Independent Study T     6     Compulsory Bonus     No 10 %      Written exam     90 Minuten      General Engineering     Civil- and Environme     Logistics and Mobility	wn work results in front o ccientific development of c they can give and accept de work in-term homework ring the lecture period, all rime 124, Study Time in Lu Form Written elaboration Science (German program intal Engineering: Core Qu y: Specialisation Traffic Pla	f others colleagues professional constructive criticism rk assignments. Due to the in-term feedback, ready. ecture 56 Description Hausübungen mit Testat, betreut durch Si n, 7 semester): Specialisation Civil Engineering ialification: Compulsory	tudentische Tutor	
Social Competence Autonomy Workload in Hours Credit points Course achievement Examination Examination duration and scale Assignment for the	participate in :         defend their o         promote the s         Furthermore, I      The students are ab learning progress du Independent Study T 6      Compulsory Bonus No 10 %      Written exam 90 Minuten      General Engineering Civil- and Environme Logistics and Mobility Technomathematics:	wn work results in front o ccientific development of c they can give and accept de work in-term homework ring the lecture period, all rime 124, Study Time in Lu Form Written elaboration Science (German program intal Engineering: Core Qu y: Specialisation Traffic Pla : Specialisation III. Engineer	f others colleagues professional constructive criticism rk assignments. Due to the in-term feedback, ready. ecture 56 Description Hausübungen mit Testat, betreut durch Si n, 7 semester): Specialisation Civil Engineering ialification: Compulsory anning and Systems: Elective Compulsory	tudentische Tutor	en (Tutorium)

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

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

Courses					
Title			Тур	Hrs/wk	СР
Building Materials and Building Chemistry (L0248)			Lecture	4	4
Building Materials and Building Chemistry (L0249)			Recitation Section (small)	1	2
Module Responsible	Prof. Frank Schmidt-Döh	I			
Admission Requirements	a None				
<b>Recommended Previous</b>	I Previous Module Principles of Building Materials and Building Physics				
Knowledge					
Educational Objectives	After taking part success	sfully, students have reache	d the following learning results		
Professional Competence					
Knowledge	The students are able	e to explain the most im	portant components, the manufacture	, the structure,	the most importa
	characteristics of the m	nechanical behaviour and th	e corrosion behaviour, the material te	sting and the field	s of utilization of
	relevant building materia	als.			
Skills	ills The students are able to assess the usability of building materials for different applications and to select building			t building materi	
	according to their specific advantages and disadvantages. The students are able to prepare the mixture of a normal type concret				
	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			n the very extensive specialist knowled	lge in learning gro	ups and to carry o
	exercises in small group	is in the lab.			
Autonomy	The students are able to	make the timing and the o	peration steps to learn the specialist kno	wledge of a very e	xtensive field.
Workload in Hours	Independent Study Time	e 110, Study Time in Lecture	70		
Credit points					
Course achievement	Compulsory Bonus F	orm	Description		
	No 10 % P	Presentation			
Examination	Written exam				
Examination duration and	2 h written exam				
scale					
Assignment for the	General Engineering Scie	ence (German program, 7 s	emester): Specialisation Civil Engineerin	g: Compulsory	
Following Curricula	Civil- and Environmental	I Engineering: Core Qualifica	tion: Compulsory		
	1	e Qualification: Elective Con			

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

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

Courses						
Title				Тур	Hrs/wk	СР
Project Seminar Concrete I (L0896)	)			Seminar	1	1
Reinforced Concrete Design I (L0303)				Lecture	2	3
Reinforced Concrete Design I (L030	05)			Recitation Section (large)	2	2
Module Responsible	Prof. Günter Romba	ch				
Admission Requirements	None					
<b>Recommended Previous</b>	Basic knowledge in	structural analysis and	d building materials.			
Knowledge	Madulaa Chuvahuural					
	Modules: Structural	Analysis I, Mechanics	1+11			
Educational Objectives	After taking part suc	ccessfully, students ha	ave reached the following	ng learning results		
Professional Competence						
Knowledge	The students can ou	utline the history of co	ncrete construction an	d explain the basics of struc	tural engineering,	including usual lo
	combinations and s	afety concepts. They	are able to draft and di	mension simple structures,	as well as to eval	uate and discuss t
	behaviour of the ma	terials and of structur	al members.			
Skills	The students are able to apply basic procedures of the conception and dimensioning to practical cases. They are capable to dra					
51115				and bending with axial fo		
				etches and draw up technica		then actuming a
	execution. Horeover	r, they can make desig		teries and araw up teerinica	r desemptions.	
Personal Competence						
-						
Social Competence	The shudents are als	1. h	to also in the second sublem	and dimensioning of should		U 61
Autonomy	The students are ab	le to carry out simple	tasks in the conception	and dimensioning of struct	ures and to critica	lly reflect the resu
Workload in Hours	Independent Study	Time 110, Study Time	in Lecture 70			
Credit points	6					
Course achievement	Compulsory Bonus	Form	Description			
	Yes None	Excercises				
Examination	Written exam					
Examination duration and	120 minutes					
scale						
Assignment for the	General Engineering	g Science (German pro	gram, 7 semester): Sp	ecialisation Civil Engineering	: Compulsory	
Following Curricula	Civil- and Environme	ental Engineering: Cor	e Qualification: Compu	lsory		
	•					
Course L0896: Project Semir	nar Concrete I					
Тур	Seminar					
Hrs/wk	1					
	1					

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

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

Course L0305: Reinforced Co	ourse L0305: Reinforced Concrete Design I			
Тур	Recitation Section (large)			
Hrs/wk	2			
CP	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)	Recitation	Section (large)	2	3		
Module Responsible	Prof. Uwe Starossek					
Admission Requirements	None					
<b>Recommended Previous</b>	Mechanics I/II					
Knowledge	Mathematics I/II					
	Differential Equations I					
	Structural Analysis I					
Educational Objectives	After taking part successfully, students have reached the following learning	results				
Professional Competence						
Knowledge		basic aspects of	linear frame ar	nalysis of statica		
	indeterminate systems.					
Skills	After successful completion of this module, the students are able to anal	yze state variables	and to construc	t influence lines		
	statically inderminate plane and spatial frame and truss structures.					
Personal Competence						
Social Competence	Students can					
	<ul> <li>participate in subject-specific and interdisciplinary discussions,</li> </ul>					
	<ul> <li>defend their own work results in front of others</li> </ul>					
	promote the scientific development of colleagues					
	Furthermore, they can give and accept professional constructive critic	icism				
Autonomy	The students are able to work in-term homework assignments. Due to the	in torm foodback 1	thow are enabled	to colf accors th		
Autonomy	learning progress during the lecture period, already.	in-term reeuback, t	they are enabled			
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56					
Credit points						
Course achievement						
	No 10 % Written elaboration Hausübungen mit Testat	t, betreut durch Stu	dentische Tutore	en (Tutorium)		
Examination						
Examination duration and						
scale						
Assignment for the Following Curricula	General Engineering Science (German program, 7 semester): Specialisation Civil- and Environmental Engineering: Core Qualification: Compulsory	CIVII Engineering: (	compulsory			
ronowing curricula	Civie and Environmental Engineering: Core Qualification: Compulsory					
Course L0673: Structural An	alvsis II					
Typ						
Hrs/wk						
CP						
Workload in Hours						

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

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					
<b>Recommended Previous</b>	Structural analysis I, Structural analysis II					
Knowledge	Mechanics I, Mechanics II					
	Building Materials and Building Chemistry					
	Principles of Building Materials and Building	Physics				
Educational Objections						
	After taking part successfully, students have reach	ed the following learning results				
Professional Competence	After packing this module students are able to					
Knowleage	After passing this module students are able to					
	give a summary of the security concept					
	explain the priciples of the design process					
	<ul> <li>describe and illustrate the bhaviour of memers in tension, compression and bending</li> </ul>					
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 ser	viceability 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 organize themselves in groups. They will be					
	successful in guided building a truss with bolted co	nnections according to design drawings.				
Autonomy						
Workload in Hours		e 56				
Credit points						
Course achievement	None					
	Written exam					
Examination duration and	120 minutes					
scale						
	General Engineering Science (German program, 7 s		g: Compulsory			
Following Curricula	Civil- and Environmental Engineering: Core Qualific					
	General Engineering Science (English program, 7 s	emester): Specialisation Civil Engineering	: Compulsory			
Course L0299: Steel Structu	res I					
	Lecture					
Hrs/wk						
CP	3					
	Independent Study Time 62, Study Time in Lecture	28				
	Dref Marcus Dutner	20				

Workload in Hours	Independent Study Time 62, Study Time in Lecture 28				
Lecturer	Prof. Marcus Rutner				
Language					
Cycle	5				
Content	<ul> <li>Introduction to steel constructions</li> <li>Materials</li> <li>Design and security model</li> <li>Tension rods</li> <li>Beams (elsatic and plastic design</li> <li>Column design</li> <li>Bolted connections</li> </ul>				
Literature	sen, C.: Stahlbau, 4. Auflage 2013, Springer-Vieweg Verlag				
	<ul> <li>Wagenknecht, G.: Stahlbau-Praxis nach Eurocode 3, Bauwerk-Verlag 2011</li> <li>Band 1 Tragwerksplanung, Grundlagen</li> <li>Band 2 Verbindungen und Konstruktionen</li> </ul>				

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

Courses							
Title					Tun	Hrs/wk	СР
Hydrology (L0909)					<b>Typ</b> Lecture	пт <b>5/</b> wк 1	1
Hydrology (L0956)					Project-/problem-based Learning	1	2
Hydromechanics (L0615)					Lecture	2	2
Hydromechanics (L0616)					Project-/problem-based Learning	1	1
Module Responsible	Prof. Peter Fr	öhle					
Admission Requirements	None						
Recommended Previous	Mathematics	I, II and II	1				
Knowledge							
	Mechanics I u	und II					
Educational Objectives	After taking p	oart succe	ssfully, students have r	eached the following	g learning results		
Professional Competence							
Knowledge	The students	are able	to define the basic ter	ms of hvdromecha	nics, hydrology groundwater h	vdrology and	water manageme
2					ii) kinematics of flows and iii)		
	-				cycle. Besides, the students		
					models as well as the concep		
	hydrograph.		5				
	J 5 - 1-						
Skills	The students	are able	to apply the fundament	al formulations of hy	ydromechanics to basic practic	al problems. F	urthermore, they a
	able to run, e	explain an	d document basic hydra	aulic experiments.			
	Pacidae, they are able to apply basic hydrological approaches and watheds to simple hydrological methods. The students have						
	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 pe	are able to perform, analyze and assess respective measurements.					
Personal Competence							
-	The students	ara abla	to work in groups in	a goal orientated is	tructured menner. They can a	valain thair r	
Social Competence					tructured manner. They can e		
	plenary sessions by use of peer learning approaches. Furthermore, they are able to prepare and present technical presentations for given topics in groups.						
	for given top	ics in grou	ips.				
Autonomy	Students are	capable o	of organising their indivi	dual work flow to co	ontribute to the conduct of exp	eriments and	to present disciplir
	specific know	vledge. Th	ney can provide each o	ther with feedback	and suggestions on their resu	lts. They are	capable of reflecti
	their study te	echniques	and learning strategy o	n an individual basi	s.		
Workload in Hours	Indonondont	Study Tim	ne 110, Study Time in L	octuro 70			
Credit points		Study III	ie 110, Study fille if E				
Course achievement	Compulsory B	onus	Form	Description			
	Yes N	lone	Group discussion	Erstellung eir	ne Posters zu einer Themat	tik aus dem	Themengebiet o
				Hydrologie in (	Gruppen und Präsentation		-
	Yes N	lone	Excercises	Übungsaufgab	en Hydrologie		
		lone	Subject theoretical		Dokumentation und Prä	sentation zu	ı einem Versuc
			practical work		ik oder Hydraulik in Gruppen		
Examination	Written exam	า					
Examination duration and	150 minutes						
scale							
Assignment for the	General Engi	neering S	cience (German prograr	n, 7 semester): Spe	cialisation Civil Engineering: Co	ompulsory	
Following Curricula	Civil- and Env	vironment	al Engineering: Core Qu	alification: Compuls	sory		
	General Engi	neering S	cience (English program	, 7 semester): Spec	ialisation Civil Engineering: Co	mpulsory	
	Logistics and Mobility: Specialisation Traffic Planning and Systems: Elective Compulsory						
	Engineering and Management - Major in Logistics and Mobility: Specialisation Traffic Planning and Systems: Elective Compulso						

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

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

Course L0615: Hydromechan	ics
Тур	Lecture
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Prof. Peter Fröhle
Language	DE
Cycle	WiSe
Content	Fundamentals of Hydromechanics
	Characteristics of fluids
	Hydrostatics
	Kinematics of flows, laminar and turbulent flows
	Conservation laws
	Conservation of mass
	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	urse L0616: Hydromechanics		
Тур	Project-/problem-based Learning		
Hrs/wk	1		
CP	1		
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14		
Lecturer	Prof. Peter Fröhle		
Language	DE		
Cycle	Cycle WiSe		
Content	See interlocking course		
Literature	See interlocking course		

Courses						
Title				Тур	Hrs/wk	СР
Soil Mechanics (L0550) Soil Mechanics (L0551)				Lecture Recitation Section (large)	2	2
Soil Mechanics (L0551)				Recitation Section (large)	2	2
Module Responsible	Prof. Jürgen Grabe					
Admission Requirements	None					
<b>Recommended Previous</b>	Modules :					
Knowledge	Mechanics I-	11				
Educational Objectives	After taking part su	ccessfully, students	have reached the follow	ing learning results		
Professional Competence						
Knowledge	The students know	the basics of soil me	echanics as the structure	and characteristics of soil, s	tress distribution	due to weight, wa
	or structures, conso	lidation and settlem	ent calculations, as well	as failure of the soil due to g	round- or slope fa	ilure.
Skills	After the successfu	I completion of the	module the students sho	ould be able to describe the r	mechanical prope	rties and to evalua
	them with the help	o of geotechnical st	andard tests. They can	calculate stresses and defor	rmation in the so	oils due to weight
	influence of structu	res. They are are ab	le to prove the usability	(settlements) for shallow four	ndations.	
Personal Competence						
Social Competence						
Autonomy						
Workload in Hours	Independent Study	Time 96, Study Time	e in Lecture 84			
Credit points	6					
Course achievement		Form	Description			
	No 20 %	Attestation				
	Written exam					
Examination duration and						
scale						
-	-			ecialisation Civil Engineering	: Compulsory	
Following Curricula			ore Qualification: Compu			
	-		affic Planning and Syster			
			Engineering Science: Ele			
	Engineering and Ma	anagement - Major ir	1 Logistics and Mobility: S	Specialisation Traffic Planning	and Systems: Ele	ective Compulsory

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

Course L1493: Soil Mechanic	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		

Courses				
Title	Ту	•	Hrs/wk	СР
Basics in Structural Design (L0209)		oject-/problem-based Learning	2	4
Basics of Structural Design (L0205) Basics in Structural Design (L0208)		ecture ecitation Section (large)	2 1	1
Module Responsible		section (large)	1	1
Admission Requirements	None			
Recommended Previous	Contents of module "Principles of Building Materials and Building Ph	vsics"		
Knowledge	contents of module remeiples of building Materials and building en	ysics		
	After taking part successfully, students have reached the following	learning results		
Professional Competence	Arter taking part successiony, students have reached the following	carning results		
	After attending the "Building Construction" module students are abl			
Kilowieuge	Arter attending the Durang construction module students are abi	c		
	<ul> <li>to define the basics of building regulations law</li> </ul>			
	<ul> <li>to explain load effects and associated concepts</li> </ul>			
	<ul> <li>to describe overriding conventions of the construction industriated</li> </ul>	ry		
	<ul> <li>to specify typical building components</li> </ul>			
	<ul> <li>to distinguish between different possibilities of load bearing between the second secon</li></ul>	behaviour and risks due to lac	k of stability	
	<ul> <li>to explain the main objective of fire control.</li> </ul>			
Skills	After the successful completion of the "Building Construction" modu	ile, students will be able		
	<ul> <li>to apply industry-specific drawing conventions</li> </ul>			
	carry out preliminary dimensioning of basic building component	ents		
	<ul> <li>develop stability and foundation concepts</li> </ul>			
	use BIM software			
	<ul> <li>and to design and construct standard cross-sections due to standard cross-sectio</li></ul>	tructural aspects.		
Demonstration of the second				
Personal Competence				
Social Competence	After attending the course students are able			
	<ul> <li>to work in a team and to persent the results of the team work</li> </ul>	K		
	• to use the feedback from other students to improve the own	results		
	• to give a feedback to other students in a constructive manne	:r		
Autonomy	After attending the course students are able			
	<ul> <li>to control and improve their knowledge with the help of week</li> </ul>	akly procontations (locture re-	m) and tasts	(פדוום)
	<ul> <li>to divide the main task in different parts, to deduce the need</li> </ul>	ed knowledge and to schedule	e the differen	t work steps
Workload in Hours	Independent Study Time 110, Study Time in Lecture 70			
Credit points				
Course achievement				
Examination	Subject theoretical and practical work			
Examination duration and	Desing, Construction and prelimnary design in a written form			
scale	seeing, construction and preiminary design in a written form			
Assignment for the	General Engineering Science (German program, 7 semester): Specia	alisation Civil Engineering: Co	mpulsorv	
Following Curricula	Civil- and Environmental Engineering: Core Qualification: Compulso			
gculu		lisation Civil Engineering: Con		

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

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

e L0208: Basics in Stru	ctural Design			
Typ	Recitation Section (large)			
Hrs/wk				
CP				
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14			
Lecturer	Sebastian Rybczynski			
Language	DE			
Cycle	WiSe			
Content				
	Constructing a small individuell building in groups of 4 persons			
	Analysing the informations and the contents of development plans and building regulation laws			
	Design of building components and approving of the funcionality (sealing, facades, roofs)			
	Design and approve of the funcionality of the component interconnections			
	<ul> <li>Proofing and assessing of moisture behaviour, energy comsumption, acoustic protection and fire control</li> </ul>			
	Assessing the building stability			
	Basics of building services			
	<ul> <li>Each week the results of different work steps are presented in oral and written form</li> </ul>			
Literature	Vertragefallen des Lehmenzetelbung stehen über CTUD 10 mm deutsland zur Verfügung			
Literature	Vortragsfolien der Lehrveranstaltung stehen über STUD.IP zum download zur Verfügung			
	Read to the second se			
	Neumann, Dietrich (Hestermann, Ulf.; Rongen, Ludwig.; Weinbrenner, Ulrich)			
	Frick/Knöll Baukonstructionslehre 1 / [Internet-Ressource]			
	ISBN: 978-3-8351-9121-1			
	Wiesbaden : B.G. Teubner Verlag / GWV Fachverlage GmbH, Wiesbaden, 2006			
	Frick[Begr.], Otto (Knöll[Begr.], Karl.; Neumann, Dietrich.; Hestermann, Ulf.; Rongen, Ludwig.)			
	Baukonstruktionslehre 2 / [Internet-Ressource]			
	ISBN: 978-3-8348-9486-1			
	Wiesbaden : Vieweg+Teubner Verlag / GWV Fachverlage GmbH, Wiesbaden, 2008			
	Dierks, Klaus (Wormuth, Rüdiger.)			
	Baukonstruktion : [Einführung, Grundlagen, Gründungen, technische Ausrüstung, Wände, Geschossdecken, Treppen, Däche			
	Fenster, Türen, Konstruktionsatlas]			
	ISBN: 3804150454 (Gb.) ISBN: 978-3-8041-5045-4			
	Neuwied : Werner, 2007			
	Schneider, Klaus-Jürgen (Goris, Alfons.; Berner, Klaus)			
	Bautabellen für Ingenieure : mit Berechnungshinweisen und Beispielen ; [auf CD-ROM: Stabwerksprogramm IQ 100 B, Tools			
	den konstr. Ingenieurbau, Fachinformationen, Normentexte]			
	ISBN: 3804152287			
	Neuwied : Werner, 2006			
	Wendehorst, Reinhard (Wetzell, Otto W.,; Baumgartner, Herwig,; Deutsches Institut für Normung)			
	Wendehorst Bautechnische Zahlentafeln			
	ISBN: 978-3-8351-0055-8 ISBN: 3835100556			
	Stuttgart [u.a.] : Teubner Berlin [u.a.] : Beuth, 2007			
	Neufert, Ernst (Kister, Johannes)			
	Bauentwurfslehre : Grundlagen, Normen, Vorschriften über Anlage, Bau, Gestaltung, Raumbedarf, Raumbeziehungen, Maße			
	Gebäude, Räume, Einrichtungen, Geräte mit dem Menschen als Maß und Ziel ; Handbuch für den Baufachmann, Bauher			
	Lehrenden und Lernenden			
	ISBN: 978-3-8348-0732-8 (GB.)			
	Wiesbaden : Vieweg + Teubner, 2009			

Module M0631: Reinf	orced Concrete	e Structure	es II			
Courses						
Title Project Concrete Structures II (L089 Concrete Structures II (L0348) Concrete Structures II (L0349)	94)			<b>Typ</b> Project Seminar Lecture Recitation Section (large)	Hrs/wk 1 2 2	<b>CP</b> 1 3 2
Module Responsible	Prof. Günter Rombac	h		Reclation Section (large)	-	-
Admission Requirements	None					
Recommended Previous Knowledge	<ul><li>Basics of safet</li><li>Knowledge in</li></ul>	ty format are re design of beam	s and columns for ultim			
Educational Objectives	After taking part suc	cessfully. stude	nts have reached the fo	llowing learning results		
Professional Competence	Filter taking part bac	cessiany, seade		in the second		
Knowledge Skills	<ul> <li>methods to estimate</li> <li>The students serviceability</li> <li>The students of</li> </ul>	the member fo can design rei limit state (crac can estimate the	inforced concrete struc	ture in the ultimate limit sta ) including detailing (anchorag ple slabs.	te (shear, bending,	
Personal Competence Social Competence Autonomy				a real concrete building and pr	esent the results at	the end.
Workload in Hours	Independent Study T	ime 110 Study	Time in Lecture 70			
Credit points	6	,uuj				
Course achievement	Compulsory Bonus Yes None	Form Excercises	Descriptio	on		
Examination	Written exam					
Examination duration and scale	120 minutes					
Assignment for the	General Engineering	Science (Germa	an program, 7 semester	): Specialisation Civil Engineeri	ng: Elective Compu	lsory
Following Curricula	Civil- and Environme Civil- and Environme Civil- and Environme Civil- and Environme	ntal Engineering ntal Engineering ntal Engineering ntal Engineering	g: Core Qualification: Co g: Specialisation Civil Er g: Specialisation Traffic g: Specialisation Water		ory apulsory	
Course L0894: Project Concre	ete Structures II					

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

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

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

Courses				
Title		Тур	Hrs/wk	СР
Stuctural Mechanics (L2475)		Integrated Lecture	2	3
Module Responsible	Prof. Christian Cyron			
Admission Requirements	None			
<b>Recommended Previous</b>				
Knowledge				
Educational Objectives	After taking part successfully, students have reach	ned the following learning results		
Professional Competence				
Knowledge				
Skills				
Personal Competence				
Social Competence				
Autonomy				
Workload in Hours	Independent Study Time 62, Study Time in Lecture	e 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 Engineeri	ng: Compulsory	
Following Curricula	Civil- and Environmental Engineering: Specialisation	on Civil Engineering: Compulsory		
Course L2475: Stuctural Med	hanics			
Тур	Integrated Lecture			

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

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

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

Module M0612: Steel	Structures II			
Courses				
Title		Тур	Hrs/wk	СР
Steel Structures II (L0301)		Lecture	2	3
Steel Structures II (L0302)		Recitation Section (large)	2	3
Module Responsible	Prof. Marcus Rutner			
Admission Requirements	None			
Recommended Previous	Steel Structures I			
Knowledge				
J.				
Educational Objectives	After taking part successfully, students h	have reached the following learning results		
Professional Competence				
Knowledge	After successful completition students ca	an		
	describe and explain the behavior			
	<ul> <li>design and check simple halls and</li> </ul>	-		
		imple structures (trusses, beams, frames)		
	<ul> <li>illustrate and dimension he main</li> </ul>	details (framework, column base, load application p	points)	
Skills	Students are able to design simple struc	ctures and connections, describe the load distributi	on and recognize t	he possible modes
511115		ections, calculate according to 2nd order theory an	-	
			a verify their result	51
Personal Competence				
Social Competence				
Autonomy				
Workload in Hours	Independent Study Time 124, Study Tim	ne in Lecture 56		
Credit points	6			
Course achievement	None			
Examination	Written exam			
Examination duration and	120 minutes			
scale				
Assignment for the	General Engineering Science (German p	rogram, 7 semester): Specialisation Civil Engineerir	ng: Elective Compul	sory
Following Curricula	Civil- and Environmental Engineering: Co	ore Qualification: Compulsory		
-		pecialisation Civil Engineering: Compulsory		
		pecialisation Traffic and Mobility: Elective Compulso	iry	
		pecialisation Water and Environment: Elective Com	-	

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

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	chnics II					
Courses						
itle		<b>-</b>	Here to de	65		
Foundation Engineering (L0552)		<b>Typ</b> Lecture	Hrs/wk	<b>CP</b> 2		
Foundation Engineering (L0552)		Recitation Section (larg		2		
Foundation Engineering (L1494)		Recitation Section (ang	- /	2		
Module Responsible	Prof. Jürgen Grabe	Nectation Section (since	2	2		
Admission Requirements	None					
Recommended Previous	Modules:					
Knowledge	House.					
Kilowieuge	Mechanics I-II					
	Geotechnics I					
Educational Objectives	After taking part successfully, students hav	ve reached the following learning results				
Professional Competence						
Knowledge	The students know the basic principles and methods which are required to verificate the stability of geotechnical structures.					
Skills	After successful completion of the module the students are able to:					
	·					
	<ul><li>verificate the stability and usability of foundations,</li><li>know individual methods of ground improvement and apply them in their range of application,</li></ul>					
	<ul> <li>design retaining walls.</li> </ul>					
Personal Competence						
Social Competence						
Autonomy						
Workload in Hours	Independent Study Time 96, Study Time in	Lecture 84				
Credit points	6					
Course achievement	Compulsory Bonus Form	Description				
course acmevement	No 20 % Attestation					
Examination	Written exam					
Examination duration and	60 minutes					
scale						
Assignment for the	General Engineering Science (German prog	gram, 7 semester): Specialisation Civil Engin	eering: Elective Compu	ulsory		
Following Curricula	General Engineering Science (German prog	gram, 7 semester): Specialisation Civil Engin	eering: Elective Compu	ulsory		
-	Civil- and Environmental Engineering: Core	Qualification: Compulsory				
	Civil- and Environmental Engineering: Spec					
		ialisation Traffic and Mobility: Elective Com	oulsory			
		ialisation Water and Environment: Elective (	-			
		ram, 7 semester): Specialisation Civil Engine		lsorv		
	Technomathematics: Specialisation III. Engl					
	reennomathematics, specialisation III, Eng	incerning science. Elective compulsory				

Course L0552: Foundation E	ngineering
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>

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

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

## **Specialization Bioprocess Engineering**

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

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

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

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

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

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 Techno	ology (L2269	9)	Lecture	2	2	
Module Responsible	Prof. Alexa	Prof. Alexander Penn					
Admission Requirements	None						
Recommended Previous Knowledge		interest, lo	ogical skills, integral-	and differential calculus, basic physical conc	epts such as tempera	ture, mass, velocit	
Educational Objectives	After takin	ig part suc	cessfully, students ha	ve reached the following learning results			
Professional Competence		51					
	Physical b			ics (theory of motion), rotation of rigid bo aperature and heat, ideal gas.	dies, energy and mo	mentum, electrici	
				easurement uncertainty, basics of sensor ter vel measurement, flow measurement. Usage o		nciples, temperatu	
		Practical course: Pressure drop in piping, calorimetry, image data acquisition, flow measurement, concentration measureme mass transfer, capacitive measurements of solid concentrations, spectroscopy, error calculation, chromatography					
Skills	Literature research, categorisation of thematical topics, analysis of an experimental test stand, preparation of test protocol, fir programming with Matlab, use of relevant laboratory measurement technology, preparation of a test protocol, execution calculations.						
Personal Competence							
Social Competence	experimen	ntal stand	-	tical training and learning groups, assessme tion with persons responsible for teaching,		-	
Autonomy		-		pendent development of the thematic basics, g, practice of presentation in front of a gr			
	formulation	n of enquir	ries/detailed question	s by using clicker.		tion in the lectur	
Workload in Hours			ries/detailed question ime 96, Study Time in			tion in the lecture	
Workload in Hours Credit points	Independe					tion in the lecture	
	Independe 6 Compulsory	ent Study T Bonus	ime 96, Study Time in	n Lecture 84 Description		tion in the lecture	
Credit points Course achievement	Independe 6 Compulsory No	Bonus 20 %	ime 96, Study Time i	n Lecture 84	]	tion in the lecture	
Credit points Course achievement Examination	Independe 6 <b>Compulsory</b> No Written ex	Bonus 20 %	ime 96, Study Time in	n Lecture 84 Description	]	tion in the lectur	
Credit points Course achievement Examination Examination duration and	Independe 6 Compulsory No Written ex 120 min	Bonus 20 %	ime 96, Study Time in	n Lecture 84 Description	9	tion in the lectur	
Credit points Course achievement Examination Examination duration and scale	Independe 6 Compulsory No Written ex 120 min	ent Study T Bonus 20 % cam	ime 96, Study Time in Form Excercises	n Lecture 84 Description Popup-Quizzes währen der Vorlesung		tion in the lectur	
Credit points Course achievement Examination Examination duration and scale Assignment for the	Independe 6 Compulsory No Written ex 120 min General Er	Bonus 20 % cam	Form Excercises Science (German pro	n Lecture 84 Description Popup-Quizzes währen der Vorlesung gram, 7 semester): Specialisation Process Eng	ineering: Compulsory	tion in the lecture	
Credit points Course achievement Examination Examination duration and scale	Independe 6 Compulsory No Written ex 120 min General Er General Er	Bonus 20 % cam	ime 96, Study Time in Form Excercises Science (German pro Science (German pro	n Lecture 84 Description Popup-Quizzes währen der Vorlesung gram, 7 semester): Specialisation Process Eng gram, 7 semester): Specialisation Process Eng	ineering: Compulsory ineering: Compulsory		
Credit points Course achievement Examination Examination duration and scale Assignment for the	Independe 6 Compulsory No Written ex 120 min General Er General Er General Er	Bonus 20 % cam	ime 96, Study Time in Form Excercises Science (German pro Science (German pro Science (German pro	n Lecture 84 Description Popup-Quizzes währen der Vorlesung gram, 7 semester): Specialisation Process Eng gram, 7 semester): Specialisation Process Eng gram, 7 semester): Specialisation Bioprocess	ineering: Compulsory ineering: Compulsory Engineering: Compulso		
Credit points Course achievement Examination Examination duration and scale Assignment for the	Independe 6 Compulsory No Written ex 120 min General Er General Er General Er General Er	Bonus 20 % cam ngineering ngineering ngineering ngineering	Form Excercises Science (German pro Science (German pro Science (German pro Science (German pro Science (German pro	n Lecture 84 Description Popup-Quizzes währen der Vorlesung gram, 7 semester): Specialisation Process Eng gram, 7 semester): Specialisation Process Eng gram, 7 semester): Specialisation Bioprocess gram, 7 semester): Specialisation Green Tech	ineering: Compulsory ineering: Compulsory Engineering: Compulso		
Credit points Course achievement Examination Examination duration and scale Assignment for the	Independe 6 Compulsory No Written ex 120 min General Er General Er General Er Bioprocess	Bonus 20 % am ngineering ngineering ngineering ngineering s Engineeri	Form Excercises Science (German pro Science (German pro Science (German pro Science (German pro Science (German pro Science (German pro Science (German pro	pescription Popup-Quizzes währen der Vorlesung gram, 7 semester): Specialisation Process Eng gram, 7 semester): Specialisation Process Eng gram, 7 semester): Specialisation Bioprocess gram, 7 semester): Specialisation Green Tech h: Compulsory	ineering: Compulsory ineering: Compulsory Engineering: Compulsory nologies: Compulsory		
Credit points Course achievement Examination Examination duration and scale Assignment for the	Independe 6 Compulsory No Written ex 120 min General Er General Er General Er Bioprocess General Er	Bonus 20 % aam ngineering ngineering ngineering ngineering s Engineering	Form Excercises Science (German pro Science (English pro	Description Popup-Quizzes währen der Vorlesung gram, 7 semester): Specialisation Process Eng gram, 7 semester): Specialisation Process Eng gram, 7 semester): Specialisation Bioprocess gram, 7 semester): Specialisation Green Tech n: Compulsory gram, 7 semester): Specialisation Process Engi	ineering: Compulsory ineering: Compulsory Engineering: Compulsory nologies: Compulsory		
Credit points Course achievement Examination Examination duration and scale Assignment for the	Independe 6 Compulsory No Written ex 120 min General Er General Er General Er Bioprocess General Er General Er	Bonus 20 % aam ngineering ngineering ngineering ngineering s Engineerin ngineering hnologies:	Form Excercises Science (German pro Science (English pro	Description Popup-Quizzes währen der Vorlesung gram, 7 semester): Specialisation Process Eng gram, 7 semester): Specialisation Process Eng gram, 7 semester): Specialisation Bioprocess gram, 7 semester): Specialisation Green Tech n: Compulsory gram, 7 semester): Specialisation Process Engi te: Core Qualification: Compulsory	ineering: Compulsory ineering: Compulsory Engineering: Compulsory nologies: Compulsory		

Course L2270: Practical Cour	rse Measurement Technology
Тур	Practical Course
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Prof. Alexander Penn
Language	DE
Cycle	WiSe
Content	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.

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

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

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

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

Course L0092: Fluid Mechani	cs for Process Engineering
Тур	Recitation Section (large)
Hrs/wk	2
СР	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Prof. Michael Schlüter
Language	DE
Cycle	SoSe
Content	In the exercise-lecture the topics from the main lecture are discussed intensively and transferred into application. For that, the students receive example tasks for download. The students solve these problems based on the lecture material either independently or in small groups. The solution is discussed with the students under scientific supervision and parts of the solutions are presented on the chalk board. At the end of each exercise-lecture, the correct solution is presented on the chalk board. Parallel to the exercise-lecture tutorials are held where the student solve exam questions under a set time-frame in small groups and discuss the solutions afterwards.
	<ol> <li>Crowe, C. T.: Engineering fluid mechanics. Wiley, New York, 2009.</li> <li>Durst, F.: Strömungsmechanik: Einführung in die Theorie der Strömungen von Fluiden. Springer-Verlag, Berlin, Heidelberg, 2006.</li> <li>Fox, R.W.; et al.: Introduction to Fluid Mechanics. J. Wiley &amp; Sons, 1994</li> <li>Herwig, H.: Strömungsmechanik: Eine Einführung in die Physik und die mathematische Modellierung von Strömungen. Springer Verlag, Berlin, Heidelberg, New York, 2006</li> <li>Herwig, H.: Strömungsmechanik: Einführung in die Physik von technischen Strömungen: Vieweg+Teubner Verlag / GWV Fachverlage GmbH, Wiesbaden, 2008</li> <li>Kuhlmann, H.C.: Strömungsmechanik. Grundgleichungen, Lösungsmethoden, Softwarebeispiele. Vieweg+ Teubner Verlag / GWV Fachverlage GmbH, Wiesbaden, 2009</li> <li>Schade, H.; Kunz, E.: Strömungslehre. Verlag de Gruyter, Berlin, New York, 2007</li> <li>Truckenbrodt, E.: Fluidmechanik 1: Grundlagen und elementare Strömungsvorgänge dichtebeständiger Fluide. Springer-Verlag, Berlin, Heidelberg, 2008</li> <li>Schlichting, H.: Grenzschicht-Theorie. Springer-Verlag, Berlin, 2006</li> <li>van Dyke, M.: An Album of Fluid Motion. The Parabolic Press, Stanford California, 1882.</li> <li>White, F.: Fluid Mechanics, Mcgraw-Hill, ISBN-10: 0071311211, ISBN-13: 978-0071311212, 2011</li> </ol>

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Courses				
Title		Тур	Hrs/wk	СР
Phase Equilibria Thermodynamics (		Lecture	2	2
Phase Equilibria Thermodynamics (		Recitation Section (small)	1	2
Phase Equilibria Thermodynamics (		Recitation Section (large)	1	2
Module Responsible				
Admission Requirements				
	Mathematics, Physical Chemistry, Thermodynam	ics I and II		
Knowledge				
	After taking part successfully, students have rea	ched the following learning results		
Professional Competence				
Knowledge	<ul> <li>Starting from the very basics of thermost</li> </ul>	lynamics, the students learn the mathemati	cal tools to dos	cribo thormodyna
		iynamics, the students learn the mathemati		
	equilibria.	enced by the mixing of compounds and learn		
		inced by the mixing of compounds and learn	i concepts to qu	dantitatively desc
	these properties.		a stad stude i ala stada a	
		equilibria can be described mathematically	•	3
		ist in equilibrium. Furthermore the fundamen		1 3
		camples relevant for different kinds of proc	esses are show	n and the necess
	knowledge for plotting and interpreting th	e equilibria are taught.		
Skills				
	<ul> <li>Applying their knowledge, the students a</li> </ul>	are able to identify the correct equation for	the determination	on of the equilibr
	state and know how to simplify these equa	ations meaningfully.		
	<ul> <li>The students know models which can be</li> </ul>	used to determine the properties of the syst	em in the equili	brium state and t
	are able to solve the resulting mathematic	cal relations.		
	<ul> <li>For specific applications, they are able to</li> </ul>	self-reliantly find necessary physico-chemica	I properties of c	ompounds as wel
	model parameters in literature sources.			
	Beside pure compound properties the stud	dents are capable of describing the properties	of mixtures.	
	• The students know how to visualize phase	equilibria graphically and they know how to	interpret the occ	urring phenomen
		s are able to understand fundamental cor		
	separation and reaction processes in chen			
Personal Competence				
	The students are able to work in small groups	to solve the corresponding problems and to	procept them or	aly to the tutors
Social competence	The students are able to work in small groups,	to solve the corresponding problems and to	present them of	aly to the tutors
	other students			
Autonomy	• The students are able to find necessary in	formation self-reliantly in literature sources a	nd to iudae their	auality.
	-	able to check their learning progress conti		
	knowledge the students can adept their le		indeably in exer	
	knowledge the students can adept their re			
Workload in Hours	Independent Study Time 124, Study Time in Lect	ture 56		
Credit points	6			
Course achievement	None			
Examination				
	120 minutes; theoretical questions and calculation	ons		
scale				
-	General Engineering Science (German program,			
Following Curricula	General Engineering Science (German program,			
	General Engineering Science (German program,	7 semester): Specialisation Green Technologi	es, Focus Renew	able Energy: Elec
	Compulsory			
	General Engineering Science (German program,	7 semester): Specialisation Green Technologi	es, Focus Renew	able Energy: Elec
	Compulsory			
	Bioprocess Engineering: Core Qualification: Com	pulsory		
	Green Technologies: Energy, Water, Climate: Spe	ecialisation Bioresource Technology: Elective	Compulsory	
	Green Technologies: Energy, Water, Climate: Spe	ecialisation Energy Systems: Elective Compul	sory	
	Process Engineering: Core Qualification: Compute			

ourse L0114: Phase Equilib	ria Thermodynamics			
Тур	Lecture			
Hrs/wk	2			
CP				
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: reaction coordinate, mass action law, influence of pressure and temperature</li> <li>Osmotic pressure</li> </ol>			
Literature	<ul> <li>Jürgen Gmehling, Bärbel Kolbe: Thermodynamik. VCH 1992</li> <li>J.M. Prausnitz, R.N. Lichtenthaler, E.G. de Azevedo: Molecular Thermodynamics of Fluid-Phase Equilibria, 3rd ed. Prentice Hall, 1999.</li> <li>J.W. Tester, M. Modell: Thermodynamics and its Applications. 3 <sup>rd</sup> ed. Prentice Hall, 1997.J.P. O'Connell, J.M. Haile Thermodynamics. Cambridge University Press, 2005.</li> </ul>			

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

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

Courses					
Title	Ту	n	Hrs/wk	СР	
Biochemistry (L0351)		cture	2	2	
Biochemistry (L0728)		pject-/problem-based Learning	1	1	
Microbiology (L0881)		cture	2	2	
Microbiology (L0888)	Pro	oject-/problem-based Learning	1	1	
Module Responsible	Prof. Johannes Gescher				
Admission Requirements	None				
<b>Recommended Previous</b>	none				
Knowledge					
Educational Objectives	After taking part successfully, students have reached the following le	earning results			
Professional Competence					
Knowledge	At the end of this module the students can:				
	- explain the methods of biological and biochemical research to dete	arming the properties of bigm	alaculac		
	- explain the methods of biological and biochemical research to dete	annue 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,				
Social competence					
	- to gather knowledge in groups of about 10 students				
	- to introduce their own knowledge and to argue their view in discus	sions in teams			
	- to divide a complex task into subtasks, solve these and to present	the combined results			
Autonomv	The students are able to present the results of their subtasks in a wr	ritten report			
,	· · · · · · · · · · · · · · · · · · ·	p.			
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 Cor	npulsory		
	Orientation Studies: Core Qualification: Elective Compulsory				
	Technomathematics: Specialisation III. Engineering Science: Elective	Compulsory			

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

Course L0728: Biochemistry	
Тур	Project-/problem-based Learning
Hrs/wk	1
CP	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				
	evolution				
	<ul> <li>taxonomy and specific properties of Archaea, Bacteria, and viruses</li> </ul>				
	structure and properties of the cell				
	• growth				
	2. Metabolism				
	<ul> <li>fermentation and anaerobic respiration</li> </ul>				
	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	All sensing All webicles in 0. A. fl. 2007. Eacher C. (User) This webicles (E4.05.0)				
	• Allgemeine Mikrobiologie, 8. Aufl., 2007, Fuchs, G. (Hrsg.), Thieme Verlag (54,95 €)				
	• Mikrobiologie, 13 Aufl., 2013, Madigan, M., Martinko, J. M., Stahl, D. A., Clark, D. P. (Hrsg.), ehemals "Brock", Pearson Verlag (89,95 €)				
	Taschenlehrbuch Biologie Mikrobiologie, 2008, Munk, K. (Hrsg.), Thieme Verlag				
	• Grundlagen der Mikrobiologie, 4. Aufl., 2010, Cypionka, H., Springer Verlag (29,95 €), http://www.grundlagen-der- mikrobiologie.icbm.de/				

Course L0888: Microbiology					
Тур	Project-/problem-based Learning				
Hrs/wk	1				
CP	1				
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14				
Lecturer	Prof. Johannes Gescher				
Language	DE				
Cycle	SoSe				
Content	1. The procaryotic cell				
	evolution				
	<ul> <li>taxonomy and specific properties of Archaea, Bacteria, and viruses</li> </ul>				
	structure and properties of the cell				
	• growth				
	2. Metabolism				
	fermentation and anaerobic respiration				
	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				
	• Grundlagen der Mikrobiologie, 4. Aufl., 2010, Cypionka, H., Springer Verlag (29,95 €), http://www.grundlagen-der- mikrobiologie.icbm.de/				

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

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

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

Course L0843: Bioprocess 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		

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			
	Basic knowledge: Technical Thermodynamics			
Knowledge	,			
Educational Objectives	After taking part successfully, students have reacl	had the following learning results		
Professional Competence	Arter taking part successiony, students have react	the following learning results		
Knowledge				
Skills	<ul> <li>heat exchanger, chemical reactors).</li> <li>They are capable of distinguish and charact transfer and thermal radiation.</li> <li>The students have the ability to explain qualitative and quantitative by using suitab</li> <li>They are able to depict the analogy between the ability to explain qualitative and quantitative by using suitab</li> <li>They are able to depict the analogy between the ability to explain the students are able to set reasonable sy and to balance the corresponding energy at the calculate the corresponding heat flow.</li> <li>Using dimensionless quantities, the student</li> <li>They are able to distinguish between diffus for the description and design of apparatus</li> <li>In this context, the students are capable to application considering their advantages ar</li> <li>In addition, they can calculate both, steady</li> <li>The students are capable to connect th particular the courses thermodynamics, fl problems.</li> </ul>	the physical basis for mass transfer in ole mass transfer theories. In heat- and mass transfer and to describe system boundaries for a given transport pro- nd mass flow, respectively. Ansfer problems (e.g. heated chemical rea- ws. Its can execute scaling up of technical proce- sion, convective mass transition and mass (e.g. extraction column, rectification colum choose and design fundamental types of P and disadvantages, respectively. -state and non-steady-state processes in p neir knowledge obtained in this course	detail and to des complex linked pr oblem by using th ctors, temperatur esses or apparatur transfer. They car an). weat and mass exc rocedural apparat with knowlegde	scribe mass trans rocesses in detail. ne gained knowled e alteration in fluid s. n use this knowled changer for a speci cus. of other courses
Personal Competence Social Competence			orally in a reasonal	
Autonomy	<ul> <li>The students are able to find and evaluate necessary information from suitable sources</li> <li>They are able to prove their level of knowledge during the course with accompanying procedure continuously (click system, exam-like assignments) and on this basis they can control their learning processes.</li> </ul>			
Workload in Hours	Independent Study Time 124, Study Time in Lectu	ire 56		
Credit points	6			
Course achievement	None			
Examination	Written exam			
	120 minutes; theoretical questions and calculation	าร		
scale		-		
	General Engineering Science (German program, 7	semester). Specialization Process Enginee	ring: Compulsory	
-	General Engineering Science (German program, 7 General Engineering Science (German program, 7			
Following Curricula	General Engineering Science (German program, 7 General Engineering Science (German program, 7			JI Y
				ring: Compulsors
	General Engineering Science (German program, 7		ionientai Enginee	ing. compulsory
	Bioprocess Engineering: Core Qualification: Comp			
	Energy and Environmental Engineering: Core Qual			
	General Engineering Science (English program, 7			-
	General Engineering Science (English program, 7	semester): Specialisation Energy and Envir	omental Engineer	ing: Compulsory
	General Engineering Science (English program, 7	semester): Specialisation Process Engineer	ing: Compulsory	
	Green Technologies: Energy, Water, Climate: Core	e Qualification: Compulsory		
	Green Technologies: Energy, Water, Climate: Core Technomathematics: Specialisation III. Engineering			

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

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

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

ourses				
itle		Тур	Hrs/wk	СР
hermal Separation Processes (L01	18)	Lecture	2	2
hermal Separation Processes (L01	19)	Recitation Section (small)	2	2
hermal Separation Processes (L01	41)	Recitation Section (large)	1	1
eparation Processes (L1159)		Practical Course	1	1
•	Prof. Irina Smirnova			
	None			
Recommended Previous Knowledge	Recommended requirements: Thermodynamics III			
Educational Objectives	After taking part successfully, students have reached	the following learning results		
<b>Professional Competence</b>				
Knowledge	<ul> <li>The students can distinguish and describe different types of separation processes such as distillation, extraction, an adsorption</li> <li>The students develop an understanding for the course of concentration during a separation process, the estimation of the energy demand of a process, the possibilities of energy saving, and the selection of separation systems</li> <li>They have good knowledge of designing methods for separation processes and devices</li> </ul>			
Skills	<ul> <li>Using the gained knowledge the students can select a reasonable system boundary for a given separation process close the associated energy and material balances</li> <li>The students can use different graphical methods for the designing of a separation process and define the a theoretical stages required</li> <li>They can select and design a basic type of thermal separation process for a given case based on the advant disadvantages of the process</li> <li>The students are capable to obtain independently the needed material properties from appropriate sources (diagitables)</li> <li>They can calculate continuous and discontinuous processes</li> <li>The students are able to prove their theoretical knowledge in the experimental lab work.</li> <li>The students are able to discuss the theoretical background and the content of the experimental work with the te colloquium.</li> </ul>		lefine the amount the advantages a burces (diagrams a	
<b>Personal Competence</b> Social Competence	The students are capable of linking their gained know technical problems. Other lectures such as thermody <ul> <li>The students can work technical assignments in the students in the students.</li> </ul>	namics, fluid mechanics and chemic	al engineering.	
Autonomy	<ul> <li>The students are able to carry out practical lab work in small groups and organize a functional division of labor betwee them. They are able to discuss their results and to document them scientifically in a report.</li> <li>The students are capable to obtain the needed information from suitable sources by themselves and assess their quality</li> <li>The students can proof the state of their knowledge with exam resembling assignments and in this way control the learning process</li> </ul>			
Workload in Hours	Independent Study Time 96, Study Time in Lecture 84	4		
Credit points	6			
Course achievement	None			
Examination Examination duration and	Written exam 120 minutes; theoretical questions and calculations			
scale	•			
Assignment for the Following Curricula         General Engineering Science (German program, 7 semester): Specialisation Process Engineering: Compulsory           General Engineering Science (German program, 7 semester): Specialisation Bioprocess Engineering: Compulsory         General Engineering Science (German program, 7 semester): Specialisation Green Technologies, Focus Renewable Ener Compulsory           General Engineering Science (German program, 7 semester): Specialisation Green Technologies, Focus Renewable Ener Compulsory         General Engineering Science (German program, 7 semester): Specialisation Green Technologies, Focus Renewable Compulsory           General Engineering Science (German program, 7 semester): Specialisation Energy and Environmental Engineering: Com Bioprocess Engineering: Core Qualification: Compulsory         Energy and Environmental Engineering: Core Energy and Environmental Engineering: Core Qualification: Elective Compulsory           General Engineering Science (English program, 7 semester): Specialisation Bioprocess Engineering: Compulsory         General Engineering: Core Qualification: Elective Compulsory		ory rable Energy: Elect Renewable Energ ring: Compulsory		
	General Engineering Science (English program, 7 sem General Engineering Science (English program, 7 sem Green Technologies: Energy, Water, Climate: Speciali Green Technologies: Energy, Water, Climate: Speciali	nester): Specialisation Process Engin sation Energy Systems: Elective Cor	eering: Compulsory npulsory	ing: Compulsory

Process Engineering: Core Qualification: Compulsory

L

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

Course L0119: Thermal Sepa	ration Processes		
Тур	ecitation 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			
Literature	<ul> <li>The students work on tasks in small groups and present their results in front of all students.</li> <li>G. Brunner: Skriptum Thermische Verfahrenstechnik</li> <li>J. King: Separation Processes, McGraw-Hill, 2. Aufl. 1980</li> <li>Sattler: Thermische Trennverfahren, VCH, Weinheim 1995</li> <li>J.D. Seader, E.J. Henley: Separation Process Principles, Wiley, New York, 1998.</li> <li>Mersmann: Thermische Verfahrenstechnik, Springer, 1980</li> <li>Grassmann, Widmer, Sinn: Einführung in die Thermische Verfahrenstechnik, 3. Aufl., Walter de Gruyter, Berlin 1997</li> <li>Brunner, G.: Gas extraction. An introduction to fundamentals of supercritical fluids and the application to separation processes. Steinkopff, Darmstadt; Springer, New York; 1994. ISBN 3-7985-0944-1; ISBN 0-387-91477-3.</li> <li>R. Goedecke (Hrsg.): Fluid-Verfahrenstechnik, Wiley-VCH Verlag, Weinheim, 2006.</li> <li>Perry"s Chemical Engineers" Handbook, R.H. Perry, D.W. Green, J.O. Maloney (Hrsg.), 6th ed., McGraw-Hill, New York 1984 Ullmann"s Enzyklopädie der Technischen Chemie</li> </ul>		

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

Course L1159: Separation Pro	ocesses
Тур	Practical Course
Hrs/wk	1
CP	1
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14
Lecturer	Prof. Irina Smirnova
Language	DE/EN
Cycle	WiSe
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 car 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 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		Recitation Section (large)	2	2
Experimental Course Chemical Eng	ineering (Fundamentals) (L0221)	Practical Course	2	2
Module Responsible	Prof. Raimund Horn			
Admission Requirements	None			
<b>Recommended Previous</b>	Contents of the previous modules mathematics	I-III, physical chemistry, technical thermody	namics I+II as w	ell as computationa
Knowledge	methods for engineers.			
Educational Objectives	After taking part successfully, students have rea	ched the following learning results		
Professional Competence				
Knowledge	The students are able to explain basic concepts	of chemical reaction engineering. They are a	able to point out	differences betweer
	thermodynamical and kinetical processes. The	students have a strong ability to outline part	rts of isotherma	I and non-isotherma
	ideal reactors and to describe their properties.			
Skills	After successful completion of the module, stude	ents are able to:		
	- apply different computational methods to dime	ension isothermal and non-isothermal ideal rea	actors,	
	- determine and compute stable operation point	s for these reactors ,		
	- conduct experiments on a lab-scale pilot plants	and document these according to scientific g	juidelines.	
Personal Competence				
•	After successful completition of the lab-course	the students have a strong ability to organize	themselfes in s	mall groups to solve
	issues in chemical reaction engineering. The si			
	their teachers.	-	5 5	
Autonomy	The students are able to obtain further info	ormation and assess their relevance auton	omously. Stude	nts can apply thei
	knowldege discretely to plan, prepare and condu	uct experiments.	-	
Workload in Hours	Independent Study Time 96, Study Time in Lectu	ure 84		
Credit points	6			
Course achievement	Compulsory Bonus Form	Description		
	Yes None Subject theoretical a	and		
	practical work			
Examination	Written exam			
Examination duration and	120 min			
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): Specialisation Bioprocess Engine	eering: Compulso	ory
	Bioprocess Engineering: Core Qualification: Com	pulsory		
	General Engineering Science (English program,	7 semester): Specialisation Bioprocess Engine	ering: Compulso	ry
	General Engineering Science (English program,	7 semester): Specialisation Process Engineerir	ig: Compulsory	
	Green Technologies: Energy, Water, Climate: Sp	ecialisation Bioresource Technology: Elective	Compulsory	
	Process Engineering: Core Qualification: Compul	sory		

Course L0204: Chemical Reaction Engineering (Fundamentals)		
Тур	Lecture	
Hrs/wk	2	
CP	2	
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28	
Lecturer	Prof. Raimund Horn	
Language	DE	
Cycle	WiSe	
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?, 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, integration of the batch reactor mole balance for various kinetics, partial fraction decomposition, mole balance of a batch reactor, mole balance of the plug flow reactor, analogy batch reactor - plug flow reactor, design of plug flow reactors for reactions with volume change and complex reactions, mole balance of a fixed bed reactor, design of a membrane reactor, mole balance of a continuously stirred tank reactor, comparison of CSTR and PFR with respect to conversion and selectivity, mole-balance of a cascade of tank reactors) non-isothermal ideal reactors (energy balance of a reactor, adiabatic reactor, adiabatic temperature rise, staged reactor for adiabatic exothermic reactions limited by chemical equilibrium, design of an adiabatic plug flow reactor, Levenspiel-plots, heat transfer through a reactor wall, heat transfer by convection, heat conduction, heat transfer through a cylindrical wall, design of a plug flow reactor in parallel and counter flow, heat balance of the cooling fluid, CSTR with heat e
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
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Prof. Raimund Horn, Dr. Oliver Korup
Language	DE
Cycle	WiSe
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, 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, integration of the batch reactor mole balance for various kinetics, partial fraction decomposition, mole balance of the semi-batch reactor, mole balance of the balance of the balance of the balance of the semi-batch reactor, mole balance of tak reactors, underighting wereactors, underighting wereactors, nucle chalance of a continuously stirred tank reactors, comparison of CSTR and PFR with respect to conv
	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 L0221: Experimental	Course Chemical Engineering (Fundamentals)
Тур	Practical Course
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Prof. Raimund Horn
Language	DE/EN
Cycle	SoSe
Content	Performing and evaluation of experiments concerning chemical reaction engineering with emphasis on ideal reactors:
	* Batch reactor - Estimation of kinetic parameters for the saponification of ethylacetate
	*CSTR - Residence time distribution, reaction
	*CSTR in Series - Residence time distribution, reaction
	* Plug Flow Reactor - Residence time distribution, reaction
	Before the practical conduct of the experiments a colloquium takes place in which the students explain, reflect and discuss the theoretical basics and their translation into practice.
	The students write up a report for every experiment. They receive feedback to their level of scientific writing (citation methods, labeling of graphs, etc.), so that they can improve their competence in this field over the course of the practical course.
Literature	Levenspiel, O.: Chemical reaction engineering; John Wiley & Sons, New York, 3. Ed., 1999 VTM 309(LB)
	Praktikumsskript
	Skript Chemische Verfahrenstechnik 1 (F.Keil)

Module M1275: Enviro	onmental Tech	nology			
Courses					
Title			Тур	Hrs/wk	CP
Practical Exercise Environmental Te	5,		Practical Course Lecture	1 2	1 2
Environmental Technologie (L0326	1		Lecture	Z	Z
Module Responsible		litt			
Admission Requirements					
Recommended Previous	Fundamentals of inor	ganic/organic chemistry	and biology		
Knowledge	A.C	<u></u>			
	After taking part succ	cessfully, students have r	reached the following learning results		
Professional Competence					
Knowledge	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.				
Skills	Students are able to propose appropriate management and mitigation measures for environmental problems. They are able to determine geochemical parameters and to assess the potential of pollutants to migrate and transform. The students are able to work out well founded opinions on how Environmental Technology contributes to sustainable development, and they can present and defend these opinons in front of and against the group.				
Personal Competence					
Social Competence	The students are able	e to discuss the various t	echnical and scientific tasks, both subject	-specific and multidisci	plinary. They are at
	to develop different a	approaches to the task as	s a group as well as to discuss their theore	etical or practical imple	mentation.
Autonomy	Students can indeper	ndently exploit sources a	bout of the subject, acquire the particular	knowledge and tranfer	it to new problems
Workload in Hours	Independent Study Ti	ime 48, Study Time in Le	cture 42		
Credit points	3				
Course achievement	Compulsory Bonus	Form	Description		
	Yes None	Subject theoretical	and		
		practical work			
Examination	Written exam				
Examination duration and	1 hour				
scale					
Assignment for the	General Engineering	Science (German progra	m, 7 semester): Specialisation Process En	gineering: Elective Com	npulsory
Following Curricula			m, 7 semester): Specialisation Bioprocess		
			m, 7 semester): Specialisation Energy and	l Enviromental Enginee	ring: Compulsory
		ng: Core Qualification: El			
	5,5	5 5	Qualification: Compulsory		
			n, 7 semester): Specialisation Bioprocess		
			n, 7 semester): Specialisation Energy and	-	
			n, 7 semester): Specialisation Process Eng	ineering: Elective Com	puisory
	Process Engineering:	Core Qualification: Elect	ive compulsory		

Course L1387: Practical Exercise Environmental Technology		
Тур	Practical Course	
Hrs/wk	1	
СР	1	
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14	
Lecturer	Prof. Martin Kaltschmitt, Dr. Isabel Höfer	
Language	DE	
Cycle	SoSe	
Content	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	I Technologie
Тур	Lecture
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Prof. Martin Kaltschmitt, Dr. Isabel Höfer
Language	DE
Cycle	WiSe
Content	<ol> <li>Introductory seminar on environmental science:</li> <li>Environmental impact and adverse effects</li> <li>Wastewater technology</li> <li>Air pollution control</li> <li>Noise protection</li> <li>Waste and recycling management</li> <li>Soil and ground water protection</li> <li>Renewable energies</li> <li>Resource conservation and energy efficiency</li> </ol>
Literature	Förster, U.: Umweltschutztechnik; 2012; Springer Berlin (Verlag) 8., Aufl. 2012; 978-3-642-22972-5 (ISBN)

Courses				
Title				
	(11107)	<b>Typ</b> Lecture	Hrs/wk 2	<b>CP</b> 4
Bioprocess Engineering - Advanceo Bioprocess Engineering - Advanceo		Recitation Section (small)	2	2
Module Responsible	Prof. An-Ping Zeng			
Admission Requirements	None			
Recommended Previous	Content of module "Biochemical Engineering I"			
Knowledge				
Educational Objectives	After taking part successfully, students have reach	ed the following learning results		
Professional Competence				
Knowledge	After successful completion of this module, studen	ts should be able to		
	describe and explain different kinetic approx	aches for growth and substrate-uptake		
	identification of scientific problems with cor	ncrete industrial use (cultivation of microor	ganisms and mar	nmalian cells)
	<ul> <li>describe and explain important downstreat methods</li> </ul>	aming steps for proteins and their applica	ation as well as	basic immobilizat
Skills	After successful completion of this module, studen	ts should be able to		
	- to identifiy scientific questions or possible microorganisms and animal cells ) and to formulate		rial applications	eg cultivation
	- To assess the application of scale-up criteria for o problems (anaerobic , aerobic or microaerobically)		s and to apply th	ese criteria to giv
	- to formulate questions for the analysis and optim	ization of real biotechnological production	processes approp	priate solutions ,
	- To describe the effects of the energy generation behavior of microorganisms and to the total ferme		its , and the gro	wth inhibition of t
	<ul> <li>Establish material flow balance equations and s calculate immobilization and activity yields ,</li> </ul>	olve them to determine the kinetic param	neters of differen	t approaches and
	- to select process control strategies (batch , fed-b	atch , continuity ) appropriately and to cal	culate basic type	s and evaluate the
Personal Competence Social Competence	After completion of this module participants shoul	d be able to debate technical questions in	small teams to e	nhance the ability
	take position to their own opinions and increase th	eir capacity for teamwork.		
Autonomy	After completion of this module participants are al unknown issues and to present these.	ble to aquire new sources of knowledge an	d apply their kno	wledge to previou
Workload in Hours	Independent Study Time 124, Study Time in Lectur	re 56		
Credit points	6			
Course achievement	None			
Examination	Written exam			
Examination duration and	90 min			
scale			and an of the	
	General Engineering Science (German program, 7		eering: Compulso	ory
Following Curricula	Bioprocess Engineering: Core Qualification: Compu General Engineering Science (English program, 7 s Green Technologies: Energy, Water, Climate: Spec	emester): Specialisation Bioprocess Engine		Ŷ
	Green Technologies: Energy, Water, Climate: Spec Technomathematics: Specialisation III. Engineering		Compuisory	

Course L1107: Bioprocess En	igineering - Advanced
Тур	Lecture
Hrs/wk	2
CP	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	<ul> <li>K. Buchholz, V. Kasche, U. Bornscheuer: Biocatalysts and Enzyme Technology, 2. Aufl. Wiley-VCH, 2012</li> <li>H. Chmiel: Bioproze&amp;technik, Elsevier, 2006</li> <li>R.H. Balz et al.: Manual of Industrial Microbiology and Biotechnology, 3. edition, ASM Press, 2010</li> <li>H.W. Blanch, D. Clark: Biochemical Engineering, Taylor &amp; Francis, 1997</li> <li>P. M. Doran: Bioprocess Engineering Principles, 2. edition, Academic Press, 2013</li> <li>Skripte für die Vorlesung</li> </ul>

Course L1108: Bioprocess Er	ngineering - Advanced
Тур	Recitation Section (small)
Hrs/wk	2
CP	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>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	<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> <li>Skripte für die Vorlesung</li> </ul>

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					
Recommended Previous					
Knowledge					
Educational Objectives	After taking part successfully, students have reac	hed the following learning results			
Professional Competence					
Knowledge	With the completion of this module the studen environmental problems which might occur from about the methodological diversity and are comp impacts. Besides the students are able to estima difficulties with their measurement.	production processes, projects or constructed etent in dealing with different methods and	tion measures.	They have knowled assess environmen	
Skills	The students are able to select a suitable method for the respective case from the variety of assessment methods. Thereby the can develop suitable solutions for managing and mitigating environmental problems in a business context. They are able to car out Life Cycle Impact Assessments independently and can apply the software programs OpenLCA and the database Econver After finishing the course the students have the competence to critically judge research results or other publications of 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 a to develop jointly different solutions and to discuss their theoretical or practical implementation. Due to the selected lect topics, the students receive insights into the multi-layered issues of the environment protection and the concept of sustainabil Their sensitivity and consciousness towards these subjects are raised and which helps to raise their awareness of their fut social responsibilities in their role as engineers.				
Autonomy	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 publication				
Workload in Hours	Independent Study Time 48, Study Time in Lecture 42				
Credit points					
Course achievement					
	n Written exam				
Examination duration and scale	1 hour written exam				
Assignment for the	General Engineering Science (German program, 7	semester): Specialisation Process Engineer	ring: Elective Cor	npulsory	
-	General Engineering Science (German program, 7		-		
	General Engineering Science (German program, 7 semester): Specialisation Energy and Enviromental Engineering: Compulsory				
	Bioprocess Engineering: Core Qualification: Electiv	ve Compulsory			
	Energy and Environmental Engineering: Core Qua	lification: Compulsory			
	General Engineering Science (English program, 7				
	General Engineering Science (English program, 7 General Engineering Science (English program, 7 Process Engineering: Core Qualification: Elective O	semester): Specialisation Energy and Enviro			

Course L0860: Environmenta	I Assessment	
Тур	Lecture	
Hrs/wk	2	
CP	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		
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	
CP	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	

ïtle						
				Тур	Hrs/wk	СР
Process and Plant Engineering I (L0095)				Lecture	2	2
Process and Plant Engineering I (L0096)				Recitation Section (large)	1	2
rocess and Plant Engineering I (L1	214)			Recitation Section (small)	1	2
Module Responsible		ki				
Admission Requirements						
Recommended Previous	unit operation of them	mal an dmechanical sep	aration processes			
Knowledge	chemical reactor eing	ineering				
Educational Objectives	After taking part succ	essfully, students have	reached the following	g learning results		
Professional Competence						
Knowledge	ge students can:					
	classify and formulate blobal balance equations of chemical processes					
	specify linear component equations of complex chemical processes					
	explain linear regression and data reconcilliation problems					
	explain pfd-diagrams					
Skills	students are capable of					
	- formulation of mass and energy balance equations and estimation of product streams					
	- estimation of compo	onent streams of chemic	al plants using linea	component balance model	s	
	- solution of data reco	oncilliation tasks				
	- conduction of proces	ss synthesis				
	- economic evaluation	n of processes and the e	stimation of product	ion costs		
Personal Competence						
Social Competence						
Autonomy						
Workload in Hours	Independent Study Ti	me 124, Study Time in L	ecture 56			
Credit points	6					
Course achievement	Compulsory Bonus	Form	Description			
	Yes 10 %	Subject theoretical	and			
		practical work				
Examination						
Examination duration and scale	120 Min. lectures note	es and books				
Assignment for the	General Engineering S	Science (German progra	m, 7 semester): Spe	cialisation Process Engineer	ing: Compulsory	
Following Curricula	General Engineering S	Science (German progra	m, 7 semester): Spe	cialisation Bioprocess Engine	eering: Compulso	ory
	Bioprocess Engineerir	ng: Core Qualification: C	ompulsory			
	General Engineering S	Science (English program	n, 7 semester): Spec	ialisation Bioprocess Engine	ering: Compulso	ту
	General Engineering	Science (English prog	ram, 7 semester):	Specialisation Energy and	Enviromental E	ingineering: Electi
	Compulsory					
	General Engineering S	Science (English program	n, 7 semester): Spec	ialisation Process Engineeri	ng: Compulsory	
	Green Technologies: I	Energy, Water, Climate:	Specialisation Biores	ource Technology: Elective	Compulsory	

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

	<ul> <li>Data reconciliation and data validation</li> <li><b>Process Synthesis</b> <ul> <li>Decision levels</li> <li>Experimental process development</li> <li>Reactor synthesis</li> <li>Synthesis of separation processes (process alternatives and criteria for selection) <ul> <li>Integration of reaction systems/separation systems (interactions, recycle streams)</li> </ul> </li> <li><b>Process safety</b></li> <li><b>Cost estimation of production plants</b> <ul> <li>Production costs, capital costs, economic evaluation</li> </ul> </li> </ul></li></ul>
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
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	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,
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	G. Fieg, Inz. Chem. Proc., 5(1979), S.15-19
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	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
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	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

ourse L0096: Process and Plant Engineering I		
Тур	Recitation Section (large)	
Hrs/wk	1	
CP	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	

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

Courses					
Title			Тур	Hrs/wk	СР
Particle Technology I (L0434)			Lecture	2	3
Particle Technology I (L0435)			Recitation Section (small)	1	1
Particle Technology I (L0440)			Practical Course	2	2
Module Responsible		h			
Admission Requirements	None				
Recommended Previous	keine				
Knowledge					
Educational Objectives	After taking part suc	ccessfully, students have	reached the following learning results		
Professional Competence					
Knowledge	After successful com	mpletion of the module stu	dents are able to		
	<ul> <li>name and exp</li> </ul>	plain processes and unit-	operations of solids process engineering,		
			ions and to discuss their bulk properties		
Skills	Students are able to	0			
		• ··· ·	ocesses for solids processing according to the	desired solids prop	perties of the prod
			vior in solids processing steps		
	<ul> <li>document the</li> </ul>	eir work scientifically.			
Personal Competence					
Social Competence	The students are al	able to discuss scientific t	opics orally with other students or scientific	personal and to	develop solutions
	technical-scientific is	issues in a group.			
	Students are able to	o analyze and solve quest	and recording colid particles independently		
Autonomy			ons regarding solid particles independently.		
		Time 110. Study Time in I			
Workload in Hours	Independent Study 1	Time 110, Study Time in I			
	Independent Study 1	Time 110, Study Time in I			
Workload in Hours Credit points	Independent Study 1 6	-	ecture 70	à 5-10 Seiten	
Workload in Hours Credit points Course achievement	Independent Study 1 6 Compulsory Bonus Yes None	Form	Description	à 5-10 Seiten	
Workload in Hours Credit points Course achievement	Independent Study 1 6 Compulsory Bonus Yes None Written exam	Form	Description	à 5-10 Seiten	
Workload in Hours Credit points Course achievement Examination	Independent Study 1 6 Compulsory Bonus Yes None Written exam	Form	Description	à 5-10 Seiten	
Workload in Hours Credit points Course achievement Examination Examination duration and	Independent Study 1 6 Compulsory Bonus Yes None Written exam 90 minutes	Form Written elaboration	Description		
Workload in Hours Credit points Course achievement Examination Examination duration and scale	Independent Study 1 6 Compulsory Bonus Yes None Written exam 90 minutes General Engineering	Form Written elaboration g Science (German progra	Description sechs Berichte (pro Versuch ein Bericht)	ering: Compulsory	ory
Workload in Hours Credit points Course achievement Examination Examination duration and scale Assignment for the	Independent Study 1 6 Compulsory Bonus Yes None Written exam 90 minutes General Engineering General Engineering	Form Written elaboration g Science (German progra g Science (German progra	ecture 70  Description sechs Berichte (pro Versuch ein Bericht)  m, 7 semester): Specialisation Process Engine	ering: Compulsory ineering: Compulso	-
Workload in Hours Credit points Course achievement Examination Examination duration and scale Assignment for the	Independent Study 1 6 Compulsory Bonus Yes None Written exam 90 minutes General Engineering General Engineering Engineering: Elective	Form Written elaboration g Science (German progra g Science (German progra g Science (German progra g Science (German progra	ecture 70  Description sechs Berichte (pro Versuch ein Bericht)  m, 7 semester): Specialisation Process Engine m, 7 semester): Specialisation Bioprocess Eng im, 7 semester): Specialisation Green Technol	ering: Compulsory ineering: Compulso ogies, Focus Wate	r and Environmen
Workload in Hours Credit points Course achievement Examination Examination duration and scale Assignment for the	Independent Study 1 6 Compulsory Bonus Yes None Written exam 90 minutes General Engineering General Engineering Engineering: Elective General Engineering	Form Written elaboration g Science (German progra g Science (German progra g Science (German progra re Compulsory g Science (German progra	ecture 70  Description sechs Berichte (pro Versuch ein Bericht)  m, 7 semester): Specialisation Process Engine m, 7 semester): Specialisation Bioprocess Eng um, 7 semester): Specialisation Green Technol m, 7 semester): Specialisation Energy and Env	ering: Compulsory ineering: Compulso ogies, Focus Wate	r and Environmen
Workload in Hours Credit points Course achievement Examination Examination duration and scale Assignment for the	Independent Study 1 6 Compulsory Bonus Yes None Written exam 90 minutes General Engineering General Engineering General Engineering Engineering: Elective General Engineering Bioprocess Engineer	Form Written elaboration g Science (German progra g Science (German progra g Science (German progra re Compulsory g Science (German progra ring: Core Qualification: C	ecture 70  Description sechs Berichte (pro Versuch ein Bericht)  m, 7 semester): Specialisation Process Engine m, 7 semester): Specialisation Bioprocess Eng im, 7 semester): Specialisation Green Technol m, 7 semester): Specialisation Energy and Env ompulsory	ering: Compulsory ineering: Compulso ogies, Focus Wate	r and Environmen
Workload in Hours Credit points Course achievement Examination Examination duration and scale Assignment for the	Independent Study 1 6 Compulsory Bonus Yes None Written exam 90 minutes General Engineering General Engineering Engineering: Elective General Engineering Bioprocess Engineer Energy and Environr	Form Written elaboration g Science (German progra g Science (German progra g Science (German progra re Compulsory g Science (German progra ring: Core Qualification: C mental Engineering: Core	ecture 70  Description sechs Berichte (pro Versuch ein Bericht)  m, 7 semester): Specialisation Process Engine m, 7 semester): Specialisation Bioprocess Eng im, 7 semester): Specialisation Green Technol m, 7 semester): Specialisation Energy and Env pmpulsory Qualification: Elective Compulsory	ering: Compulsory ineering: Compuls ogies, Focus Wate iromental Enginee	r and Environmen
Workload in Hours Credit points Course achievement Examination Examination duration and scale Assignment for the	Independent Study 1 6 Compulsory Bonus Yes None Written exam 90 minutes General Engineering General Engineering Engineering: Elective General Engineering Bioprocess Engineer Energy and Environr General Engineering	Form Written elaboration g Science (German progra g Science (German progra g Science (German progra g Science (German progra ring: Core Qualification: C imental Engineering: Core g Science (English program	ecture 70  Description sechs Berichte (pro Versuch ein Bericht)  m, 7 semester): Specialisation Process Engine m, 7 semester): Specialisation Bioprocess Eng im, 7 semester): Specialisation Green Technol m, 7 semester): Specialisation Energy and Env pompulsory Qualification: Elective Compulsory n, 7 semester): Specialisation Bioprocess Engi	ering: Compulsory ineering: Compuls ogies, Focus Wate iromental Enginee neering: Compulso	r and Environmen ring: Compulsory ry
Workload in Hours Credit points Course achievement Examination Examination duration and scale Assignment for the	Independent Study 1 6 Compulsory Bonus Yes None Written exam 90 minutes General Engineering General Engineering Engineering: Elective General Engineering Bioprocess Engineer Energy and Environr General Engineering General Engineering General Engineering	Form Written elaboration g Science (German progra g Science (German progra g Science (German progra g Science (German progra ring: Core Qualification: C imental Engineering: Core g Science (English progra g Science (English progra	ecture 70  Description sechs Berichte (pro Versuch ein Bericht)  m, 7 semester): Specialisation Process Enginem , 7 semester): Specialisation Bioprocess Eng m, 7 semester): Specialisation Green Technol m, 7 semester): Specialisation Energy and Env pompulsory Qualification: Elective Compulsory n, 7 semester): Specialisation Bioprocess Engin n, 7 semester): Specialisation Energy and Envi	ering: Compulsory ineering: Compulso ogies, Focus Wate iromental Enginee neering: Compulso romental Engineer	r and Environmer
Workload in Hours Credit points Course achievement Examination Examination duration and scale Assignment for the	Independent Study 1 6 Compulsory Bonus Yes None Written exam 90 minutes General Engineering General Engineering Engineering: Elective General Engineering Bioprocess Engineer Energy and Environr General Engineering General Engineering General Engineering General Engineering General Engineering	Form Written elaboration g Science (German progra g Science (German progra g Science (German progra g Science (German progra ring: Core Qualification: C imental Engineering: Core g Science (English prograr g Science (English prograr g Science (English prograr	ecture 70  Description sechs Berichte (pro Versuch ein Bericht)  m, 7 semester): Specialisation Process Engine m, 7 semester): Specialisation Bioprocess Eng im, 7 semester): Specialisation Green Technol m, 7 semester): Specialisation Energy and Env pompulsory Qualification: Elective Compulsory n, 7 semester): Specialisation Bioprocess Engi	ering: Compulsory ineering: Compulso ogies, Focus Wate iromental Enginee neering: Compulso romental Engineer	r and Environmer

Course L0434: Particle Technology I		
Тур	Lecture	
Hrs/wk	2	
CP	3	
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28	
Lecturer	Prof. Stefan Heinrich	
Language	DE	
Cycle	SoSe	
Content	<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
CP	1
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14
Lecturer	Prof. Stefan Heinrich
Language	DE
Cycle	SoSe
Content	See interlocking course
Literature	See interlocking course

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

## **Specialization Electrical Engineering**

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

Graduates will have

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

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

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

## Module M0708: Electrical Engineering III: Circuit Theory and Transients

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

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

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

Courses				
Title		Тур	Hrs/wk	СР
Computer Engineering (L0321)		Lecture	3	4
Computer Engineering (L0324)		Recitation Section (small)	1	2
Module Responsible	Prof. Heiko Falk			
Admission Requirements	None			
<b>Recommended Previous</b>	Basic knowledge in electrical engineering			
Knowledge				
Educational Objectives	After taking part successfully, students have reached th	e following learning results		
Professional Competence				
Knowledge	<ul> <li>This module deals with the foundations of the functionality of computing systems. It covers the layers from the assembly-liprogramming down to gates. The module includes the following topics:</li> <li>Introduction</li> <li>Combinational logic: Gates Boolean algebra Boolean functions, bardware synthesis, combinational networks.</li> </ul>			
	<ul> <li>Combinational logic: Gates, Boolean algebra, Boolean functions, hardware synthesis, combinational networks</li> <li>Sequential logic: Flip-flops, automata, systematic hardware design</li> <li>Technological foundations</li> <li>Computer arithmetic: Integer addition, subtraction, multiplication and division</li> <li>Basics of computer architecture: Programming models, MIPS single-cycle architecture, pipelining</li> <li>Memories: Memory hierarchies, SRAM, DRAM, caches</li> <li>Input/output: I/O from the perspective of the CPU, principles of passing data, point-to-point connections, busses</li> </ul>			
Skills	The students perceive computer systems from the archi composition of computer systems. The students can and collection of few and simple components. They are abl today's computing systems - from gates and circuits up After successful completion of the module, the studen system and the software executed on it. In particular, t on the hardware-centric abstraction layers from the ass the impact that these low abstraction levels have on an	alyze, how highly specific and individu e to distinguish between and to expl to complete processors. ts are able to judge the interdepend hey shall understand the consequence embly language down to gates. This	al computers car ain the different a encies between a es that the execu way, they will be	h be built based of abstraction layers a physical compu- tion of software h enabled to evalua
Personal Competence				
	Students are able to solve similar problems alone or in a	aroup and to present the results acc	ordinaly	
Social Competence	Students are able to solve similar problems alone of in a	I group and to present the results acc	bruingry.	
Autonomy	Students are able to acquire new knowledge from specif	ic literature and to associate this kno	wledge with othe	classes.
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56			
Credit points				
Course achievement		iption		
	Yes 10 % Excercises			
Examination	Written exam			
Examination duration and	90 minutes, contents of course and labs			
scale				
Assignment for the		ster): Specialisation Computer Science	e: Compulsory	
Following Curricula				
	General Engineering Science (German program, 7 seme			
	General Engineering Science (German program, 7	semester): Specialisation Mechanica	l Engineering, F	ocus Mechatroni
	Compulsory	weater) Constitution Machanical		Alizza fit. Country
	General Engineering Science (German program, 7 se	mester): Specialisation Mechanical	Engineering, Foc	us Aircraft Syste
	Engineering: Compulsory General Engineering Science (German program, 7 seme	stor): Specialisation Mechanical Engli	ooring Focus Th	oorotical Mochani
	Engineering: Compulsory	ster). Specialisation meenamear Engi	leening, rocus m	
	General Engineering Science (German program, 7	semester): Specialisation Mechanic	al Engineering,	Focus Materials
	Engineering Sciences: Compulsory			
	Engineering Sciences: Compulsory General Engineering Science (German program, 7 semi	ester): Specialisation Mechanical Eng	ineering, Focus P	
		ester): Specialisation Mechanical Eng	ineering, Focus P	
	General Engineering Science (German program, 7 sem and Production: Compulsory General Engineering Science (German program, 7 se			roduct Developme
	General Engineering Science (German program, 7 sem and Production: Compulsory General Engineering Science (German program, 7 se Compulsory	mester): Specialisation Mechanical I	Engineering, Foc	roduct Developme us Energy System
	General Engineering Science (German program, 7 sem and Production: Compulsory General Engineering Science (German program, 7 se Compulsory General Engineering Science (German program, 7 se	mester): Specialisation Mechanical I	Engineering, Foc	roduct Developm us Energy Syster
	General Engineering Science (German program, 7 sem and Production: Compulsory General Engineering Science (German program, 7 se Compulsory	mester): Specialisation Mechanical I semester): Specialisation Mechanica ster): Specialisation Naval Architectur ster): Specialisation Biomedical Engin ster): Specialisation Bioprocess Engine ster): Specialisation Electrical Engine	Engineering, Focu I Engineering, F e: Compulsory eering: Compulso ering: Compulsory	roduct Developm us Energy Syster ocus Biomechani ry ry
	General Engineering Science (German program, 7 sem and Production: Compulsory General Engineering Science (German program, 7 se Compulsory General Engineering Science (German program, 7 se Compulsory General Engineering Science (German program, 7 seme General Engineering Science (German program, 7 seme	mester): Specialisation Mechanical I semester): Specialisation Mechanica ster): Specialisation Naval Architectur ster): Specialisation Biomedical Engin ster): Specialisation Bioprocess Engine ster): Specialisation Electrical Engine	Engineering, Focu I Engineering, F e: Compulsory eering: Compulso ering: Compulsory	roduct Developm us Energy Syster ocus Biomechani ry ry
	General Engineering Science (German program, 7 sem and Production: Compulsory General Engineering Science (German program, 7 se Compulsory General Engineering Science (German program, 7 se Compulsory General Engineering Science (German program, 7 seme General Engineering Science (German program, 7 seme	mester): Specialisation Mechanical I semester): Specialisation Mechanica ster): Specialisation Naval Architectur ster): Specialisation Biomedical Engin ster): Specialisation Bioprocess Engine ster): Specialisation Electrical Engine	Engineering, Focu I Engineering, F e: Compulsory eering: Compulso ering: Compulsory	roduct Developm us Energy Syster ocus Biomechani ry ry
	General Engineering Science (German program, 7 sem and Production: Compulsory General Engineering Science (German program, 7 se Compulsory General Engineering Science (German program, 7 se Compulsory General Engineering Science (German program, 7 seme General Engineering Science (German program, 7 seme Compulsory	mester): Specialisation Mechanical I semester): Specialisation Mechanica ster): Specialisation Naval Architectur ster): Specialisation Biomedical Engin ster): Specialisation Bioprocess Engine ster): Specialisation Electrical Engine	Engineering, Focu I Engineering, F e: Compulsory eering: Compulso ering: Compulsory	roduct Developm us Energy Syster ocus Biomechani ry ry
	General Engineering Science (German program, 7 sem- and Production: Compulsory General Engineering Science (German program, 7 se Compulsory General Engineering Science (German program, 7 se Compulsory General Engineering Science (German program, 7 seme General Engineering Science (German program, 7 seme Compulsory Computer Science: Core Qualification: Compulsory Data Science: Core Qualification: Elective Compulsory Electrical Engineering: Core Qualification: Compulsory General Engineering Science (English program, 7 semes	mester): Specialisation Mechanical I semester): Specialisation Mechanica ster): Specialisation Naval Architectur ster): Specialisation Bioprocess Engin ster): Specialisation Bioprocess Engin ster): Specialisation Green Technologi ster): Specialisation Green Technologi	Engineering, Focu I Engineering, F e: Compulsory eering: Compulso ering: Compulsory es, Focus Renewa Compulsory	roduct Developm us Energy Syster ocus Biomechani ry ry able Energy: Elect
	General Engineering Science (German program, 7 sem and Production: Compulsory General Engineering Science (German program, 7 se Compulsory General Engineering Science (German program, 7 se Compulsory General Engineering Science (German program, 7 seme General Engineering Science (German program, 7 seme Compulsory Computer Science: Core Qualification: Compulsory Electrical Engineering: Core Qualification: Compulsory	mester): Specialisation Mechanical I semester): Specialisation Mechanica ster): Specialisation Naval Architectur ster): Specialisation Bioprocess Engin ster): Specialisation Bioprocess Engin ster): Specialisation Green Technologi ster): Specialisation Green Technologi	Engineering, Focu I Engineering, F e: Compulsory eering: Compulso ering: Compulsory es, Focus Renewa Compulsory	roduct Developm us Energy Syster ocus Biomechani ry ry able Energy: Elect

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

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

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

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

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

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

	ials in Electrical Engineering			
Courses				
Title		Тур	Hrs/wk	CP
Electrotechnical Experiments (L071 Materials in Electrical Engineering (		Lecture Lecture	2	1 3
Materials in Electrical Engineering (		Recitation Section (small)	2	2
Module Responsible	Prof. Manfred Eich			
Admission Requirements	None			
<b>Recommended Previous</b>	Highschool level physics and mathematics			
Knowledge				
Educational Objectives	After taking part successfully, students hav	ve reached the following learning results		
Professional Competence				
-	Students can explain the composition and the structural properties of materials used in electrical engineering. Students of explicate the relevance of mechanical, electrical, thermal, dielectric, magnetic and chemical properties of materials in view of the applications in electrical engineering.			
SkillS	Students can identify appropriate descriptive models and apply them mathematically. They can derive approximative solut and judge factors influential on the performance of materials in electrical engineering applications.		roximative solutio	
Personal Competence				
Social Competence	Students can jointly solve subject related problems in groups. They can present their results effectively within the framework of t 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 exan 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	n Lecture 70		
Credit points	6			
Course achievement	None			
Examination	Written exam			
Examination duration and	60 minutes			
scale				
Assignment for the	General Engineering Science (German prog	gram, 7 semester): Specialisation Electrical Engin	eering: Compulsor	у
Following Curricula	Electrical Engineering: Core Qualification: C	Compulsory		

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

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

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

Module M0854: Math	ematics IV			
Courses				
Title		Тур	Hrs/wk	СР
Differential Equations 2 (Partial Dif	erential Equations) (11043)	Lecture	2	1
Differential Equations 2 (Partial Dif		Recitation Section (small)	1	1
Differential Equations 2 (Partial Dif	-	Recitation Section (large)	1	1
Complex Functions (L1038)		Lecture	2	1
Complex Functions (L1041)		Recitation Section (small)	1	1
Complex Functions (L1042)		Recitation Section (large)	1	1
	Drof Anucch Toroz			
Module Responsible				
Admission Requirements	None			
<b>Recommended Previous</b>	Mathematics 1 - III			
Knowledge				
Educational Objectives	After taking part successfully, students have reached the f	ollowing learning results		
Professional Competence		5 5		
-				
Knowledge	<ul> <li>Students can name the basic concepts in Mathemat</li> </ul>	ics IV. They are able to explain the	m using appropri	ate examples.
	<ul> <li>Students can discuss logical connections between t</li> </ul>			
	the help of examples.			
	<ul> <li>They know proof strategies and can reproduce them</li> </ul>			
Skills				
	<ul> <li>Students can model problems in Mathematics IV w</li> </ul>		ed in this course	. Moreover, they a
	capable of solving them by applying established me	thods.		
	<ul> <li>Students are able to discover and verify further logical</li> </ul>	cal connections between the conce	pts studied in the	e course.
	<ul> <li>For a given problem, the students can develop ar</li> </ul>	nd execute a suitable approach, a	nd are able to c	ritically evaluate t
	results.			
Personal Competence				
Social Competence				
	<ul> <li>Students are able to work together in teams. They a</li> </ul>			
	<ul> <li>In doing so, they can communicate new concepts a</li> </ul>	ccording to the needs of their coop	perating partners	. Moreover, they c
	design examples to check and deepen the understa	nding of their peers.		
Autonomv				
Autonomy	<ul> <li>Students are capable of checking their understandi</li> </ul>	ng of complex concepts on their o	wn. They can sp	ecify open questic
	precisely and know where to get help in solving the	m.		
	• Students have developed sufficient persistence to	be able to work for longer period	s in a goal-orien	ted manner on ha
	problems.	5	<u>.</u>	
	problems.			
Workload in Hours Credit points	Independent Study Time 68, Study Time in Lecture 112			
Course achievement				
	Written exam			
	60 min (Complex Functions) + 60 min (Differential Equatio	ns 2)		
scale		- 1		
Assignment for the	General Engineering Science (German program, 7 semeste	er): Specialisation Electrical Engine	ering: Compulson	V
-	General Engineering Science (German program, 7 seriesce			-
. Snowing curricula			Engineering, I	. Jeas meenau Ull
	Compulsory			
	General Engineering Science (German program, 7 semeste		1	
	General Engineering Science (German program, 7 semeste	er): Specialisation Mechanical Engir	neering, Focus Th	neoretical Mechani
	Engineering: Elective Compulsory			
	Computer Science: Specialisation Computational Mathema	tics: Elective Compulsory		
	Electrical Engineering: Core Qualification: Compulsory			
	General Engineering Science (English program, 7 semester	r): Specialisation Electrical Engineer	rina: Compulsory	
	General Engineering Science (English program, 7 seriester			
	General Engineering Science (English program, 7 sen	nester). Specialisation Mechanica	in Engineering, I	ocus Mecharioni
	Compulsory			a sucht and the state of
	Compulsory General Engineering Science (English program, 7 semeste	er): Specialisation Mechanical Engir	eering, Focus Th	leoretical Mechan
		er): Specialisation Mechanical Engir	ieering, Focus Th	ieoretical Mechan
	General Engineering Science (English program, 7 semeste		-	
	General Engineering Science (English program, 7 semeste Engineering: Compulsory Computational Science and Engineering: Specialisation II. I	Mathematics & Engineering Science	-	
	General Engineering Science (English program, 7 semeste Engineering: Compulsory Computational Science and Engineering: Specialisation II. I Mechanical Engineering: Specialisation Mechatronics: Com	Mathematics & Engineering Science	e: Elective Compu	
	General Engineering Science (English program, 7 semeste Engineering: Compulsory Computational Science and Engineering: Specialisation II. I Mechanical Engineering: Specialisation Mechatronics: Com Mechanical Engineering: Specialisation Theoretical Mechar	Mathematics & Engineering Science	e: Elective Compu	
	General Engineering Science (English program, 7 semeste Engineering: Compulsory Computational Science and Engineering: Specialisation II. I Mechanical Engineering: Specialisation Mechatronics: Com Mechanical Engineering: Specialisation Theoretical Mechar Mechatronics: Core Qualification: Compulsory	Mathematics & Engineering Science	e: Elective Compu	
	General Engineering Science (English program, 7 semeste Engineering: Compulsory Computational Science and Engineering: Specialisation II. I Mechanical Engineering: Specialisation Mechatronics: Com Mechanical Engineering: Specialisation Theoretical Mechar	Mathematics & Engineering Science	e: Elective Compu	

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

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

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

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

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

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

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

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

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

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

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

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

Courses				
Title		Тур	Hrs/wk	СР
ntroduction to Communications ar	d Random Processes (L0442)	Lecture	3	4
ntroduction to Communications ar	d Random Processes (L0443)	Recitation Section (large)	1	1
ntroduction to Communications ar	d Random Processes (L2354)	Recitation Section (small)	1	1
Module Responsible				
Admission Requirements	None			
<b>Recommended Previous</b>	Mathematics 1-3			
Knowledge	Signals and Systems			
Educational Objectives	After taking part successfully, students have	e reached the following learning results		
Professional Competence				
Knowledge	The students know and understand the fun	damental building blocks of a communications sy	stem. They can o	describe and analy
	the individual building blocks using knowled	dge of signal and system theory as well as the the	eory of stochasti	ic processes. The
	aware of the essential resources and evalu	ation criteria of information transmission and are	able to design a	and evaluate a ba
	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 e	error rate and to decide for a suitable transmission	method.	
Personal Competence				
Social Competence	The students can jointly solve specific prob	lems.		
Autonomy	The students are able to acquire relevan	nt information from appropriate literature sourc	es. They can c	ontrol their level
,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,		ing tutorial problems, software tools, clicker syste	-	
Workload in Hours	Independent Study Time 110, Study Time in	Lecture 70		
Credit points				
Course achievement				
	Written exam			
Examination duration and	90 min			
scale				
-		ram, 7 semester): Specialisation Electrical Enginee	ring: Compulsor	у
Following Curricula	Computer Science: Specialisation Computer and Software Engineering: Elective Compulsory			
	Computer Science: Specialisation Computat			
	Data Science: Core Qualification: Elective Co			
	Electrical Engineering: Core Qualification: Co			
		am, 7 semester): Specialisation Electrical Engineer	ing: Compulsory	
	Computational Science and Engineering: Co	re Qualification: Compulsory		

Course L0442: Introduction t	o Communications and Random Processes
Тур	Lecture
Hrs/wk	3
CP	4
Workload in Hours	Independent Study Time 78, Study Time in Lecture 42
Lecturer	Prof. Gerhard Bauch
Language	DE/EN
Cycle	WiSe
Content	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.

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

Course L2354: Introduction t	urse L2354: Introduction to Communications and Random Processes			
Тур	citation Section (small)			
Hrs/wk	1			
CP				
Workload in Hours	ependent Study Time 16, Study Time in Lecture 14			
Lecturer	. Gerhard Bauch			
Language	/EN			
Cycle	Cycle WiSe			
Content	ee interlocking course			
Literature	See interlocking course			

Courses							
Title		Тур	Hrs/wk	СР			
Theoretical Electrical Engineering I		Lecture	3	5			
Theoretical Electrical Engineering I		Recitation Section (small)	2	1			
	Prof. Christian Schuster						
Admission Requirements	None						
Recommended Previous	Electrical Engineering I, Electrical Engineering II,	Theoretical Electrical Engineering I					
Knowledge	Mathematics I, Mathematics II, Mathematics III, M	Aathematics IV					
Educational Objectives	After taking part successfully, students have rea	ched the following learning results					
Professional Competence							
Knowledge	Students are able to explain fundamental		-				
	electromagnetic fields. They can assess the prir						
	regard to respective sources. They can describ solutions for simple fields. The students are awa						
	able to explicate these.	ine of applications for the theory of time-de	pendent electronia	agrietic fields and a			
Skills	Students are able to apply a variety of procedure	es in order to solve the diffusion and the wa	ave equation for ge	neral time-depende			
	field problems. They can assess the principal effects of given time-dependent sources of fields and analyze these quantitativel						
	They can deduce meaningful quantities for the characterization of fully dynamic fields (wave impedance, skin depth, Poynting						
	vector, radiation resistance, etc.) from given fiel	ds and interpret them with regard to practi	cal applications.				
_							
Personal Competence							
Social Competence	Students are able to work together on subject re during exercise sessions).	elated tasks in small groups. They are able	to present their re	sults effectively (e.			
	during exercise sessions).						
Autonomy	Students are capable to gather necessary inform	nation from provided references and relate	this information to	the lecture. They a			
	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 acquired knowledge and ongoing research at the Hamburg						
	University of Technology (TUHH), e.g. in the area	a of high frequency engineering and optics.					
Mauldeed in H	Independent Chudy Time 110, Chudy Time 1, 1	hung 70					
Workload in Hours Credit points	Independent Study Time 110, Study Time in Lec	ture /o					
Course achievement	None						
	Written exam						
Examination duration and							
scale							
Assignment for the	General Engineering Science (German program,	7 semester): Specialisation Electrical Engir	eering: Compulsor	у			
Following Curricula	Electrical Engineering: Core Qualification: Comp	ulsory					
	Technomathematics: Specialisation III. Engineering Science: Elective Compulsory						

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

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

Module M0760: Elect	onic Devices							
Courses								
Title			Тур		Hrs/wk	СР		
Electronic Devices (L0720) Electronic Devices (L0721)			Lecture Project-/proble	m-based Learning	3 2	4 2		
Module Responsible	Prof. Hoc Khiem Trieu							
Admission Requirements	None							
<b>Recommended Previous</b>	Atomic model and quantum theory, electrical currents in solid state materials, basics in solid-state physics							
Knowledge	Successful participation	of Physics for Enginee	rs and Materials in Electrical Engi	ineering or course	s with equival	ent contents		
Educational Objectives	After taking part success	sfully, students have re	eached the following learning res	ults				
Professional Competence								
Knowledge								
	Students are able							
	to an and the l							
	<ul> <li>to represent the b</li> </ul>	basics of semiconducto	r physics,					
	<ul> <li>to explain the operation</li> </ul>	erating principle of imp	ortant semiconductor devices,					
	to outline device	characteristics and equ	ivalent circuits as well as to exp	lain their derivatio	n and			
	<ul> <li>to discuss the limit</li> </ul>	itation of device mode	s					
			5.					
Skills								
	Students are capable							
	e to apply dovices i	n bacic circuite						
	<ul> <li>to apply devices i</li> </ul>	II basic circuits,						
	<ul> <li>to realize the physical</li> </ul>	sical context and to so	lve complex problems by oneself	F				
Personal Competence								
Social Competence	Students are able to pre	pare and perform thei	r lab experiments in team work a	as well as to prese	nt and discus	s the results in fro		
	of audience.							
Autonomy	Students are capable to	acquire knowledge ba	sed on literature in order to prep	are their experime	ents.			
Workload in Hours	Independent Study Time	e 110, Study Time in Le	ecture 70					
Credit points	6							
Course achievement		orm	Description	Klaingruppon Wice	on zu oinom	bostimmton Thom		
		Subject theoretical practical work	andStudierenden erarbeiten in demonstrieren dieses in					
	,		Diskussion. Darüber hinau					
			inhaltlich zu dem jeweiligen	Versuch gehört.				
	Written exam							
Examination duration and	120 min							
scale Assignment for the	General Engineering Sci-	ence (German program	n, 7 semester): Specialisation Ele	ctrical Engineering	a: Compulson	1		
Following Curricula	Electrical Engineering: C			concor Engineering	. compuisory	,		
<b>3</b>	Engineering Science: Sp							
			, 7 semester): Specialisation Elec					
	Computational Science a	and Engineering: Speci	alisation II. Mathematics & Engin	eering Science: El	ective Compu	lsory		

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; MOSFET: operating principle, depletion mode and enhancement mode MESFET; MIS structure: accumulation, depletion, inversion, strong inversion, flatband voltage, oxide charges, threshold voltage, capacitance voltage characteristics; MOSFET: basic structure, principle of operation, current voltage characteristics, frequency response, subthreshold behaviour, threshold voltage, device scaling; CMOS)</li> </ul>
Literature	<ul> <li>S.M. Sze: Semiconductor devices, Physics and Technology, John Wiley &amp; Sons (1985)F. Thuselt: Physik der Halbleiterbauelemente, Springer (2011)</li> <li>T. Thille, D. Schmitt-Landsiedel: Mikroelektronik, Halbleiterbauelemente und deren Anwendung in elektronischen Schaltungen, Springer (2004)</li> <li>B.L. Anderson, R.L. Anderson: Fundamentals of Semiconductor Devices, McGraw-Hill (2005)</li> <li>D.A. Neamen: Semiconductor Physics and Devices, McGraw-Hill (2011)</li> <li>M. Shur: Introduction to Electronic Devices, John Wiley &amp; Sons (1996)</li> <li>S.M. Sze: Physics of semiconductor devices, John Wiley &amp; Sons (2007)</li> <li>H. Schaumburg: Halbleiter, B.G. Teubner (1991)</li> <li>A. Möschwitzer: Grundlagen der Halbleiter-&amp;Mikroelektronik, Bd1 Elektronische Halbleiterbauelemente, Carl Hanser (1992)</li> <li>HG. Unger, W. Schultz, G. Weinhausen: Elektronische Bauelemente und Netzwerke I, Physikalische Grundlagen der Halbleiterbauelemente, Vieweg (1985)</li> </ul>

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

	ical Power Systems I: Introductio				
Courses					
Title		Тур	Hrs/wk	СР	
-	ction to Electrical Power Systems (L1670)	Lecture	3	4	
	ectrical Power Systems I: Introduction to Electrical Power Systems (L1671) Recitation Section (small) 2 2				
Module Responsible					
Admission Requirements	None				
Recommended Previous	Fundamentals of Electrical Engineering				
Knowledge					
Educational Objectives	After taking part successfully, students have read	ched the following learning results			
Professional Competence					
Knowledge	Students are able to give an overview of convent				
	evaluate technologies of electric power generation	on, transmission, storage, and distribution	as well as integrat	ion of equipment int	
	electric power systems.				
Skills	With completion of this module the students a	are able to apply the acquired skills in	applications of the	e design, integration	
	development of electric power systems and to as	sess the results.			
Personal Competence					
Social Competence	The students can participate in specialized and in	iterdisciplinary discussions, advance ideas	and represent the	ir own work results i	
	front of others.				
Autonomy	Students can independently tap knowledge of the	e emphasis of the lectures.			
Workload in Hours	Independent Study Time 110, Study Time in Lect	ure 70			
Credit points	6				
Course achievement	None				
Examination	Written exam				
Examination duration and	90 - 150 minutes				
scale					
Assignment for the	General Engineering Science (German program,	7 semester): Specialisation Electrical Engir	neering: Elective Co	ompulsory	
Following Curricula	General Engineering Science (German program,	7 semester): Specialisation Green Technol	ogies, Focus Renew	vable Energy: Electiv	
	Compulsory				
	Data Science: Core Qualification: Elective Compu	lsory			
	Electrical Engineering: Core Qualification: Elective	e Compulsory			
	Energy and Environmental Engineering: Specialis	ation Energy Engineering: Elective Compu	llsory		
	Energy Systems: Specialisation Energy Systems:	Elective Compulsory			
	General Engineering Science (English program, 7		-	mpulsory	
	Green Technologies: Energy, Water, Climate: Spe		-		
	Computational Science and Engineering: Speciali		nce: Elective Comp	ulsory	
	Renewable Energies: Core Qualification: Compute	•			
	Theoretical Mechanical Engineering: Technical Co		У		
	Theoretical Mechanical Engineering: Specialisatic	n Energy Systems: Elective Compulsory			

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

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

Module M0783: Meas	urements: Metl	nods and Da	ta Processing				
Courses							
Title				Тур	Hrs/wk	СР	
EE Experimental Lab (L0781)				Practical Course	2	2	
Measurements: Methods and Data	Processing (L0779)			Lecture	2	3	
Measurements: Methods and Data	Processing (L0780)			Recitation Section (small)	1	1	
Module Responsible	Prof. Alexander Schla	efer					
Admission Requirements	None						
<b>Recommended Previous</b>	principles of mathem	atics					
Knowledge	principles of electrica	l engineering					
Educational Objectives	After taking part succ	essfully, students	have reached the following	ng learning results			
Professional Competence							
Knowledge	The students are able	e to explain the p	urpose of metrology and	the acquisition and proce	essing of measureme	ents. They can deta	
	aspects of probability	theory and errors	s, and explain the process	ing of stochastic signals.	Students know meth	ods to digitalize an	
	describe measured si	gnals.					
Skills	The students are able to evaluate problems of metrology and to apply methods for describing and processing of measurements.						
Personal Competence							
Social Competence	The students solve pr	oblems in small g	roups.				
Autonomy	The students can refl	act their knowledg	ge and discuss and evalua	to their results			
Autonomy	The students carrier	eet their knowledg		te then results.			
Workload in Hours	Independent Study Ti	me 110, Study Tir	me in Lecture 70				
Credit points							
Course achievement		Form	Description				
	Yes 10 %	Excercises					
Examination	Written exam						
Examination duration and	90 min						
scale							
Assignment for the	General Engineering	Science (German	program, 7 semester): Spe	ecialisation Electrical Engi	ineering: Elective Co	mpulsory	
Following Curricula							
			rogram, 7 semester): Spe	cialisation Electrical Engin	neerina: Elective Cor	npulsorv	
			Engineering Science: Elec	-			
			Defender Liee				

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

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

Courses						
Title		Тур	Hrs/wk	СР		
Semiconductor Circuit Design (L076	3)	Lecture	3	4		
Semiconductor Circuit Design (L086	54)	Recitation Section (small)	1	2		
Module Responsible	Prof. Matthias Kuhl					
Admission Requirements	None					
<b>Recommended Previous</b>	Fundamentals of electrical engineering					
Knowledge	Basics of physics, especially semiconductor physics					
Educational Objectives	After taking part successfully, students have	reached the following learning results				
Professional Competence Knowledge Skills	<ul> <li>Students are able to explain how analo</li> <li>Students are able to explain the functi</li> <li>Students know the fundamental digita</li> <li>Students have knowledge about memo</li> <li>Students know the appropriate fields for</li> </ul>		l. nd their specificatio s and disadvantage: nd specifications.	5.		
	<ul> <li>Students can calculate the specifications of different MOS devices and can define the parameters of electric</li> <li>Students are able to develop different logic circuits and can design different types of logic circuits.</li> <li>Students can use MOS devices, operational amplifiers and bipolar transistors for specific applications.</li> </ul>					
Personal Competence Social Competence						
Autonomy	Students are able to assess their level	of knowledge.				
Workload in Hours	Independent Study Time 124, Study Time in I	Lecture 56				
Credit points						
Course achievement						
Examination						
Examination duration and	120 min					
scale						
Assignment for the	General Engineering Science (German progra	am, 7 semester): Specialisation Electrical Engine	eering: Compulsory			
-		ogram, 7 semester): Specialisation Mechanic				
	Compulsory					
	Data Science: Core Qualification: Elective Cor	mpulsory				
	Electrical Engineering: Core Qualification: Core	mpulsory				
	Engineering Science: Specialisation Electrical	Engineering: Compulsory				
	Engineering Science: Specialisation Mechatro					
		m, 7 semester): Specialisation Electrical Engine				
		gram, 7 semester): Specialisation Mechanic	al Engineering, F	ocus Mechatron		
	Compulsory	m 7 competer), Specialization Machatranian Co	mpulcon			
	5 5 7 5	m, 7 semester): Specialisation Mechatronics: Co cialisation II. Mathematics & Engineering Science		sony		
	Mechanical Engineering: Specialisation Mecha		.e. Liecuve Compu	301 y		
	Mechatronics: Core Qualification: Compulsory					
	Technomathematics: Specialisation III. Engine					

ourse L0763: Semiconducto	or Circuit Design
Тур	Lecture
Hrs/wk	3
CP	4
Workload in Hours	Independent Study Time 78, Study Time in Lecture 42
Lecturer	Prof. Matthias Kuhl
Language	DE
Cycle	SoSe
Content	<ul> <li>Repetition Semiconductorphysics and Diodes</li> <li>Functionality and characteristic curve of bipolar transistors</li> <li>Basic circuits with bipolar transistors</li> <li>Functionality and characteristic curve of MOS transistors</li> <li>Basic circuits with MOS transistors for amplifiers</li> <li>Operational amplifiers and their applications</li> <li>Typical applications for analog and digital circuits</li> <li>Realization of logical functions</li> <li>Basic circuits with MOS transistors for combinational logic</li> <li>Memory circuits</li> <li>Basic circuits with MOS transistors for sequential logic</li> <li>Basic concepts of analog-to-digital and digital-to-analog-converters</li> </ul>
Literature	U. Tietze und Ch. Schenk, E. Gamm, Halbleiterschaltungstechnik, Springer Verlag, 14. Auflage, 2012, ISBN 3540428496 R. J. Baker, CMOS - Circuit Design, Layout and Simulation, J. Wiley & Sons Inc., 3. Auflage, 2011, ISBN: 047170055S H. Göbel, Einführung in die Halbleiter-Schaltungstechnik, Berlin, Heidelberg Springer-Verlag Berlin Heidelberg, 2011, ISBN: 9783642208874 ISBN: 9783642208867 URL: http://site.ebrary.com/lib/alltitles/docDetail.action?docID=10499499 URL: http://dx.doi.org/10.1007/978-3-642-20887-4 URL: http://ebooks.ciando.com/book/index.cfm/bok_id/319955 URL: http://www.ciando.com/img/bo

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

Courses				
Fitle		Тур	Hrs/wk	СР
Electrical Engineering Project Labor	ratory (L0640)	۲۰ Project-/problem-based Learn		6
Module Responsible			5	
Admission Requirements				
· · ·	Electrical Engineering I, Electrical Enginee	ering II		
Knowledge				
	After taking part successfully, students ha	ave reached the following learning results		
Professional Competence				
Knowledge		of the technical details of projects in the area of		
		ble of describing and communicating relevant prob		
	technical language. They can explain the	typical process of solving practical problems and pr	esent related res	uits.
Skills	The students can transfer their fundame	ental knowledge on electrical engineering to the p	process of solvin	g practical problem
		ems during the realization of projects in the context		
	able to develop, compare, and choose co	nceptual solutions for non-standardized problems.		
Personal Competence				
Social Competence		mixed-subject groups in order to independently de		
		are able to effectively present and explain their re e ability to develop alternative approaches to		
	independently or in groups and discuss a			ingineering proble
Autonomy	Students are capable of independently so	olving electrical engineering problems using provide	ed literature. The	y are able to fill gap
	in as well as extent their knowledge usi	ing the literature and other sources provided by t	he supervisor. Fu	irthermore, they ca
	meaningfully extend given problems and	pragmatically solve them by means of corresponding	ig solutions and o	concepts.
	Independent Study Time 68, Study Time 6	IN LECLURE 112		
Course achievement				
	Subject theoretical and practical work			
Examination duration and	based on task + presentation			
scale	subcu on cosk i presentation			
Assignment for the	General Engineering Science (German pro	ogram, 7 semester): Specialisation Electrical Engine	ering: Compulsor	у
-	Electrical Engineering: Core Qualification:		5	-
-	Engineering Science: Specialisation Electr	rical Engineering: Compulsory		
	General Engineering Science (English pro	gram, 7 semester): Specialisation Electrical Enginee	ring: Compulsory	/
	Technomathematics: Specialisation III. En	igineering Science: Elective Compulsory		

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

Courses						
Title				Тур	Hrs/wk	СР
Computer Science for Engineers - P	Programming Concepts. 1	Data Handling & Communicatio	on (L2689)	Lecture	3	3
Computer Science for Engineers - P				Recitation Section (small)	2	3
Module Responsible	Prof. Sibylle Fröschle					
Admission Requirements	None					
Recommended Previous						
Knowledge						
Educational Objectives	After taking part succ	essfully, students have read	hed the follow	ing learning results		
Professional Competence						
Knowledge						
Skills						
<b>D</b> 10 1						
Personal Competence						
Social Competence Autonomy						
Workload in Hours	Indonendent Chudu Ti	ma 110 Chudu Tima in Lash				
Credit points		me 110, Study Time in Lect	ure 70			
Course achievement		Form	Description			
course achievement	No 10%	Attestation		en semesterbegleitend statt.		
Examination	Written exam			-		
Examination duration and	120 min					
scale						
Assignment for the	General Engineering	Science (German program	m, 7 semeste	er): Specialisation Mechanica	l Engineering, F	ocus Biomechan
Following Curricula	Compulsory					
	General Engineering	Science (German program, 7	7 semester): S	pecialisation Process Engineer	ing: Compulsory	
	Compulsory			): Specialisation Mechanical ): Specialisation Mechanical		
	Engineering: Compuls	sory		er): Specialisation Mechanic		
	Engineering Sciences General Engineering		m, 7 semeste	er): Specialisation Mechanica	al Engineering, I	Focus Mechatron
	Compulsory					
	General Engineering Engineering: Compute		7 semester): S	pecialisation Mechanical Engi	neering, Focus Th	neoretical Mechan
	and Production: Elect	ive Compulsory		Specialisation Mechanical Eng		
				pecialisation Electrical Engine pecialisation Green Technolog		
		ng: Core Qualification: Comp g: Core Qualification: Compu	-			
	Energy and Environm	ental Engineering: Core Qua	alification: Com	npulsory		
	General Engineering			ecialisation Process Engineeri ): Specialisation Energy and		
	Compulsory		cialisation Eng	way Cychama, Elective Comput	lsory	
		Energy, Water, Climate: Spe		rgy systems: Elective Compu	1501 y	
	Logistics and Mobility	: Core Qualification: Compu	lsory			
	Logistics and Mobility Logistics and Mobility	: Core Qualification: Computer: Specialisation Information	lsory		Johy	
	Logistics and Mobility Logistics and Mobility Mechatronics: Core Q	: Core Qualification: Compu	lsory Technology: C		Jory	

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

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

## **Specialization Green Technologies**

Module M1711: Green	n Technologies I			
Courses				
Title		Тур	Hrs/wk	СР
Introduction to Green Technologies	; (L2727)	Seminar	2	2
Meteorology and Climate Systems	- Introduction (L2726)	Lecture	2	2
Meteorology and Climate Systems	- Introduction (L2829)	Recitation Section (	small) 2	2
Module Responsible	Prof. Martin Kaltschmitt			
Admission Requirements	None			
<b>Recommended Previous</b>	none			
Knowledge				
Educational Objectives	After taking part successfully, students have re	eached the following learning results		
Professional Competence				
Knowledge	Upon completion of this module, students w	ill be able to describe and critically	v evaluate current enviro	nmental and climate
	problems, especially in Hamburg. Furthermore	e, they are able to find and process s	uitable approaches to sol	utions. The students
	can compare learned technologies in the field and defend it in discussions.	d of climate and environmental prote	ection, develop and take a	a standpoint on then
	In addition, students can give an overview of t	he basics of meterology and climate.		
Skills	The students are able to apply the knowledge and climate-friendly water, energy and climate		-	-
	Furthermore, the students are able to explain to renewable energy projects in the context of		bics of climate and metero	logy and apply them
Personal Competence				
Social Competence	Students can			
	<ul> <li>work together in a team of about 3-5 per</li> </ul>	anla		
	<ul> <li>discuss tasks on the topics of environm solutions,</li> <li>present their own work results to fellow</li> <li>assess the performance of fellow stude performance.</li> </ul>	ental, resource and climate protection students and		
Autonomy	The students are able to independently acc respective learning status in consultation v necessary to solve them.			
Workload in Hours	Independent Study Time 96, Study Time in Leo	cture 84		
Credit points	6			
	Computerny Bonus Form	Description		
Course achievement	CompulsoryBonusFormYes20 %Presentation	Description		
Framination	Written exam			
Examination duration and				
Examination duration and scale				
	Conoral Engineering Science (Cormon arcora	7 competer): Specialization Cross	Tochnologios: Compulsary	
Assignment for the	General Engineering Science (German program Green Technologies: Energy, Water, Climate: (		echnologies. Compuisory	
Following Curricula	Green reciniologies. Energy, water, climate: C			
Course L2727: Introduction t	o Green Technologies			
	-			
Тур	Seminar			
Hrs/wk	2			
СР	2			
Workload in Hours		cture 28		
Lecturer				
Language				
Cycle	WiSe			
Content	Preliminary discussion of the seminar			

Preliminary discussion of the seminar
 Interesting presentations by people responsible for climate and environmental protection in Hamburg, keyword: Green Port of Hamburg
 Handing out of topics and tasks from the area of the seminar topic (green port of Hamburg) to individual students / groups of students (depending on the number of participating students
 Presentation of the task / the topic to be worked on with PPT presentation or poster presentation of the results

Literature Eigenständiges Literaturstudium in der Bibliothek und aus anderen Quellen.

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

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

Courses					
Title			Тур	Hrs/wk	СР
Practical Course Measurement Technology (L2270)		Practical Course	2	2	
Measurement Technology (L2268)		Lecture	2	2	
Physical Fundamentals of Measurement Technology (L2269)			Lecture	2	2
Module Responsible	Prof. Alexander Per	nn			
Admission Requirements	None				
Recommended Previous Knowledge					
Educational Objectives	After taking part su	uccessfully, students ha	ve reached the following learning results		
Professional Competence	1				
Knowledge	-		ics (theory of motion), rotation of rigid boo operature and heat, ideal gas.	lies, energy and mo	omentum, electrici
			easurement uncertainty, basics of sensor tec vel measurement, flow measurement. Usage of		nciples, temperatu
			calorimetry, image data acquisition, flow meas of solid concentrations, spectroscopy, error calo		
Skills	Literature research, categorisation of thematical topics, analysis of an experimental test stand, preparation of test protocol, fi programming with Matlab, use of relevant laboratory measurement technology, preparation of a test protocol, execution calculations.				
Personal Competence					
Social Competence	-	nd in groups, consulta	tical training and learning groups, assessmer tion with persons responsible for teaching,		-
Autonomy	Time management of the workload, independent development of the thematic basics, personal responsibility for the provision protective equipment and work clothing, practice of presentation in front of a group, active participation in the lecture formulation of enquiries/detailed questions by using clicker.				
Workload in Hours	Independent Study	/ Time 96, Study Time ir	n Lecture 84		
	6				
Credit points					
Credit points Course achievement		Form	Description Popup Quizzos währen der Verlegung		
Course achievement	No 20 %	Form Excercises	Description Popup-Quizzes währen der Vorlesung		
Course achievement Examination	No 20 % Written exam				
Course achievement Examination Examination duration and	No20 %Written exam120 min				
Course achievement Examination Examination duration and scale	No 20 % Written exam 120 min	Excercises	Popup-Quizzes währen der Vorlesung		
Course achievement Examination Examination duration and scale Assignment for the	No     20 %       Written exam       120 min       General Engineerin	Excercises	Popup-Quizzes währen der Vorlesung gram, 7 semester): Specialisation Process Engi	neering: Compulsory	
Course achievement Examination Examination duration and scale	No     20 %       Written exam       120 min       General Engineerin       General Engineerin	Excercises ng Science (German pro ng Science (German pro	Popup-Quizzes währen der Vorlesung gram, 7 semester): Specialisation Process Engi gram, 7 semester): Specialisation Process Engi	neering: Compulsory neering: Compulsory	
Course achievement Examination Examination duration and scale Assignment for the	No     20 %       Written exam       120 min       General Engineerin       General Engineerin       General Engineerin	Excercises ng Science (German pro ng Science (German pro ng Science (German pro	Popup-Quizzes währen der Vorlesung gram, 7 semester): Specialisation Process Engi gram, 7 semester): Specialisation Process Engi gram, 7 semester): Specialisation Bioprocess E	ineering: Compulsory ineering: Compulsory ingineering: Compulso	
Course achievement Examination Examination duration and scale Assignment for the	No     20 %       Written exam       120 min       General Engineerin       General Engineerin       General Engineerin       General Engineerin       General Engineerin	Excercises ng Science (German pro ng Science (German pro ng Science (German pro ng Science (German pro ng Science (German pro	Popup-Quizzes währen der Vorlesung gram, 7 semester): Specialisation Process Engi gram, 7 semester): Specialisation Process Engi gram, 7 semester): Specialisation Bioprocess E gram, 7 semester): Specialisation Green Techr	ineering: Compulsory ineering: Compulsory ingineering: Compulso	
Course achievement Examination Examination duration and scale Assignment for the	No     20 %       Written exam       120 min       General Engineerin       General Engineerin       General Engineerin       General Engineerin       General Engineerin       Bioprocess Engineerin	Excercises ng Science (German pro ng Science (German pro ng Science (German pro ng Science (German pro ering: Core Qualification	Popup-Quizzes währen der Vorlesung gram, 7 semester): Specialisation Process Engi gram, 7 semester): Specialisation Process Engi gram, 7 semester): Specialisation Bioprocess E gram, 7 semester): Specialisation Green Techr h: Compulsory	ineering: Compulsory ineering: Compulsory ingineering: Compulso iologies: Compulsory	
Course achievement Examination Examination duration and scale Assignment for the	No     20 %       Written exam     120 min       General Engineerin	Excercises ng Science (German pro ng Science (German pro ng Science (German pro ng Science (German pro ering: Core Qualification ng Science (English prog	Popup-Quizzes währen der Vorlesung gram, 7 semester): Specialisation Process Engi gram, 7 semester): Specialisation Process Engi gram, 7 semester): Specialisation Bioprocess E gram, 7 semester): Specialisation Green Techr 1: Compulsory gram, 7 semester): Specialisation Process Engir	ineering: Compulsory ineering: Compulsory ingineering: Compulso iologies: Compulsory	
Course achievement Examination Examination duration and scale Assignment for the	No         20 %           Written exam         120 min           General Engineerin         General Engineerin           General Engineerin         General Engineerin	Excercises ng Science (German pro ng Science (German pro ng Science (German pro ng Science (German pro ering: Core Qualification ng Science (English prog	Popup-Quizzes währen der Vorlesung gram, 7 semester): Specialisation Process Engi gram, 7 semester): Specialisation Process Engi gram, 7 semester): Specialisation Bioprocess E gram, 7 semester): Specialisation Green Techr 1: Compulsory gram, 7 semester): Specialisation Process Engir te: Core Qualification: Compulsory	ineering: Compulsory ineering: Compulsory ingineering: Compulso iologies: Compulsory	

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

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

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

Courses				
<b>Fitle</b>		Тур	Hrs/wk	СР
Energy systems and markets (L274	4)	Lecture	2	2
ossil Energy Sources (L2745)		Lecture	3	3
ossil Energy Sources (L2746)		Recitation Section (large)	1	1
Module Responsible	Prof. Martin Kaltschmitt			
Admission Requirements	None			
<b>Recommended Previous</b>	none			
Knowledge				
Educational Objectives	After taking part successfully, students	have reached the following learning results		
Professional Competence				
Skills	energy trade in this context, taking into which is applicable to almost all energy them. Furthermore, they can explain th of reserves and resources as well as g especially take into account the mitigat Students are able to apply methodolog Furthermore, they can evaluate energy able to design them under certain give manner, especially by means of non-sta	ies for determining energy demand or energy sup y systems technically, ecologically and economica n conditions. They are able to select the regulatio	The students can ex rgy systems and tak rgy systems. They a ludes the legal fram ply to different type ally as well as syste ns necessary for this	plain this knowled ee a critical stance lso have an overvi nework, which sho es of energy system emically and are a s in a subject-spec
Personal Competence				
Social Competence	The students are able to analyze suit criteria under sustainability aspects.	able technical alternatives and to assess them w	ith technical, econo	mical and ecologi
Autonomy	Students can independently exploit so questions.	urces , acquire the particular knowledge about th	ne subject area and	l transform it to r
Workload in Hours	Independent Study Time 96, Study Time	e in Lecture 84		
Credit points	6			
Course achievement	None			
Examination	Written exam			
Examination duration and	90 min			
scale				
Assignment for the	General Engineering Science (German	program, 7 semester): Specialisation Green Techno	logies: Compulsory	
Following Curricula	General Engineering Science (German	program, 7 semester): Specialisation Green Techno	logies: Compulsory	
-		-		

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

Course L2745: Fossil Energy	Course L2745: Fossil Energy Sources		
Тур	Lecture		
Hrs/wk	3		
CP	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	ourse L2746: Fossil Energy Sources		
Тур	Recitation Section (large)		
Hrs/wk	1		
CP	1		
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14		
Lecturer	Prof. Martin Kaltschmitt		
Language	DE		
Cycle	SoSe		
Content			
Literature			

Courses				
Title		Тур	Hrs/wk	СР
Renewable Energies I (L2740)		Lecture	2	2
Renewable Energies I (L2742)		Recitation Section (large)	1	1
Renewable Energies II (L2741)		Lecture	2	2
Renewable Energies II (L2743)		Recitation Section (large)	1	1
Module Responsible	Prof. Martin Kaltschmitt			
Admission Requirements	None			
<b>Recommended Previous</b>	none			
Knowledge				
Educational Objectives	After taking part successfully, students	have reached the following learning results		
Professional Competence				
Knowledge	Upon completion of this module, studer	nts will be able to provide an overview of characteri	stics of renewable e	energy systems. T
	will be able to explain the issues that	arise in these systems. Furthermore, they are able	to explain knowled	lae of eneray sup
	•	in this context, taking into account contexts borde		
		or such energy systems and take a critical stand of		
	1 5	5,7 ,7		, i
		ble energy systems and have an overview of the e	conomic classificat	tion of the respec
	options.			
Chille	Chudonto ano oble te engli methodolog	iss for determining energy demond or energy suppl	u to different turner	of renewable on
		ies for determining energy demand or energy suppl		
	systems. Furthermore, they can evaluate	ate such energy systems technically, ecologically a	nd economically as	well as systemic
	and also design them under certain giv	en conditions. They are able to select the regulation	is necessary for this	s in a subject-spe
	manner, especially by means of non-sta	andard solutions to a problem.		
	Students are able to orally explain issu	les from the subject area and approaches to dealir	g with them and to	classify them in
	respective context.			
Personal Competence				
-	Chudente en able te investigate avital			
	-	ole technical alternatives and ultimately evaluate t	hem based on tech	hnical, economic
	ecological criteria - and thus from a sus	stainability perspective.		
Autonomy	Students will be able to independently	access sources about the field, acquire knowledge a	nd transform it to a	address new issue
, accountly				
	Independent Study Time 96, Study Time	e in Lecture 84		
Credit points Course achievement	6 None			
	Written exam			
Examination duration and scale	90 min			
	General Engineering Science (German	program, 7 semester): Specialisation Green Technol	ogies: Compulsory	
	Sector Engineering Science (German)			
	Conoral Engineering Colones /Comment	program, 7 semester): Specialisation Green Technol		

Course L2740: Renewable En	Course 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	This module includes a presentation of the renewable energy supply and a discussion of the respective technologies for providing the desired final or useful energy. Specifically, this includes the options for solar energy use for heat and power generation (i.e., passive solar energy use, solar collectors for low-temperature heat provision, solar thermal power generation, photovoltaic power generation), wind energy use for power generation (i.e. onshore and offshore wind power use), hydroelectric power use for electricity generation (i.e., run-of-river and storage hydroelectric power), ocean energy use for electricity generation (including tidal power plants), and geothermal energy use for heat and electricity generation (i.e., near-surface use by means of heat pumps, deep geothermal energy use for heat and/or electricity generation).		
Literature	Kaltschmitt, M.; Streicher, W.; Wiese, A. (Hrsg.): Erneuerbare Energien - Systemtechnik, Wirtschaftlichkeit, Umweltaspekte; Springer, Berlin, Heidelberg, 2020, 6. Auflage		

Course L2742: Renewable Er	ergies I
Тур	Recitation Section (large)
Hrs/wk	1
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 En	ergies II
Тур	Lecture
Hrs/wk	2
СР	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Prof. Martin Kaltschmitt
Language	DE
Cycle	SoSe
Content	This lecture covers all options for energy supply from biomass; this includes the supply of heat, electricity and fuels. The biomass resource and its origin will be discussed first. Afterwards the biomass supply is addressed, which bridges the gap between biomass generation and utilization. Subsequently, the different conversion options are discussed. Only those options are presented in depth that have a corresponding significance on the market in Germany and Europe. This includes (a) heat generation from biogenic solid fuels in small and large-scale plants (b) power generation from solid biomass via combustion (c) a biogas production from residues, by-products and waste, (d) alcohol production from sugar and starch (e) biodiesel production from vegetable oils. Special attention is also paid to the corresponding environmental aspects. An economic classification of the various options is also provided.
Literature	

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

Courses				
Title		Тур	Hrs/wk	СР
Fundamentals of Fluid Mechanics (	_0091)	Lecture	2	4
Fluid Mechanics for Process Engine		Recitation Section (large)	2	2
Module Responsible				
Admission Requirements	None			
Recommended Previous	Mathematics I+II+III			
Knowledge	Technical Mechanics I+II			
	<ul> <li>Technical Thermodynamics I+II</li> </ul>			
	<ul> <li>Working with force balances</li> </ul>			
	<ul> <li>Simplification and solving of partial differential</li> </ul>	equations		
	Integration			
Educational Objectives	After taking part successfully, students have reached	the following learning results		
Professional Competence				
Knowledge	Students are able to:			
		- 6 6		
	<ul> <li>explain the difference between different types</li> <li>give an overview for different applications of the second secon</li></ul>		ss opginooring	
	<ul> <li>explain simplifications of the Continuity- and N</li> </ul>			ions
			Soundary contain	10115
Skills	The students are able to			
	<ul> <li>describe and model incompressible flows math</li> </ul>	ematically		
	<ul> <li>reduce the governing equations of fluid mecha</li> </ul>	nics by simplifications to archive quantit	tative solutions e	.g. by integration
	<ul> <li>notice the dependency between theory and teo</li> </ul>	hnical applications		
	<ul> <li>use the learned basics for fluid dynamical appli</li> </ul>	cations in fields of process engineering		
Personal Competence				
Social Competence	The students			
	<ul> <li>are capable to gather information from subject</li> </ul>	t related, professional publications and	relate that inforr	nation to the conte
	of the lecture and • able to work together on subject related tasks	in small groups. They are able to pres	ont their results	effectively in Engli
	(e.g. during small group exercises)	in small groups. They are able to pres	ent then results	enectively in Engli
	<ul> <li>are able to work out solutions for exercises by</li> </ul>	themselves, to discuss the solutions ora	lly and to presen	t the results.
Autonomy	The students are able to			
	<ul> <li>search further literature for each topic and to e</li> </ul>	xpand their knowledge with this literatu	ıre,	
	<ul> <li>work on their exercises by their own and to evaluate the evaluation of the evaluation of</li></ul>	aluate their actual knowledge with the fe	eedback.	
Workload in Hours	Independent Study Time 124, Study Time in Lecture 5	56		
Credit points				
Course achievement		scription		
	Yes 5 % Midterm			
Examination	Written exam			
Examination duration and	3 hours			
scale				
-	General Engineering Science (German program, 7 ser			
Following Curricula	General Engineering Science (German program, 7 ser			ory
	General Engineering Science (German program, 7 ser		ies: Compulsory	
	Bioprocess Engineering: Core Qualification: Compulso Energy and Environmental Engineering: Core Qualification			
	Green Technologies: Energy, Water, Climate: Core Quality			
	Logistics and Mobility: Specialisation Traffic Planning			
	Technomathematics: Specialisation III. Engineering So			
	Process Engineering: Core Qualification: Compulsory			
	Engineering and Management - Major in Logistics and	Mobility: Specialisation Traffic Planning	and Systems: El	ective Compulsory

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

Course L0092: Fluid Mechani	cs for Process Engineering
Тур	Recitation Section (large)
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Prof. Michael Schlüter
Language	DE
Cycle	SoSe
Content	In the exercise-lecture the topics from the main lecture are discussed intensively and transferred into application. For that, the students receive example tasks for download. The students solve these problems based on the lecture material either independently or in small groups. The solution is discussed with the students under scientific supervision and parts of the solutions are presented on the chalk board. At the end of each exercise-lecture, the correct solution is presented on the chalk board. Parallel to the exercise-lecture tutorials are held where the student solve exam questions under a set time-frame in small groups and discuss the solutions afterwards.
Literature	<ol> <li>Crowe, C. T.: Engineering fluid mechanics. Wiley, New York, 2009.</li> <li>Durst, F.: Strömungsmechanik: Einführung in die Theorie der Strömungen von Fluiden. Springer-Verlag, Berlin, Heidelberg, 2006.</li> <li>Fox, R.W.; et al.: Introduction to Fluid Mechanics. J. Wiley &amp; Sons, 1994</li> <li>Herwig, H.: Strömungsmechanik: Eine Einführung in die Physik und die mathematische Modellierung von Strömungen. Springer Verlag, Berlin, Heidelberg, New York, 2006</li> <li>Herwig, H.: Strömungsmechanik: Einführung in die Physik von technischen Strömungen: Vieweg+Teubner Verlag / GWV Fachverlage GmbH, Wiesbaden, 2008</li> <li>Kuhlmann, H.C.: Strömungsmechanik: Grundlagen, Grundgleichungen, Lösungsmethoden, Softwarebeispiele. Vieweg+ Teubner Verlag / GWV Fachverlage GmbH, Wiesbaden, 2009</li> <li>Schade, H.; Kunz, E.: Strömungslehre. Verlag de Gruyter, Berlin, New York, 2007</li> <li>Truckenbrodt, E.: Fluidmechanik 1: Grundlagen und elementare Strömungsvorgänge dichtebeständiger Fluide. Springer-Verlag, Berlin, Heidelberg, 2008</li> <li>Schlichting, H.: Grenzschicht-Theorie. Springer-Verlag, Berlin, 2006</li> <li>van Dyke, M.: An Album of Fluid Motion. The Parabolic Press, Stanford California, 1882.</li> <li>White, F.: Fluid Mechanics, Mcgraw-Hill, ISBN-10: 0071311211, ISBN-13: 978-0071311212, 2011</li> </ol>

Courses				
Title		Тур	Hrs/wk	СР
Wastewater Disposal (L0276)		Lecture	2	2
Wastewater Disposal (L0278)		Recitation Section (large)	1	1
Drinking Water Supply (L0306)		Lecture	2	1
Drinking Water Supply (L0308)		Recitation Section (large)	1	2
Module Responsible	Prof. Ralf Otterpohl			
Admission Requirements	None			
<b>Recommended Previous</b>	- Desis knowledge on Chemistry and Bislamy			
Knowledge	Basic knowledge on Chemistry and Biology			
	<ul> <li>Hydraulics of pipe systems and open channels</li> </ul>			
	<ul> <li>Basic knowledge on water management: water</li> </ul>	quantity and water quality		
	<ul> <li>Basic knowledge on Environmental Legislation:</li> </ul>	Federal Water Act		
Educational Objectives	After taking part successfully, students have reached	the following learning results		
Professional Competence				
Knowledge	The students can examplify their expert knowledge	on urban water infrastructures. They ca	n present the de	rivation and detail
	explanation of important standards for the design of	drinking water supply and wastewater d	isposal systems	in Germany and th
	are capable of reproducing the relevant empiricals as	sumptions and scientific simplifcations.	The students are	e able to present a
	discuss sanitary engineering processes and the tech			
	existing problems in the field of sanitary engineering			
	draft the features and effectiveness of important te		ind low-pressure	
	systems and techniques for the removal of trace pollu	itants.		
Skills	The students are able to apply the relevant standard	s and guidelines for the design and ope	eration of urban	water infrastructur
	independently. Their expertise comprises expert skills	s to design drinking water supply and u	ban drainage sy	stems as well as tl
	associated treatment facilities. Besides the acquirem			
	problems in the filed of drinking water and wastewa			
			ble to develop i	deas of their own
	improve the existing water related infrastructures, sy	stems 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 pr	ocesses. Therefo	ore they can acqui
	appropriate knowledge when being given some clue			
	follow-up of the exercises).			(preparation a
	Tonow-up of the exercises).			
	Independent Study Time 96, Study Time in Lecture 84	1		
Credit points Course achievement				
	Written exam			
Examination duration and				
scale	120 1111			
Assignment for the	General Engineering Science (German program, 7 ser	nester): Specialisation Civil Engineering:	Elective Compul	sory
	General Engineering Science (German program, 7 ser			
. ee.ning curricula	Civil- and Environmental Engineering: Core Qualificat		22. compaisory	
	Civil- and Environmental Engineering: Core Qualificat			
	General Engineering Science (English program, 7 sem		Elective Compuls	sory
	Green Technologies: Energy, Water, Climate: Core Qu	alification: Compulsory		

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

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

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

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

	n Technologies II			
Courses				
Title		Тур	Hrs/wk	СР
Practical Exercise Environmental Te	echnology (L1387)	Practical Course	1	1
Environmental Assessment (L0860)		Lecture	2	2
Environmental Assessment (L1054)		Recitation Section (small)	1	1
Environmental Technologie (L0326		Lecture	2	2
Module Responsible	Dr. Isabel Höfer			
Admission Requirements	None			
<b>Recommended Previous</b>	Fundamentals of inorganic/organic chemistr	y and biology.		
Knowledge				
Educational Objectives	After taking part successfully, students have	e reached the following learning results		
Professional Competence				
Knowledge	With the completion of this modul the stude	nts obtain profound knowledge of environment	al technology. They	are able to describ
	the behaviour of chemicals in the environm	ent. Students can give an overview of scientif	ic disciplines involv	ed. They can explai
	terms and allocate them to related methods			
	Additional students assuits in donth knowle	due of important course official chains of national	ial any disample and all s	wahlanaa which migh
		dge of important cause-effect chains of potent		
		r construction measures. They have knowledge		
		hods and instruments to assess environmenta		
	to estimate the complexity of these environ	mental processes as well as uncertainties and	difficulties with the	r measurement.
Skills	Students are able to propose appropriate	management and mitigation measures for en	vironmental proble	ms. They are able
	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 Env	ironmental Technology contributes to sustaina	ble development,	and they can prese
	and defend these opinons in front of and ag	ainst the group.		
		nethod for the respective case from the variet	-	-
		g and mitigating environmental problems in a		-
		ndently and can apply the software programs		
		ave the competence to critically judge res	earch results or c	ther publications of
	environmental impacts.			
Personal Competence				
Social Competence	The students are able to discuss the various	technical and scientific tasks, both subject-spe	ecific and multidisci	plinary. They are at
	to develop different approaches to the task	as a group as well as to discuss their theoretics	al or practical imple	ementation.
		ents receive insights into the multi-layered issu		
		and consciousness towards these subjects are	e raised and which	helps to raise the
	awareness of their future social responsibilit	ies in their role as engineers.		
Autonomy	The students learn to research, process a	nd present a scientific topic independently. T	hev are able to ca	arry out independer
		ental problem in a business context and are ab		
	·····		,	
Workload in Hours	Independent Study Time 96, Study Time in I	ecture 84		
Credit points	6			
Course achievement	None			
Examination	Written exam			
Examination duration and	120 min			
scale				
Assignment for the	General Engineering Science (German progr	am, 7 semester): Specialisation Green Technol	ogies: Compulsorv	
Following Curricula	Green Technologies: Energy, Water, Climate		5 · · · · · · · · · · · · · · · · · · ·	

Course L1387: Practical Exer	cise Environmental Technology
Тур	Practical Course
Hrs/wk	1
СР	1
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14
Lecturer	Prof. Martin Kaltschmitt, Dr. Isabel Höfer
Language	DE
Cycle	SoSe
Content	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	l 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: Environmenta	I Assessment
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, 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: Environmenta	al Technologie	
Тур	Lecture	
Hrs/wk		
CP		
Workload in Hours	ndependent Study Time 32, Study Time in Lecture 28	
Lecturer	rof. Martin Kaltschmitt, Dr. Isabel Höfer	
Language	DE	
Cycle	WiSe	
Content	<ol> <li>Introductory seminar on environmental science:</li> <li>Environmental impact and adverse effects</li> <li>Wastewater technology</li> <li>Air pollution control</li> <li>Noise protection</li> <li>Waste and recycling management</li> <li>Soil and ground water protection</li> <li>Renewable energies</li> <li>Resource conservation and energy efficiency</li> </ol>	
Literature	Förster, U.: Umweltschutztechnik; 2012; Springer Berlin (Verlag) 8., Aufl. 2012; 978-3-642-22972-5 (ISBN)	

C	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)	<u> </u>	Recitation Section (large)	1	2
Module Responsible				
Admission Requirements				
Recommended Previous	3	2S		
Knowledge				
Educational Objectives	After taking part successfully, students have	e reached the following learning results		
Professional Competence				
Knowledge		ng qualitative and determining quantitative heat t	ransfer in proce	dural annaratus (e
	heat exchanger, chemical reactors).	ig qualitative and determining qualititative heat t		
	-	characterize different kinds of heat transfer mecha	anisms namely h	heat conduction h
	transfer and thermal radiation.			
		xplain the physical basis for mass transfer in d	etail and to de	scribe mass tran
	qualitative and quantitative by using			
		between heat- and mass transfer and to describe c	omplex linked p	rocesses in detail.
			omprese milited p	
Skills				
		able system boundaries for a given transport pro	blem by using th	he gained knowle
	and to balance the corresponding end			
	<ul> <li>They are capable to solve specific here</li> </ul>	eat transfer problems (e.g. heated chemical react	tors, temperatur	e alteration in flu
	and to calculate the corresponding he	eat flows.		
	<ul> <li>Using dimensionless quantities, the s</li> </ul>	students can execute scaling up of technical proces	sses or apparatu	IS.
	<ul> <li>They are able to distinguish between</li> </ul>	n diffusion, convective mass transition and mass t	ransfer. They ca	n use this knowled
	for the description and design of app	aratus (e.g. extraction column, rectification column	n).	
	<ul> <li>In this context, the students are capa</li> </ul>	able to choose and design fundamental types of he	eat and mass exe	changer for a spec
	application considering their advanta	ges and disadvantages, respectively.		
	<ul> <li>In addition, they can calculate both, s</li> </ul>	steady-state and non-steady-state processes in pro	ocedural apparat	tus.
	The students are capable to conn	nect their knowledge obtained in this course w	vith knowlegde	of other courses
	particular the courses thermodynam	nics, fluid mechanics and chemical process engi	neering) to solv	ve concrete techn
	problems.			
Personal Competence				
Social Competence	,			
	<ul> <li>The students are capable to work on</li> </ul>			
		n subject-specific challenges in teams and to pres	ent the results o	orally in a reasona
	manner to tutors and other students.		ent the results o	orally in a reasona
	manner to tutors and other students.		ent the results o	orally in a reasona
	manner to tutors and other students.		ent the results o	orally in a reasona
			ent the results o	orally in a reasona
Autonomy				orally in a reasona
Autonomy	The students are able to find and eva	aluate necessary information from suitable sources		
Autonomy	<ul> <li>The students are able to find and eval</li> <li>They are able to prove their level of</li> </ul>	aluate necessary information from suitable sources of knowledge during the course with accompany	; ving procedure (	
Autonomy	<ul> <li>The students are able to find and eval</li> <li>They are able to prove their level of</li> </ul>	aluate necessary information from suitable sources	; ving procedure (	
Autonomy	<ul> <li>The students are able to find and eval</li> <li>They are able to prove their level of</li> </ul>	aluate necessary information from suitable sources of knowledge during the course with accompany	; ving procedure (	
	<ul> <li>The students are able to find and eva</li> <li>They are able to prove their level of system, exam-like assignments) and</li> </ul>	aluate necessary information from suitable sources of knowledge during the course with accompany on this basis they can control their learning proces	; ving procedure (	
Workload in Hours	<ul> <li>The students are able to find and eva</li> <li>They are able to prove their level of system, exam-like assignments) and</li> <li>Independent Study Time 124, Study Time in</li> </ul>	aluate necessary information from suitable sources of knowledge during the course with accompany on this basis they can control their learning proces	; ving procedure (	
Workload in Hours Credit points	<ul> <li>The students are able to find and eva</li> <li>They are able to prove their level of system, exam-like assignments) and</li> <li>Independent Study Time 124, Study Time in 6</li> </ul>	aluate necessary information from suitable sources of knowledge during the course with accompany on this basis they can control their learning proces	; ving procedure (	
Workload in Hours Credit points Course achievement	<ul> <li>The students are able to find and eva</li> <li>They are able to prove their level of system, exam-like assignments) and</li> <li>Independent Study Time 124, Study Time in</li> <li>6</li> <li>None</li> </ul>	aluate necessary information from suitable sources of knowledge during the course with accompany on this basis they can control their learning proces	; ving procedure (	
Workload in Hours Credit points Course achievement Examination	<ul> <li>The students are able to find and eva</li> <li>They are able to prove their level of system, exam-like assignments) and</li> <li>Independent Study Time 124, Study Time in</li> <li>6</li> <li>None</li> <li>Written exam</li> </ul>	aluate necessary information from suitable sources of knowledge during the course with accompany on this basis they can control their learning proces n Lecture 56	; ving procedure (	
Workload in Hours Credit points Course achievement Examination	<ul> <li>The students are able to find and eva</li> <li>They are able to prove their level of system, exam-like assignments) and</li> <li>Independent Study Time 124, Study Time in</li> <li>6</li> <li>None</li> </ul>	aluate necessary information from suitable sources of knowledge during the course with accompany on this basis they can control their learning proces n Lecture 56	; ving procedure (	
Workload in Hours Credit points Course achievement Examination	<ul> <li>The students are able to find and eva</li> <li>They are able to prove their level of system, exam-like assignments) and</li> <li>Independent Study Time 124, Study Time in</li> <li>6</li> <li>None</li> <li>Written exam</li> <li>120 minutes; theoretical questions and calc</li> </ul>	aluate necessary information from suitable sources of knowledge during the course with accompany on this basis they can control their learning proces n Lecture 56	; ving procedure (	
Workload in Hours Credit points Course achievement Examination Examination duration and	<ul> <li>The students are able to find and eva</li> <li>They are able to prove their level of system, exam-like assignments) and</li> <li>Independent Study Time 124, Study Time in</li> <li>6</li> <li>None</li> <li>Written exam</li> <li>120 minutes; theoretical questions and calc</li> </ul>	aluate necessary information from suitable sources of knowledge during the course with accompany on this basis they can control their learning proces n Lecture 56	; ving procedure d sses.	continuously (clici
Workload in Hours Credit points Course achievement Examination Examination duration and scale	<ul> <li>The students are able to find and eva</li> <li>They are able to prove their level of system, exam-like assignments) and</li> <li>Independent Study Time 124, Study Time in</li> <li>6</li> <li>None</li> <li>Written exam</li> <li>120 minutes; theoretical questions and calc</li> <li>General Engineering Science (German programment)</li> </ul>	aluate necessary information from suitable sources of knowledge during the course with accompany on this basis they can control their learning proces n Lecture 56	; ving procedure of sses. ng: Compulsory	continuously (clici
Workload in Hours Credit points Course achievement Examination Examination duration and scale Assignment for the	<ul> <li>The students are able to find and eva</li> <li>They are able to prove their level of system, exam-like assignments) and</li> <li>Independent Study Time 124, Study Time in</li> <li>6</li> <li>None</li> <li>Written exam</li> <li>120 minutes; theoretical questions and calc</li> <li>General Engineering Science (German prograge</li> <li>General Engineering Science (German prograge</li> </ul>	aluate necessary information from suitable sources of knowledge during the course with accompany on this basis they can control their learning proces in Lecture 56 :ulations ram, 7 semester): Specialisation Process Engineeri	; ving procedure of sses. ng: Compulsory eering: Compulsory	continuously (clici
Workload in Hours Credit points Course achievement Examination Examination duration and scale Assignment for the	<ul> <li>The students are able to find and eva</li> <li>They are able to prove their level of system, exam-like assignments) and</li> <li>Independent Study Time 124, Study Time in</li> <li>6</li> <li>None</li> <li>Written exam</li> <li>120 minutes; theoretical questions and calc</li> <li>General Engineering Science (German progragement)</li> <li>General Engineering Science (German progragement)</li> </ul>	aluate necessary information from suitable sources of knowledge during the course with accompany on this basis they can control their learning proces in Lecture 56 :ulations ram, 7 semester): Specialisation Process Engineeri ram, 7 semester): Specialisation Bioprocess Engine	; ving procedure of sses. ng: Compulsory eering: Compulsory eers: Compulsory	continuously (clici
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Workload in Hours Credit points Course achievement Examination Examination duration and scale Assignment for the	<ul> <li>The students are able to find and eva</li> <li>They are able to prove their level of system, exam-like assignments) and</li> <li>Independent Study Time 124, Study Time in</li> <li>6</li> <li>None</li> <li>Written exam</li> <li>120 minutes; theoretical questions and calc</li> <li>General Engineering Science (German progragemental Engineering Science (German programetal Engineering Science (German</li></ul>	aluate necessary information from suitable sources of knowledge during the course with accompany on this basis they can control their learning proces in Lecture 56 :ulations ram, 7 semester): Specialisation Process Engineeri ram, 7 semester): Specialisation Bioprocess Engine ram, 7 semester): Specialisation Green Technologi ram, 7 semester): Specialisation Green Technologi ram, 7 semester): Specialisation Energy and Enviro Compulsory	; ving procedure of sses. ng: Compulsory eering: Compulsory eering: Compulsory	continuously (clici
Workload in Hours Credit points Course achievement Examination Examination duration and scale Assignment for the	<ul> <li>The students are able to find and eva</li> <li>They are able to prove their level of system, exam-like assignments) and</li> <li>Independent Study Time 124, Study Time in 6</li> <li>None</li> <li>Written exam</li> <li>120 minutes; theoretical questions and calc</li> <li>General Engineering Science (German progragemental Engineering Science (German programe)</li> </ul>	aluate necessary information from suitable sources of knowledge during the course with accompany on this basis they can control their learning proces in Lecture 56 :ulations ram, 7 semester): Specialisation Process Engineeri ram, 7 semester): Specialisation Bioprocess Engine ram, 7 semester): Specialisation Green Technologi ram, 7 semester): Specialisation Energy and Enviro Compulsory re Qualification: Compulsory	; ving procedure of sses. ng: Compulsory eering: Compulsory eering: Compulsory pomental Enginee	continuously (clici
Workload in Hours Credit points Course achievement Examination Examination duration and scale Assignment for the	<ul> <li>The students are able to find and eva</li> <li>They are able to prove their level of system, exam-like assignments) and</li> <li>Independent Study Time 124, Study Time in 6</li> <li>None</li> <li>Written exam</li> <li>120 minutes; theoretical questions and calc</li> <li>General Engineering Science (German progrageneral Engineering Science (German programe)</li> </ul>	aluate necessary information from suitable sources of knowledge during the course with accompany on this basis they can control their learning proces in Lecture 56 ::ulations ram, 7 semester): Specialisation Process Engineeri ram, 7 semester): Specialisation Bioprocess Engine ram, 7 semester): Specialisation Green Technologi ram, 7 semester): Specialisation Energy and Enviro Compulsory re Qualification: Compulsory am, 7 semester): Specialisation Bioprocess Engine	; ving procedure of sses. ng: Compulsory eering: Compulsory pomental Enginee ering: Compulso	continuously (clici
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Workload in Hours Credit points Course achievement Examination Examination duration and scale Assignment for the	<ul> <li>The students are able to find and eva</li> <li>They are able to prove their level of system, exam-like assignments) and</li> <li>Independent Study Time 124, Study Time in</li> <li>6</li> <li>None</li> <li>Written exam</li> <li>120 minutes; theoretical questions and calc</li> <li>General Engineering Science (German progrageneral Engineering Science (English progrageneral Engine</li></ul>	aluate necessary information from suitable sources of knowledge during the course with accompany on this basis they can control their learning proces in Lecture 56 	; ving procedure of sses. ng: Compulsory eering: Compulsory pomental Engineer ering: Compulso mental Engineer	continuously (clici
Workload in Hours Credit points Course achievement Examination Examination duration and scale Assignment for the	<ul> <li>The students are able to find and eva</li> <li>They are able to prove their level of system, exam-like assignments) and</li> <li>Independent Study Time 124, Study Time in</li> <li>6</li> <li>None</li> <li>Written exam</li> <li>120 minutes; theoretical questions and calc</li> <li>General Engineering Science (German progrageneral Engineering Science (English progrageneral Engineering Science) (English progragenering Scien</li></ul>	aluate necessary information from suitable sources of knowledge during the course with accompany on this basis they can control their learning proces in Lecture 56 	; ving procedure of sses. ng: Compulsory eering: Compulsory pomental Engineer ering: Compulso mental Engineer	continuously (clici

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

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

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

## Focus Renewable Energy

Module M1713: Greer	n Technologies III			
Courses				
Title		Тур	Hrs/wk	СР
Study Work Green Technologies (L2	2766)	Project Seminar	2	4
Scientific Work and Writing (L2765)		Seminar	2	2
Module Responsible	Dozenten des Studiengangs			
Admission Requirements	None			
Recommended Previous	keine			
Knowledge				
Educational Objectives	After taking part successfully, students have read	hed the following learning results		
Professional Competence				
Knowledge	The students, based on a literature survey, learn	to study in detail a subject theme from	the disciplines of gre	een technologies ar
	deliver afterwards a summary presentation to a s	pecialised audience. Environmental issu	ues and their multidisc	ciplinary linkages ar
	preferred, when selecting the thematic area of th	ese studies. Through their own written o	contribution the stude	ents communicate a
	overview over the subject and practice technic	cal writing. With the discussion the st	udents practice scie	ntific debating on
	specialised subject matter.			
Chille	The shudded and the state of th			
SKIIIS	The students can, when working on a technical to	plic not familiar to them:		
	<ul> <li>conduct a literature survey</li> </ul>			
	choose the relevant information for their p	resentation		
	<ul> <li>prepare a written summary</li> </ul>			
	<ul> <li>present results in front of peers and staff</li> </ul>			
	<ul> <li>correctly cite and reference sources.</li> </ul>			
Personal Competence	-			
Social Competence	The students practice a critical assessment of th			
	their own technical sub-topic tailored to their pu		-	ai presentations, tr
	students can formulate questions to other speake	ers and participate in the ensuing discus	sion.	
	The fulfilment of the tasks combines independent	work with group and teamwork.		
Autonomy	The students can guided by instructors, critically	reflect on their learning and work statu	c and write a ccientif	ic roport
Autonomy	The students can, guided by instructors, critically	reflect on their learning and work statu	s, and write a scientin	ic report.
Workload in Hours	Independent Study Time 124, Study Time in Lect	ure 56		
Credit points	6			
Course achievement	None			
Examination	Study work			
Examination duration and	?			
scale				
Assignment for the	General Engineering Science (German program,	semester): Specialisation Green Techn	ologies, Focus Renew	able Energy: Electiv
Following Curricula	Compulsory			
	General Engineering Science (German program,	7 semester): Specialisation Green Tech	nologies, Focus Wateı	r and Environmenta
	Engineering: Elective Compulsory			
	Green Technologies: Energy, Water, Climate: Spe	cialisation Energy Technology: Elective	Compulsory	
	Green Technologies: Energy, Water, Climate: Spe	cialisation Water: Elective Compulsory		
	Green Technologies: Energy, Water, Climate: Spe	cialisation Energy Systems: Elective Cor	npulsory	
	Green Technologies: Energy, Water, Climate: Spe	cialisation Bioresource Technology: Elec	tive Compulsory	

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

Тур	Seminar
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
	Prof. Martin Kaltschmitt, Dr. Detlev Bieler, Florian Hagen
Language	
Cycle	
-	The seminar offers an introduction into the diverse aspects of academic research and writing: Finding the topic, finding speci information, knowledge organisation, writing, presenting and publishing. Suggestions for reflecting own processes of lea informing and writing - in addition to practical recommendations and tips - facilitate the start and the creation of bachelor 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?</li> </ul>
	<ul> <li>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/su 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: http://tinyurl.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 n installiertem Flash)</li> <li>Andreas Hirsch-Weber, Stefan Scherer: Wissenschaftliches Arbeiten und Abschlussarbeit in Natur-Ingenieurwissenschaften : Grundlagen, Praxisbeispiele, Übungen. Stuttgart: Ulmer, 2016.</li> <li>Werner Sesink: Einführung in das wissenschaftliche Arbeiten : inklusive E-Learning, Web-Recherche, digitale Präser</li> </ol>
	<ul> <li>u.a. 9., aktualisierte Aufl. München : Oldenbourg, 2012.</li> <li>6. Judith Theuerkauf: Schreiben im Ingenieurstudium : effektiv und effizient zur Bachelor-, Master- und Doktor. Paderborn : Schöningh, 2012.</li> <li>7. Wolfsberger, Judith: Frei geschrieben : Mut, Freiheit &amp; Strategie für wissenschaftliche Abschlussarbeiten. Wien: Böhlau</li> <li>8. Biedermann, Wieland u.a.: Forschungsmethodik in den Ingenieurwissenschaften : Skript vom Lehrste Produktentwicklung, Prof. DrIng. Udo Lindemann, Technische Universität München (TUM), https://www.mw.tum.de/fileadmin/w00btx/lpl/Documents/Forschungsmethodik_Skript.pdf</li> <li>9. Wissenschaftliches Arbeiten - HOOU Angebot der HCU Hamburg: https://blogs.hoou.de/wissarbeiten/</li> </ul>
	<ol> <li>Course Reserves Collection "Scholarly Research Methods" in the TUHH library: http://tinyurl.com/Semesterapparat 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, http://www.sciencedirect.com/science/book/9780123847270</li> <li>Writing for science and engineering : papers, presentations and reports / Heather Silyn-Roberts. 2nd ed. Amsterd Elsevier, 2013. http://www.sciencedirect.com/science/book/9780080982854</li> <li>How to research / Loraine Blaxter, Christina Hughes and Malcolm Tight. Maidenhead : Open Univ. Press, 2010.</li> <li>Managing information for research : practical help in researching, writing and designing dissertations / Elizabeth Orr Graham Stevens. Maidenhead : Open University Press McGraw-Hill, 2009.</li> <li>Writing scientific research articles : strategy and steps / Margaret Cargill and Patrick O'Connor. Chichester : Wiley-Blac</li> </ol>

Courses					
Courses			<b>T</b>	Line (order	<u></u>
Fitle Gas and Steam Power Plants (L020	5)		<b>Typ</b> Lecture	Hrs/wk 3	<b>CP</b> 5
Gas and Steam Power Plants (L020)			Recitation Section (large)	1	1
Module Responsible		her			
Admission Requirements					
Recommended Previous	None				
Knowledge	<ul> <li>"Technical The</li> </ul>	ermodynamics I and II"			
	<ul> <li>"Heat Transfer</li> </ul>				
	<ul> <li>"Fluid Mechanic</li> </ul>	ics"			
Educational Objectives	After taking part succ	cessfully, students hav	e reached the following learning results		
Professional Competence					
-	The students can ev	aluate the developme	ent of the electricity demand and the energy co	onversion routes i	in the thermal pow
	plant, describe the v	arious types of power	plant and the layout of the steam generator bloc	k. They are also a	able to determine t
	operation characteri	stics of the power p	lant. Additionally they can describe the exha	ust gas cleaning	apparatus and t
	combination possibil	ities of conventional f	ossil-fuelled power plants with solar thermal a	nd geothermal po	ower plants or plan
	equipped with Carbo	n Capture and Storage			
	The students have ba	asic knowledge about t	he principles, operation and design of turbomach	ninerv	
		-		-	
Skills			and methods of the energy technology from f		
			n of gas and steam power plants, to identify basic		
	-		al solutions. Through analysis of the problem a		
			tudents are endowed with the capability and me nd the production of heat. From the technical ba		
			ricity mix composition within the energy-political		
	environmental protec			enangie (econori	iji secure supply u
		<b>/</b>			
			udents learn the use of the specialised software		
	tool small practical ta	asks are solved with th	e PC, to highlight aspects of the design and deve	lopment of power	plant cycles.
	The students are abl	e to do simplified calc	ulations on turbomachinery either as part of a	plant, as single co	omponent or at sta
	level.				
Demonstration of the second					
Personal Competence			shure is planned for shudents that are interested	The students set	in this manner div
Social Competence			ecture is planned for students that are interested. region. The students will obtain first-hand expe	-	
			technical and political issues.	nence with a pov	
Autonomy			able to develop alone simple simulation models a	nd run with these	scenario analyses.
			knowledge from the lecture is consolidated ar		,
	process combination	s and boundary cond	litions highlighted. The students are able inde	pendently to ana	alyse the operation
	performance of stear	n power plants and cal	culate selected quantities and characteristic curv	/es.	
Workload in Hours	Independent Study T	ime 124, Study Time ir	a Lecture 56		
Credit points					
Course achievement	Compulsory Bonus	Form	Description		
course acmevement	No 5%	Attestation	15-minütiges, unbenotetes Testat	über EBSILON	Professional; n
			bestanden/nicht bestanden (keine anteili	igen Punkte)	
	No 5 %	Excercises	10 Übungsaufgaben im Laufe der Vorles	ungen à 5 Minuter	n; bis zu 5 % Bonus
			nach Anteil richtiger Abgaben		
Examination	Written exam				
Examination duration and	Written examination	of 120 min			
scale					
÷		Science (German prog	ram, 7 semester): Specialisation Green Technolo	gies, Focus Renev	vable Energy: Elect
Following Curricula					
			re Qualification: Elective Compulsory		
			Course Core Studies: Elective Compulsory	Engineering F	The Energy Custor
General Engineering Science (English program, 7 semester): Specialisation Mechanical Engineering, Focus Energy Elective Compulsory				Lus Energy Syster	
	Green Technologies: Energy, Water, Climate: Specialisation Energy Systems: Elective Compulsory				
			e: Specialisation Energy Technology: Elective Compl e: Specialisation Energy Technology: Elective Cor		
				· - · - · J	

Course L0206: Gas and Stea	m Power Plants			
Тур	Lecture			
Hrs/wk	3			
CP	5			
Workload in Hours	Independent Study Time 108, Study Time in Lecture 42			
Lecturer	Dr. Kristin Abel-Günther			
Language	DE			
Cycle	WiSe			
Content	In the 1 <sup>st</sup> 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			
	<ul> <li>Layout of the power plant block</li> <li>Individual elements of the power plant</li> </ul>			
	Cooling systems			
	Flue gas cleaning			
	Operation characteristics of the power plant			
	<ul> <li>Construction materials for power plants</li> <li>Location of power plants</li> </ul>			
	<ul> <li>Solar thermal plants/geothermal plants/Carbon Capture and Storage plants.</li> </ul>			
	These are complemented in the 2 <sup>nd</sup> 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			
	<ul> <li>Design examples of reciprocating engines and turbomachinery</li> </ul>			
	Steam power plants			
	Gas turbine systems.			
Literature	Kalide: Kraft- und Arbeitsmaschinen			
	Thomas, H.J.: Thermische Kraftanlagen. Springer-Verlag, 1985			
	Strauß, K.: Kraftwerkstechnik. Springer-Verlag, 2006			
	Kugeler und Phlippen: Energietechnik. Springer-Verlag, 1990			
	• Bohn, T. (Hrsg.): Handbuchreihe Energie, Band 7: Gasturbinenkraftwerke, Kombikraftwerke, Heizkraftwerke und			
	Industriekraftwerke, Technischer Verlag Resch / Verlag TÜV Rheinland			

ourse L0210: Gas and Stear	n Power Plants
Тур	Recitation Section (large)
Hrs/wk	
CP	
	- Independent Study Time 16, Study Time in Lecture 14
	Dr. Kristin Abel-Günther
Language	
Cycle	
Content	In the 1 <sup>st</sup> part of the lecture a general introduction into fluid-flow machines and steam power plants is offered, including:
	Energy balance of a fluid-flow machine
	Theory of turbine and compressor stage
	Equal and positive pressure blading
	Flow losses
	Characteristic numbers
	Axial and radial design
	Design features
	Hydraulic fluid-flow machines
	Pump and water turbine designs
	Design examples of reciprocating engines and turbomachinery
	Steam power plants
	Gas turbine systems
	Diesel engine systems
	Waste heat utilisation
	followed by the more specialised issues:
	Electricity Demand and Forecasting
	Thermodynamic fundamentals
	Energy Conversion in Thermal Power Plants
	Types of Power Plant
	Layout of the power plant block
	Individual elements of the power plant
	Cooling systems
	Flue gas cleaning
	Operation characteristics of the power plant
	Construction materials
	Location of power plants
	The environmental impact of acidification, fine particulate or $CO_2$ emissions and the resulting climatic effects are a special focus
	the lecture and the lecture hall exercise. The challenges in plant operation from interconnecting conventional power plants a renewable energy sources are discussed and the technical options for providing security of supply and network stability presented, also under consideration of cost effectiveness. In this critical review, focus is especially placed on the compatibility the different solutions with the environment and climate. With this, the awareness for the responsibility of an engineer's o actions are emphasized and the potential extent of the different solutions presented clearly.
	Within the framework of the exercise the students learn the use of the specialised software suite EBSILON Professional <sup>TM</sup> . With tool small tasks are solved on the PC, to highlight aspects of the design and development of power plant cycles. The stude present their results orally and can afterwards ask questions and get feedback. The course work has a positive effect on 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 u Industriekraftwerke, Technischer Verlag Resch / Verlag TÜV Rheinland</li> </ul>

Courses				
Title		Тур	Hrs/wk	СР
Thermal Separation Processes (L01		Lecture	2	2
Thermal Separation Processes (L01		Recitation Section (small) Recitation Section (large)	2	2 1
Thermal Separation Processes (L01 Separation Processes (L1159)	+1)	Practical Course	1	1
Module Responsible	Prof. Irina Smirnova			
Admission Requirements	None			
<b>Recommended Previous</b>	Recommended requirements: Thermodynamics III			
Knowledge				
Educational Objectives	After taking part successfully, students have reached	the following learning results		
Professional Competence				
Knowledge	• The students can distinguish and describe of			
	<ul> <li>adsorption</li> <li>The students develop an understanding for th energy demand of a process, the possibilities of They have good knowledge of designing meth</li> </ul>	e course of concentration during a sep of energy saving, and the selection of s	paration process, t eparation systems	he estimation of t
Skills	<ul> <li>Using the gained knowledge the students can close the associated energy and material bala</li> </ul>		or a given separa	tion process and c
	<ul> <li>The students can use different graphical me theoretical stages required</li> <li>They can select and design a basic type of</li> </ul>			
	<ul><li>disadvantages of the process</li><li>The students are capable to obtain independent to the students</li></ul>	ently the needed material properties fr	om appropriate so	urces (diagrams a
	tables) <ul> <li>They can calculate continuous and discontinuous</li> </ul>	us processes		
	<ul> <li>The students are able to prove their theoretica</li> <li>The students are able to discuss the theoretic colloquium.</li> </ul>	I knowledge in the experimental lab wo		with the teachers
	The students are capable of linking their gained know technical problems. Other lectures such as thermody		-	ner for the solution
Personal Competence Social Competence			ed results in the t	utorial
	<ul> <li>The students are able to carry out practical l them. They are able to discuss their results an</li> </ul>			on of labor betwe
Autonomy	<ul> <li>The students are capable to obtain the needed information from suitable sources by themselves and assess their quality</li> <li>The students can proof the state of their knowledge with exam resembling assignments and in this way control t learning process</li> </ul>			
Workload in Hours	Independent Study Time 96, Study Time in Lecture 8	4		
Credit points				
Course achievement	None			
Examination				
scale	120 minutes; theoretical questions and calculations			
Assignment for the Following Curricula	General Engineering Science (German program, 7 se General Engineering Science (German program, 7 se			)r)/
Following Curricula	General Engineering Science (German program, 7 se General Engineering Science (German program, 7 se		÷ ,	•
	Compulsory	nester). Specialisation Green recimilio	gies, rocus nenew	uble Energy. Elect
	General Engineering Science (German program, 7 Compulsory	semester): Specialisation Green Tec	hnologies, Focus	Renewable Energ
	General Engineering Science (German program, 7 se Bioprocess Engineering: Core Qualification: Compuls Energy and Environmental Engineering: Core Qualific	pry	romental Enginee	ring: Compulsory
	General Engineering Science (English program, 7 sen General Engineering Science (English program, 7 sen General Engineering Science (English program, 7 sen	nester): Specialisation Energy and Envir nester): Specialisation Process Engineer	romental Engineer ring: Compulsory	
	Green Technologies: Energy, Water, Climate: Special Green Technologies: Energy, Water, Climate: Special		-	

Process Engineering: Core Qualification: Compulsory

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Course L0118: Thermal Sepa	iration 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
	WiSe
Content	
Literature	<ul> <li>G. Brunner: Skriptum Thermische Verfahrenstechnik</li> <li>J. King: Separation Processes, McGraw-Hill, 2. Aufl. 1980</li> <li>Sattler: Thermische Trennverfahren, VCH, Weinheim 1995</li> <li>J.D. Seader, E.J. Henley: Separation Process Principles, Wiley, New York, 1998.</li> <li>Mersmann: Thermische Verfahrenstechnik, Springer, 1980</li> <li>Grassmann, Widmer, Sinn: Einführung in die Thermische Verfahrenstechnik, 3. Aufl., Walter de Gruyter, Berlin 1997</li> <li>Brunner, G.: Gas extraction. An introduction to fundamentals of supercritical fluids and the application to 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	<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 processes</li> <li>Advance overview of separation processes</li> <li>Selection of separation processes</li> </ul>
Literature	<ul> <li>The students work on tasks in small groups and present their results in front of all students.</li> <li>G. Brunner: Skriptum Thermische Verfahrenstechnik</li> <li>J. King: Separation Processes, McGraw-Hill, 2. Aufl. 1980</li> <li>Sattler: Thermische Trennverfahren, VCH, Weinheim 1995</li> <li>J.D. Seader, E.J. Henley: Separation Process Principles, Wiley, New York, 1998.</li> <li>Mersmann: Thermische Verfahrenstechnik, Springer, 1980</li> <li>Grassmann, Widmer, Sinn: Einführung in die Thermische Verfahrenstechnik, 3. Aufl., Walter de Gruyter, Berlin 1997</li> <li>Brunner, G.: Gas extraction. An introduction to fundamentals of supercritical fluids and the application to separatio processes. Steinkopff, Darmstadt; Springer, New York; 1994. ISBN 3-7985-0944-1; ISBN 0-387-91477-3.</li> <li>R. Goedecke (Hrsg.): Fluid-Verfahrenstechnik, Wiley-VCH Verlag, Weinheim, 2006.</li> <li>Perry"s Chemical Engineers" Handbook, R.H. Perry, D.W. Green, J.O. Maloney (Hrsg.), 6th ed., McGraw-Hill, New York 1984 Ullmann"s Enzyklopädie der Technischen Chemie</li> </ul>

ourse L0141: Thermal Sepa	
Тур	Recitation Section (large)
Hrs/wk	
СР	1
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14
Lecturer	Prof. Irina Smirnova
Language	DE
Cycle	WiSe
Content	<ul> <li>Introduction in the thermal process engineering and to the main features of separation processes</li> <li>Simple equilibrium processes, several steps processes</li> <li>Distillation of binary mixtures, enthalpy-concentration diagrams</li> <li>Extractive and azeotrope distillation, water vapor distillation, stepwise distillation</li> <li>Extraction: separation ternary systems, ternary diagram</li> <li>Multiphase separation including complex mixtures</li> <li>Designing of separation devices without discrete stages</li> <li>Drying</li> <li>Chromatographic separation processes</li> <li>Membrane separation</li> <li>Energy demand of separation processes</li> <li>Advance overview of separation processes</li> <li>Selection of separation processes</li> </ul>
Literature	<ul> <li>G. Brunner: Skriptum Thermische Verfahrenstechnik</li> <li>J. King: Separation Processes, McGraw-Hill, 2. Aufl. 1980</li> <li>Sattler: Thermische Trennverfahren, VCH, Weinheim 1995</li> <li>J.D. Seader, E.J. Henley: Separation Process Principles, Wiley, New York, 1998.</li> <li>Mersmann: Thermische Verfahrenstechnik, Springer, 1980</li> <li>Grassmann, Widmer, Sinn: Einführung in die Thermische Verfahrenstechnik, 3. Aufl., Walter de Gruyter, Berlin 1997</li> <li>Brunner, G.: Gas extraction. An introduction to fundamentals of supercritical fluids and the application to separation processes. Steinkopff, Darmstadt; Springer, New York; 1994. ISBN 3-7985-0944-1; ISBN 0-387-91477-3.</li> <li>R. Goedecke (Hrsg.): Fluid-Verfahrenstechnik, Wiley-VCH Verlag, Weinheim, 2006.</li> <li>Perry"s Chemical Engineers" Handbook, R.H. Perry, D.W. Green, J.O. Maloney (Hrsg.), 6th ed., McGraw-Hill, New York 198 Ullmann"s Enzyklopädie der Technischen Chemie</li> </ul>

se L1159: Separation Pr	Practical Course
Hrs/wk	
СР	
	Independent Study Time 16, Study Time in Lecture 14
	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 colloquiu takes place in which the students explain and discuss the theoretical background and its translation into practice with staff ar fellow students. The students work small groups with a high degree of division of labor. For every experiment, the students write a report. The
	receive instructions in terms of scientific writing as well as feedback on their own reports and level of scientific writing so they ca increase their capabilities in this area.
	<ul> <li>Topics of the practical course:</li> <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 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 separatio processes. Steinkopff, Darmstadt; Springer, New York; 1994. ISBN 3-7985-0944-1; ISBN 0-387-91477-3.</li> <li>R. Goedecke (Hrsg.): Fluid-Verfahrenstechnik, Wiley-VCH Verlag, Weinheim, 2006.</li> <li>Perry"s Chemical Engineers" Handbook, R.H. Perry, D.W. Green, J.O. Maloney (Hrsg.), 6th ed., McGraw-Hill, New York 198 Ullmann"s Enzyklopädie der Technischen Chemie</li> </ul>

Courses				
Title		Тур	Hrs/wk	СР
System Integration Renewable Ene		Lecture	2	2
System Integration Renewable Ene		Recitation Section (small)	1	1
System Integration Renewable Energy		Lecture Recitation Section (small)	2 1	2
System Integration Renewable Ene		Recitation Section (Smail)	1	I
Admission Requirements	Prof. Martin Kaltschmitt			
	Fundamentals of renewable energies and th	o oporau curtom		
Knowledge	Fundamentals of renewable energies and th	e energy system		
	After taking part successfully, students have reached the following learning results			
Professional Competence	Arter taking part successivity, students nave	reaction and to to to the to to to the to to to the to		
	With the completion of the module the students are able to use and apply the previously learned technical basics of the differ fields of renewable energies. Current problems concerning the integration of renewable energies in the energy system presented and analyzed. In particular, the sectors electricity, heat and mobility will be addressed, giving students insights sector coupling activities.			
Skills	By completing this module, students can apply the basics learned to various sector coupling problems and, in this context, asse the potentials as well as the limits of sector coupling in the German energy system. In particular, the students should use t application and linking of already learned methods and knowledge here, so that a vision of the different technologies is achieved			
Personal Competence				
Social Competence	The students will be able to discuss problem	is in the areas of sector coupling and the integrat	ion of renewable	energies.
Autonomy	The students are able to acquire own sources based on the main topics of the lecture and to increase their knowledg 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 I	Lecture 84		
Credit points	6			
Course achievement	None			
Examination	Written exam			
Examination duration and	120 min			
scale				
Assignment for the	General Engineering Science (German progr	am, 7 semester): Specialisation Green Technolog	ies, Focus Renew	able Energy: Elect
Following Curricula	Compulsory			
	Green Technologies: Energy, Water, Climate	. Consideration Energy Cystome, Elective Commu		

Course L2767: System Integ	ration Renewable Energies I
Тур	Lecture
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Prof. Martin Kaltschmitt
Language	DE
Cycle	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 I</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 - heat II</li> <li>Characteristics of renewable energy provision technologies - mobility</li> <li>Integration of renewables - heat II</li> <li>Characteristics of renewable energy provision technologies - mobility</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>

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

Тур	Lecture		
Hrs/wk	2		
CP	2		
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28		
Lecturer	Prof. Martin Kaltschmitt		
Language	DE		
Cycle	SoSe		
Content	<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 Stuttgar 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>		

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

Module M1235: Electrical Power Systems I: Introduction to Electrical Power Systems						
Courses						
Title		Тур	Hrs/wk	СР		
-	ction to Electrical Power Systems (L1670)	Lecture	3	4		
	ction to Electrical Power Systems (L1671)	Recitation Section (small)	2	2		
Module Responsible						
Admission Requirements	None					
Recommended Previous	Fundamentals of Electrical Engineering					
Knowledge						
Educational Objectives	After taking part successfully, students have read	ched the following learning results				
Professional Competence						
Knowledge	Students are able to give an overview of conventional and modern electric power systems. They can explain in detail and critica					
	evaluate technologies of electric power generation	on, transmission, storage, and distribution	as well as integrat	ion of equipment int		
	electric power systems.					
Skills	With completion of this module the students a	are able to apply the acquired skills in	applications of the	e design, integration		
	development of electric power systems and to assess the results.					
Personal Competence						
Social Competence	The students can participate in specialized and in	iterdisciplinary discussions, advance ideas	and represent the	ir own work results i		
	front of others.					
Autonomy	Students can independently tap knowledge of the	e emphasis of the lectures.				
Workload in Hours	Independent Study Time 110, Study Time in Lect	ure 70				
Credit points	6					
Course achievement	None					
Examination	Written exam					
Examination duration and	90 - 150 minutes					
scale						
Assignment for the	General Engineering Science (German program,	7 semester): Specialisation Electrical Engi	neering: Elective Co	ompulsory		
Following Curricula	General Engineering Science (German program, 7 semester): Specialisation Green Technologies, Focus Renewable Energy: Electiv					
	Compulsory					
	Data Science: Core Qualification: Elective Compulsory					
	Electrical Engineering: Core Qualification: Elective Compulsory					
	Energy and Environmental Engineering: Specialisation Energy Engineering: Elective Compulsory					
	Energy Systems: Specialisation Energy Systems: Elective Compulsory					
	General Engineering Science (English program, 7 semester): Specialisation Electrical Engineering: Elective Compulsory					
	Green Technologies: Energy, Water, Climate: Spe		-			
	Computational Science and Engineering: Speciali		nce: Elective Comp	ulsory		
	Renewable Energies: Core Qualification: Compute	•				
	Theoretical Mechanical Engineering: Technical Co		У			
	Theoretical Mechanical Engineering: Specialisatic	n Energy Systems: Elective Compulsory				

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

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

Courses						
Title				Tur	Hrs/wk	<b>CD</b>
Computer Science for Engineers - F	Programming Concepts, (	Data Handling & Communication	(L2689)	<b>Typ</b> Lecture	Hrs/wk 3	<b>СР</b> 3
Computer Science for Engineers - P				Recitation Section (small)	2	3
Module Responsible	Prof. Sibylle Fröschle					
Admission Requirements						
Recommended Previous						
Knowledge						
Educational Objectives	After taking part succ	essfully, students have reache	ed the followi	ng learning results		
Professional Competence						
Knowledge	1					
Skills						
Demonstration of the second						
Personal Competence						
Social Competence Autonomy						
Workload in Hours		me 110, Study Time in Lectur	0.70			
Credit points		The 110, Study Time in Lectur	e 70			
Course achievement		Form	Description			
course achievement	No 10 %	Attestation		en semesterbegleitend statt.		
Examination	Written exam					
Examination duration and	120 min					
scale						
Assignment for the	General Engineering	Science (German program,	7 semeste	r): Specialisation Mechanica	I Engineering, F	ocus Biomechani
Following Curricula	Compulsory					
	General Engineering	Science (German program, 7 s	emester): Sp	ecialisation Process Engineer	ing: Compulsory	
	General Engineering	Science (German program, 7 s	emester): Sp	ecialisation Biomedical Engin	eerina: Compulso	prv
		Science (German program, 7 s				
	Compulsory	Science (German program, 7 a	semester). Sp	ecialisation oreen recimolog	ies, rocus nenew	able Energy. Elect
		Science (German program,	7 comostor)	Specialisation Mechanical	Engineering Foc	us Energy System
	Compulsory	Science (German program,	/ semester).		Lingineering, Too	us Lifergy Syster
		Science (German program,	7 semester)	: Specialisation Mechanical	Engineering, Foo	us Aircraft Syste
	Engineering: Compuls					-
	General Engineering	Science (German program	, 7 semeste	er): Specialisation Mechanic	al Engineering,	Focus Materials
	Engineering Sciences	: Compulsory				
	General Engineering	Science (German program,	7 semeste	r): Specialisation Mechanica	al Engineering, I	ocus Mechatroni
	Compulsory					
	General Engineering	Science (German program, 7 s	semester): Sp	pecialisation Mechanical Engi	neering, Focus Th	eoretical Mechani
	Engineering: Compuls	sory				
	General Engineering	Science (German program, 7	semester): S	pecialisation Mechanical Eng	ineering, Focus F	roduct Developm
	and Production: Elect					
		Science (German program, 7 s				
		Science (German program, 7 s	semester): Sp	ecialisation Green Technolog	ies, Focus Renew	able Energy: Elect
	Compulsory					
	Bioprocess Engineerin	ng: Core Qualification: Compu				
	Electrical Excitor environments	Come Que lification Comenda				
		: Core Qualification: Compulse	•	pulcon		
	Energy and Environm	ental Engineering: Core Quali	fication: Com		ng: Elective Com	
	Energy and Environm General Engineering	ental Engineering: Core Quali Science (English program, 7 se	fication: Com emester): Spe	ecialisation Process Engineeri		
	Energy and Environm General Engineering General Engineering	ental Engineering: Core Quali	fication: Com emester): Spe	ecialisation Process Engineeri		
	Energy and Environm General Engineering General Engineering Compulsory	ental Engineering: Core Quali Science (English program, 7 sc Science (English program,	fication: Com emester): Spe 7 semester)	ecialisation Process Engineeri : Specialisation Energy and	Enviromental E	
	Energy and Environm General Engineering General Engineering Compulsory Green Technologies:	ental Engineering: Core Quali Science (English program, 7 se	fication: Com emester): Spe 7 semester) alisation Ener	ecialisation Process Engineeri : Specialisation Energy and	Enviromental E	
	Energy and Environm General Engineering General Engineering Compulsory Green Technologies: Logistics and Mobility	ental Engineering: Core Quali Science (English program, 7 sc Science (English program, Energy, Water, Climate: Speci	emester): Spe 7 semester) alisation Ener pry	ecialisation Process Engineeri : Specialisation Energy and rgy Systems: Elective Compu	Enviromental E	
	Energy and Environm General Engineering General Engineering Compulsory Green Technologies: Logistics and Mobility Logistics and Mobility	ental Engineering: Core Quali Science (English program, 7 sc Science (English program, Energy, Water, Climate: Speci : Core Qualification: Compulso	emester): Spe 7 semester) alisation Ener pry	ecialisation Process Engineeri : Specialisation Energy and rgy Systems: Elective Compu	Enviromental E	
	Energy and Environm General Engineering Compulsory Green Technologies: Logistics and Mobility Logistics and Mobility Mechatronics: Core Q	ental Engineering: Core Qualit Science (English program, 7 sc Science (English program, Energy, Water, Climate: Speci :: Core Qualification: Compulso :: Specialisation Information Te	fication: Com emester): Spe 7 semester) alisation Ener ory echnology: Co	ecialisation Process Engineeri : Specialisation Energy and rgy Systems: Elective Compu	Enviromental E	

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

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

Courses				
Title		Тур	Hrs/wk	СР
Metereology of climate change (L2749)		Lecture	2	2
Technical measures to mitigate climate change (L2747)		Lecture	2	2
Technical measures to mitigate cli	mate change (L2748)	Recitation Section (small)	2	2
Module Responsible	Prof. Martin Kaltschmitt			
Admission Requirements	None			
<b>Recommended Previous</b>	none			
Knowledge				
Educational Objectives	After taking part successfully, students have re	eached the following learning results		
Professional Competence				
Knowledge				
Skills				
Personal Competence				
Social Competence				
Autonomy				
Workload in Hours	Independent Study Time 96, Study Time in Leo	ture 84		
Credit points	6			
Course achievement	None			
Examination	Written exam			
Examination duration and				
scale				
Assignment for the	General Engineering Science (German program	n, 7 semester): Specialisation Green Technologi	ies, Focus Renew	able Energy: Elect
Following Curricula	Compulsory			
	Green Technologies: Energy, Water, Climate: S	Proceeding Energy Systems: Elective Comput	500/	

Course L2749: Metereology	of climate change
Тур	Lecture
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
	Prof. Martin Kaltschmitt, Prof. Dr. Jana Sillmann
Language	
Cycle Content	Course Content:
	This course provides a comprehensive introduction to the fundamentals of human-induced climate change. Important concepts such as the Earth's radiation budget, the greenhouse effect, and the various Earth system components (e.g., atmosphere, hydrosphere, cryosphere, biosphere) related to climate change are explained. Fundamentals of climate modeling and climate scenarios are explained. Findings from the Intergovernmental Panel on Climate Change's Assessment Reports are provided in relation to observed and model-based physical climate changes and their impacts on various Earth system components. Furthermore, the impacts of global and regional climate change on society (e.g. agriculture, infrastructure, energy) will be highlighted and especially the changes and impacts of weather and climate extremes will be discussed. In the last part of the lecture, current global and national climate change targets will be explained and discussed in the context of possible scenarios, options and challenges to reduce global warming. Concepts such as "net-zero" emissions and negative emissions will be addressed with important implications for the development of new technologies. Learning Objective: Basic knowledge of human-induced climate change, and how to model climate change, and its impacts on different sectors of the environment and society, and the options and consequences for different sectors to achieve the targeted climate goals (reduction of global warming).
	Structure:
	Introduction Climate Change/Climate Change Reports.
	The climate system
	Observed climate change
	Climate variability
	Climate models
	Climate scenarios
	Physical climate changes under different scenarios
	Impacts of climate change on different regions and sectors
	Weather and climate extremes
	Climate risk and adaptation
	Scenarios, options and challenges to reduce global warming

## Climate Engineering

Sustainability and climate change

Climate quiz and discussion

# Course Content:

This course provides a comprehensive introduction to the fundamentals of human-induced climate change. Important concepts such as the Earth's radiation budget, the greenhouse effect, and the various Earth system components (e.g., atmosphere, hydrosphere, cryosphere, biosphere) related to climate change are explained. Fundamentals of climate modeling and climate scenarios are explained. Findings from the Intergovernmental Panel on Climate Change's Assessment Reports are provided in relation to observed and model-based physical climate changes and their impacts on various Earth system components. Furthermore, the impacts of global and regional climate change on society (e.g. agriculture, infrastructure, energy) will be highlighted and especially the changes and impacts of weather and climate extremes will be discussed. In the last part of the lecture, current global and national climate change targets will be explained and discussed in the context of possible scenarios, options and challenges to reduce global warming. Concepts such as "net-zero" emissions and negative emissions will be addressed with important implications for the development of new technologies.

### Learning Objective:

Basic knowledge of human-induced climate change, and how to model climate change, and its impacts on different sectors of the environment and society, and the options and consequences for different sectors to achieve the targeted climate goals (reduction of global warming).

#### Structure:

Lite

	Introduction Climate Change/Climate Change Reports.
	The climate system
	Observed climate change
	Climate variability
	Climate models
	Climate scenarios
	Physical climate changes under different scenarios
	Impacts of climate change on different regions and sectors
	Weather and climate extremes
	Climate risk and adaptation
	Scenarios, options and challenges to reduce global warming
	Climate Engineering
	Sustainability and climate change
	Climate quiz and discussion
erature	

Course L2747: Technical me	asures to mitigate climate change
Тур	
Hrs/wk	2
CP	2
	Independent Study Time 32, Study Time in Lecture 28
	Prof. Martin Kaltschmitt
Language	SoSe
	Lecturers: MK, Dr. Ben Norden (GFZ), Dr. Conny Schmidt-Hattenberger (GFZ)
	Lecture Content:
	The goal of this lecture is to address and present technical measures to mitigate climate change. This primarily includes the immediate means by which climate gas emissions can be reduced when they have already occurred. Specifically, the lecture includes the following content:
	- Overview of the main greenhouse gases emitted, including their global warming potential and the average lifetime of the molecules in the atmosphere.
	- Avoidance Methane (CH <sub>4</sub> ) (point sources).
	o Emission sources: Methane slip, methane emission from combustion, etc.
	o Reduction methane slip (including gas extraction, biogas plants, waste management).
	o Reduction of methane from combustion (e.g. power plants, ship engines, car engines, CHP engines, etc.)
	o Reduction of other sources if necessary
	- Avoidance Nitrous oxide (N <sub>2</sub> O) (point sources).
	o Emission sources: Combustion processes, production processes, biological nitrogen oxidation, etc.
	o Reduction of combustion processes
	o Reduction of production processes
	o Reduction of biological nitrogen oxidation
	o Reduction of further sources, if necessary
	- Avoidance of other greenhouse gases (including F-gases) (point sources)
	- Avoidance of carbon dioxide from fossil carbon (point sources)
	o Emission sources: Combustion processes, production processes
	o Capture technologies from exhaust gases
	Capture carbon dioxide from diffuse sources (ambient air)     Temporary storage and transport of carbon dioxide
	- Final storage of carbon dioxide
	o Geological framework and storage options, infrastructure (assessment)
	o Surface installations / modes of operation / conditioning of CO $_2$ (phase behavior) etc.
	o Thermodynamic framework and interactions
	o Tightness of the storage complex (geomechanics) and long-term behavior (modeling), saltwater displacement and upwelling?
	o Monitoring concepts (monitoring methods from geophysics, geochemistry, microbiology, applied on different spatial an temporal scales) and assessment of storage safety
	o Modeling (static, dynamic, chemical, scale-dependent - borehole, reservoir, energy system modeling).
	o Retrievability (interim storage) and after-use concepts (synthetic fuels)?, backfilling (cements, etc.).
	o Examples
Literature	

Тур	Recitation Section (small)
Hrs/wk	2
СР	2
	Independent Study Time 32, Study Time in Lecture 28
	Prof. Martin Kaltschmitt
Language Cycle	
-	- Overview of the main greenhouse gases emitted, including their global warming potential and the average lifetime of
	molecules in the atmosphere.
	- Avoidance Methane (CH4) (point sources).
	o Emission sources: Methane slip, methane emission from combustion, etc.
	o Reduction methane slip (including gas extraction, biogas plants, waste management).
	o Reduction of methane from combustion (e.g. power plants, ship engines, car engines, CHP engines, etc.)
	o Reduction of other sources if necessary
	- Avoidance Nitrous oxide (N2O) (point sources).
	o Emission sources: Combustion processes, production processes, biological nitrogen oxidation, etc.
	o Reduction of combustion processes
	o Reduction of production processes
	o Reduction of biological nitrogen oxidation
	o Reduction of further sources, if necessary
	- Avoidance of other greenhouse gases (including F-gases) (point sources)
	- Avoidance of carbon dioxide from fossil carbon (point sources)
	o Emission sources: Combustion processes, production processes
	o Capture technologies from exhaust gases
	- Capture carbon dioxide from diffuse sources (ambient air)
	- Temporary storage and transport of carbon dioxide
	- Final storage of carbon dioxide
	o Geological framework and storage options, infrastructure (assessment)
	o Surface installations / modes of operation / conditioning of CO2 (phase behavior) etc.
	o Thermodynamic framework and interactions
	o Tightness of the storage complex (geomechanics) and long-term behavior (modeling), saltwater displacement and upwelling?
	o Monitoring concepts (monitoring methods from geophysics, geochemistry, microbiology, applied on different spatial a temporal scales) and assessment of storage safety
	o Modeling (static, dynamic, chemical, scale-dependent - borehole, reservoir, energy system modeling).
	o Retrievability (interim storage) and after-use concepts (synthetic fuels)?, backfilling (cements, etc.).
	o Examples

Courses				
Title		Тур	Hrs/wk	СР
Phase Equilibria Thermodynamics (		Lecture	2	2
Phase Equilibria Thermodynamics (		Recitation Section (small)	1	2
Phase Equilibria Thermodynamics (		Recitation Section (large)	1	Z
Module Responsible				
Admission Requirements	None			
Recommended Previous Knowledge	Mathematics, Physical Chemistry, Thermodynamics I	and II		
Educational Objectives	After taking part successfully, students have reached	the following learning results		
Professional Competence				
Knowledge	<ul> <li>Starting from the very basics of thermodyname quilibria.</li> <li>They learn how state variables are influenced these properties.</li> <li>Moreover, the students learn how phase equidifferent phases (vapor, liquid, solid) coexist in</li> <li>For different phase equilibria, several examp knowledge for plotting and interpreting the equivalence of the students are a state and know how to simplify these equation</li> <li>The students know models which can be used</li> </ul>	d by the mixing of compounds and learn ilibria can be described mathematically a equilibrium. Furthermore the fundamen oles relevant for different kinds of proc uilibria are taught. ble to identify the correct equation for s meaningfully.	n concepts to qu and which pher tals of reaction e esses are shown the determination	uantitatively descr nomena may occu equilibria are taugi n and the necess on of the equilibri
	<ul> <li>are able to solve the resulting mathematical rear are able to solve the resulting mathematical reference of the specific applications, they are able to self-model parameters in literature sources.</li> <li>Beside pure compound properties the students</li> <li>The students know how to visualize phase equivalence between the students are separation and reaction processes in chemical</li> </ul>	elations. reliantly find necessary physico-chemica s are capable of describing the properties ilibria graphically and they know how to e able to understand fundamental cor	l properties of co of mixtures. Interpret the occ	ompounds as well urring phenomena
Personal Competence				
Social Competence The students are able to work in small groups, to solve the content students		live the corresponding problems and to	present them or	aly to the tutors a
	<ul> <li>The students are able to find necessary inform</li> <li>During the semester the students are able knowledge the students can adept their learning</li> </ul>	to check their learning progress conti		
Workload in Hours	Independent Study Time 124, Study Time in Lecture	56		
Credit points	6			
Course achievement	None			
Examination	Written exam			
Examination duration and	120 minutes; theoretical questions and calculations			
scale				
Assignment for the	General Engineering Science (German program, 7 ser	mester): Specialisation Process Engineeri	ng: Compulsory	
Following Curricula	General Engineering Science (German program, 7 se	mester): Specialisation Bioprocess Engine	ering: Compulso	ory
	General Engineering Science (German program, 7 se	mester): Specialisation Green Technologi	es, Focus Renew	able Energy: Elec
	Compulsory			
	General Engineering Science (German program, 7 se	mester): Specialisation Green Technologi	es, Focus Renew	able Energy: Elec
	Compulsory			
	Bioprocess Engineering: Core Qualification: Compulso	bry		
	Green Technologies: Energy, Water, Climate: Special	•••		
	Green Technologies: Energy, Water, Climate: Special	sation Energy Systems: Elective Compul	sory	
	Process Engineering: Core Qualification: Compulsory			

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

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

# Focus Water and Environmental Engineering

Module M1627: Wate	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						
Admission Requirements	None					
<b>Recommended Previous</b>	Basic knowledge of chemistry					
Knowledge						
Educational Objectives	After taking part successfully, students have reached the	ne following learning results				
Professional Competence						
Knowledge	Students can define generic material interactions betw	een the environmental media. The can de	emonstrate th	neir knowledge abou		
	natural as well as anthropogenic materials. They	are capable of explaining the natural	condition o	f waters and othe		
	environmental media.					
Skills	Students are able to research environment-specific aspects of civil engineering independent. They can present their finding					
	using accredited academic media (e.g. posters) and ca	redited academic media (e.g. posters) and can give a short summary including scientific references.				
Personal Competence						
•	Students can fulfil a complex environment-related assig	anment in the field of civil engineering by	working in a	team		
Social competence	stadents can fam a complex environment related assi	ginnent in the new of ervir engineering by	working in a			
Autonomy						
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56					
Credit points	6					
Course achievement	None					
Examination	Subject theoretical and practical work					
Examination duration and	Written-theoretical part and project work					
scale						
Assignment for the	General Engineering Science (German program, 7 sem	nester): Specialisation Green Technologies	s, Focus Wate	r and Environmenta		
Following Curricula	Engineering: Elective Compulsory					
	Civil- and Environmental Engineering: Core Qualificatio	n: Compulsory				
	Green Technologies: Energy, Water, Climate: Specialisa	tion Water: Elective Compulsory				

Course L2462: Project on Wa	iter, 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 I	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	<ul> <li>Basics of global/regional Water Cycle</li> <li>quality of water</li> <li>natural/anthropogenic water ingredients</li> <li>Basics water science</li> <li>water legislation (EU/D)</li> </ul>
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 T	Frends in Water and Environm	ental Research			
Courses					
Title		Тур	Hrs/wk	СР	
Introduction to Microplastics in Env		Integrated Lecture	2	2	
Research Methods for Water and E		Lecture	1	2	
Research Trends in Water and Envi	ronmental Research (L2757)	Seminar	2	2	
Module Responsible	Prof. Nima Shokri				
Admission Requirements	None				
<b>Recommended Previous</b>	Basic knowledge in water-, soil- and en	vironmental-related research			
Knowledge					
Educational Objectives	After taking part successfully, students have	reached the following learning results			
Professional Competence					
Knowledge	Data analysis, Data curation and presentation, Understanding of hydrologic cycle				
Skills	Problem solving skills, Ability to search relevant information, Familiar with using online resources and databases				
Personal Competence					
Social Competence	Ability to work in group, Teamwork				
Autonomy	Motivated and engaged individual who	is enthusiastic about new knowledge rela	ted to water and	environment	
Workload in Hours	Independent Study Time 110, Study Time in	Lecture 70			
Credit points	6				
Course achievement	None				
Examination	Written elaboration				
Examination duration and	Report (about 5-10 pages) and Presentation	(about 15 min)			
scale					
Assignment for the	General Engineering Science (German prog	ram, 7 semester): Specialisation Green Techno	ologies, Focus Wate	r and Environment	
Following Curricula	Engineering: Elective Compulsory				
	Civil- and Environmental Engineering: Specia	alisation Water and Environment: Elective Com	pulsory		
	Green Technologies: Energy, Water, Climate	: Specialisation Water: Elective Compulsory			

Course L2755: Introduction t	o 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	Introduction - course objectives, expectations and format;
	Source of microplastics in environment;
	Microplastics sampling; Characterization of microplastics;
	Fate and distribution of microplastics in terrestrial environments;
	Effects of microplastics on terrestrial environments;
	Health risks of microplastics in environments
Literature	1- Characterization and Analysis of Microplastics, Volume 75 1st Edition
	Series Volume Editors: Teresa Rocha-Santos Armando Duarte
	Elsevier, published in 2017
	2- Microplastic Pollutants 1st Edition
	Authors: Christopher Blair Crawford, Brian Quinn
	Elsevier Science, published in 2016
	3- Microplastics in Terrestrial Environments
	Authors: Defu He and Yongming Luo
	Springer, published in 2020, DOI https://doi.org/10.1007/978-3-030-56271-7

	hods for Water and Environmental Research			
	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	Introduction - course objectives, expectations and format			
	Analyzing the Audience, purpose and occasion			
	Constructing and delivering effective technical presentations			
	How to write an abstract			
	How to write a scientific paper			
	eloping competitive and persuasive research proposals			
	Databases and resources available for water and environmental research			
	Individual proposal on water and environmental research			
	Individual project on water and environmental research			
	Group projects and presentation on water and environmental research			
Literature	The Craft of Scientific Writing Fourth edition			
	Author: Michael Alley			
	Springer-Verlag New York, Copyright 2018, DOI 10.1007/978-1-4419-8288-9			
	<ul> <li>Supplemental materials and web links which will be available to registered students.</li> </ul>			

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

Courses				
Title		Түр	Hrs/wk	СР
Study Work Green Technologies (L2	766)	Project Seminar	2	4
Scientific Work and Writing (L2765)		Seminar	2	2
Module Responsible	Dozenten des Studiengangs			
Admission Requirements	None			
<b>Recommended Previous</b>	keine			
Knowledge				
Educational Objectives	After taking part successfully, students have reach	ned the following learning results		
Professional Competence				
Knowledge	The students, based on a literature survey, learn deliver afterwards a summary presentation to a sp preferred, when selecting the thematic area of the overview over the subject and practice technic specialised subject matter.	becialised audience. Environmental iss ese studies. Through their own written	ues and their multidisc contribution the stude	ciplinary linkages a ents communicate
Skills	The students can, when working on a technical top conduct a literature survey choose the relevant information for their pr 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 their own technical sub-topic tailored to their put students can formulate questions to other speake	plic and discuss with the audience. W	nen attending technic	
	The fulfilment of the tasks combines independent			
Autonomy	The students can, guided by instructors, critically	reflect on their learning and work statu	ıs, and write a scientif	ic report.
Workload in Hours	Independent Study Time 124, Study Time in Lectu	ire 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 Techr	nologies, Focus Renew	able Energy: Elect
Following Curricula	Compulsory General Engineering Science (German program, 7 Engineering: Elective Compulsory Green Technologies: Energy, Water, Climate: Spec Green Technologies: Energy, Water, Climate: Spec Green Technologies: Energy, Water, Climate: Spec	cialisation Energy Technology: Elective cialisation Water: Elective Compulsory cialisation Energy Systems: Elective Co	Compulsory	r and Environment

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

Тур	Seminar
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
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 speci information, knowledge organisation, writing, presenting and publishing. Suggestions for reflecting own processes of lea informing and writing - in addition to practical recommendations and tips - facilitate the start and the creation of bachele 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:
	<ul> <li>Introduction, organization, attributes of science:</li> </ul>
	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/su
	information/informing-points-to-survive/
	<ul> <li>Reference management: http://www.tub.tuhh.de/en/publishing/reference-management/</li> </ul>
	Knowledge organisation and creating publications with Citavi
	Citing correctly and avoiding plagiarism
	Preparing and doing presentations
Literature	
	<ol> <li>Semesterapparat "Wissenschaftliches Arbeiten" in der TU-Bibliothek: http://tinyurl.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 n installiertem Flash)</li> <li>Andreas Hirsch-Weber, Stefan Scherer: Wissenschaftliches Arbeiten und Abschlussarbeit in Natur- Langeisumvissenschaftlichen Praviebeiseiche Übwersen Christenschaftlichen 2016</li> </ol>
	Ingenieurwissenschaften : Grundlagen, Praxisbeispiele, Übungen. Stuttgart: Ulmer, 2016. 5. Werner Sesink: Einführung in das wissenschaftliche Arbeiten : inklusive E-Learning, Web-Recherche, digitale Präser u.a. 9., aktualisierte Aufl. München : Oldenbourg, 2012.
	<ol> <li>Judith Theuerkauf: Schreiben im Ingenieurstudium : effektiv und effizient zur Bachelor-, Master- und Doktor- Paderborn : Schöningh, 2012.</li> </ol>
	<ol> <li>Wolfsberger, Judith: Frei geschrieben : Mut, Freiheit &amp; Strategie für wissenschaftliche Abschlussarbeiten. Wien: Böhlau</li> <li>Biedermann, Wieland u.a.: Forschungsmethodik in den Ingenieurwissenschaften : Skript vom Lehrst Produktentwicklung, Prof. DrIng. Udo Lindemann, Technische Universität München (TUM), https://www.mw.tum.de/fileadmin/w00btx/lpl/Documents/Forschungsmethodik_Skript.pdf</li> <li>Wissenschaftliches Arbeiten - HOOU Angebot der HCU Hamburg: https://blogs.hoou.de/wissarbeiten/</li> </ol>
	<ol> <li>Course Reserves Collection "Scholarly Research Methods" in the TUHH library: http://tinyurl.com/Semesterapparal Arbeiten</li> </ol>
	<ol> <li>Scholarly research methods via TUHH library Website: https://www.tub.tuhh.de/en/scholarly-research-methods/</li> </ol>
	<ol> <li>VISION - Online-Tutorial on research methods by the TUHH library: http://www.vision.tuhh.de (Flash has to be installed</li> </ol>
	<ol> <li>Scientific papers and presentations / Martha Davis. 3. ed. Amsterdam: Elsevier / Academic Press, http://www.sciencedirect.com/science/book/9780123847270</li> </ol>
	<ol> <li>Writing for science and engineering : papers, presentations and reports / Heather Silyn-Roberts. 2nd ed. Amster Elsevier, 2013. http://www.sciencedirect.com/science/book/9780080982854</li> </ol>
	<ol> <li>How to research / Loraine Blaxter, Christina Hughes and Malcolm Tight. Maidenhead : Open Univ. Press, 2010.</li> <li>Managing information for research : practical help in researching, writing and designing dissertations / Elizabeth Orr Graham Stevens. Maidenhead : Open University Press McGraw-Hill, 2009.</li> </ol>
	<ol> <li>Writing scientific research articles : strategy and steps / Margaret Cargill and Patrick O'Connor. Chichester : Wiley-Blac 2009.</li> </ol>

	ulic Engineering					
Courses						
<b>Title</b>				Тур	Hrs/wk	СР
lydraulics (L0957)				Lecture	1	1
lydraulics (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					
<b>Recommended Previous</b>	Hydraulic Engineering I					
Knowledge						
Educational Objectives	After taking part successfully, stu	udents have r	eached the follow	ing learning results		
Professional Competence						
Knowledge	Students are able to define the	basic terms d	of hydraulic engin	neering and hydraulics. They are	e able to expla	in the applicatior
	basic hydrodynamic formulations	s (conservatio	on laws) to practi	cal hydraulic engineering proble	ms. Besides th	is, the students
	illustrate important tasks of hydr	raulic enginee	ering and give an	overview over river engineering	, flood protect	ion, hydraulic po
	engineering and waterways engir	neering.				
<i>ci '''</i>						
SKIIIS	The students are able to apply h					
	hydraulic engineering systems. E					
	water surfaces of channel flows, i				I as flow condi	tions of pipe syst
	Furthermore, they are able to run	1, explain and	document basic	hydraulic experiments.		
Personal Competence						
	The students are able to deploy	their gained	knowledge in apr	plied problems. Additionaly, the	/ will be able t	o work in team v
,	engineers of other disciplines in a goal-orientated, structured manner. They can explain their results by use of peer learni					
	approaches.					
Autonomy	The students will be able to indep	pendently ext	end their knowled	dge and apply it to new problem	s. Furthermore,	they are capable
	organising their individual work fl					
Workload in Hours	Independent Study Time 110, Stu	udy Time in L	ecture 70			
Credit points	6					
Course achievement	Compulsory Bonus Form		Description			
	Yes None Subject	theoretical	andDurchführun	ng, Dokumentation und Prä	sentation zu	einem Versu
	practical v	work	Hydromecha	anik oder Hydraulik		
Examination	Written exam					
Examination duration and	The duration of the examination	n is 2 hours.	The examination	includes tasks with respect to	the general u	nderstanding of
scale	lecture contents and calculations	tasks.				
Assignment for the	General Engineering Science (Ge	rman program	n, 7 semester): Sp	pecialisation Civil Engineering: El	ective Compul	sory
Following Curricula	General Engineering Science (Ge	erman program	m, 7 semester): S	Specialisation Green Technologie	s, Focus Water	and Environmen
	Engineering: Elective Compulsory	ý				
	Civil- and Environmental Enginee	ring: Core Qu	alification: Compu	ulsory		
	General Engineering Science (Eng	glish program	i, 7 semester): Sp	ecialisation Civil Engineering: Ele	ective Compuls	ory
	Green Technologies: Energy, Wat	ter, Climate: S	Specialisation Wat	ter: Elective Compulsory		
Course L0957: Hydraulics						
	Lecture					
Тур						
Hrs/wk	1					
	1					
Hrs/wk		ly Time in Leo	cture 14			
Hrs/wk CP	1	dy Time in Leo	cture 14			
Hrs/wk CP Workload in Hours	1 Independent Study Time 16, Stud	dy Time in Leo	cture 14			
Hrs/wk CP Workload in Hours Lecturer	1 Independent Study Time 16, Stud Prof. Peter Fröhle	dy Time in Leo	cture 14			
Hrs/wk CP Workload in Hours Lecturer Language	1 Independent Study Time 16, Stud Prof. Peter Fröhle DE					
Hrs/wk CP Workload in Hours Lecturer Language Cycle	1 Independent Study Time 16, Stud Prof. Peter Fröhle DE WiSe/SoSe					

- 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
CP	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 Eng	ineering
Тур	Lecture
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Prof. Peter Fröhle
Language	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

ourse 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: Applie	ed Water Management			
Courses				
Title		Тур	Hrs/wk	СР
Groundwater Hydrology and Modeli		Project-/problem-based Learning		2
Groundwater Hydrology and Model		Lecture	2	2
Nature-oriented Hydraulic Engineer		Project-/problem-based Learning	J 2	2
Module Responsible				
Admission Requirements	None			
Recommended Previous	<ul> <li>Basic knowledge of analysis and diffe</li> </ul>	rential equations		
Knowledge	<ul> <li>hydromechanical and hydraulic engine</li> </ul>			
	···, -· -··· -·· -·· -·· -·· -·· -·· -··	3		
Educational Objectives	After taking part successfully, students have	e 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	g und groundw	ater hydrology. Th
	cam describe the basics concepts, the ba	sic approaches and methods of nature-oriented	hydraulic engin	eering, groundwa
	hydrology and groundwater modelling and a	are able to apply these to practical problems.		
<i>ci 11</i>				
Skills The students are able to apply the methods and approaches of nature-oriented hydraulic engineering a		-		
		demonstrate to transfer and apply these to simpl		
		aches commonly used in groundwater hydrology.	-	
		o-hydrological questions. In addition, students car	apply basic gr	oundwater model
	methods to simple problems of groundwate	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 appli			
	problems of the practical nature-based hyd	raulic engineering. Additionaly, they will be able to	demonstrate t	o work cooperativ
	in teams consisting of engineers from differ	ent subject areas.		
Autonomy	The students will be able to independently e	extend their knowledge and apply it to new problen	IS.	
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	Written-theoretical part and modeling			
scale				
Assignment for the	General Engineering Science (German prog	ram, 7 semester): Specialisation Green Technologi	es, Focus Wate	r and Environmer
Following Curricula	Engineering: Elective Compulsory			
	Civil- and Environmental Engineering: Speci	alisation Civil Engineering: Elective Compulsory		
	Civil- and Environmental Engineering: Speci	alisation Traffic and Mobility: Elective Compulsory		
	Civil- and Environmental Engineering: Speci	alisation Water and Environment: Elective Compuls	ory	

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
CP	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-orient	ed Hydraulic Engineering
Тур	Project-/problem-based Learning
Hrs/wk	2
CP	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: Partie			5 5			
Courses						
Title			Тур		Hrs/wk	СР
Particle Technology I (L0434)			Lecto	ure	2	3
Particle Technology I (L0435)				tation Section (small)	1	1
Particle Technology I (L0440)			Pract	tical Course	2	2
Module Responsible	Prof. Stefan Heinrich	1				
Admission Requirements	None					
<b>Recommended Previous</b>	keine					
Knowledge						
Educational Objectives	After taking part suc	ccessfully, students have	e reached the following lea	arning results		
Professional Competence						
Knowledge	After successful con	npletion of the module s	tudents are able to			
	<ul> <li>name and ex</li> </ul>	nlain processes and uni	t-operations of solids proc	ess engineering		
			utions and to discuss their			
	• characterize	particles, particle distrib		buik properties		
Skille	Students are able to					
JKIIIS	Students are able to	)				
	<ul> <li>choose and d</li> </ul>	esign apparatuses and p	processes for solids proces	sing according to the d	esired solids prop	perties of the prod
	<ul> <li>asses solids v</li> </ul>	with respect to their beha	avior in solids processing s	steps		
	<ul> <li>document the</li> </ul>	eir work scientifically.				
Personal Competence						
-	The students are a	hle to discuss scientific	topics orally with other	students or scientific r	personal and to	develop solutions
Social competence	technical-scientific i		topics orany with other	students of scientific p		develop solutions
Autonomy			tions regarding solid parti	icles independently		
Autonomy	students are usic to	analyze and solve ques	cions regularing solid parti	eles independently.		
Workload in Hours	Independent Study	Time 110, Study Time in	Lecture 70			
Credit points	6					
Course achievement	Compulsory Bonus	Form	Description			
	Yes None	Written elaboration	sechs Berichte (pr	o Versuch ein Bericht) à	5-10 Seiten	
Examination	Written exam					
Examination duration and	90 minutes					
scale						
Assignment for the	5 5		am, 7 semester): Speciali	-		
Following Curricula	General Engineering	g Science (German progr	am, 7 semester): Speciali	sation Bioprocess Engin	eering: Compulse	ory
			ram, 7 semester): Special	lisation Green Technolo	gies, Focus Wate	r and Environmen
	Engineering: Electiv					
			am, 7 semester): Speciali	sation Energy and Envir	omental Enginee	ring: Compulsory
		ring: Core Qualification:				
			e Qualification: Elective Co			
			am, 7 semester): Specialis			-
			am, 7 semester): Specialis		-	ing: Compulsory
	General Engineering	g Science (English progra	am, 7 semester): Specialis	ation Process Engineeri	ng: Compulsory	
	-		e: Specialisation Water: Ele	ective Compulsory		
	Dresses Engineering	: Core Qualification: Cor	nnulson			

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

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

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

Module M1630: Sanit	ary Engineering II			
Courses				
Title		Тур	Hrs/wk	СР
Management of Wastewater Infras	ructure (L2467)	Seminar	2	3
Drinking Water Treatment (L2466)		Seminar	2	3
Module Responsible	Prof. Mathias Ernst			
Admission Requirements	None			
<b>Recommended Previous</b>	Basic knowledge in the field of drinking	water supply and waste water disposal.		
Knowledge				
Educational Objectives	After taking part successfully, students	have reached the following learning results		
Professional Competence				
Knowledge	The students can examplify their expe	rt knowledge on drinking water, waste water tre	atment and the asso	ciated infrastructur
2		ing the relevant empiricals assumptions and scien		
		cally. They can also assess existing problems in		
		socio-political context. Furthermore, they know h	-	
		such as high- and low-pressure membrane filtrati		
	of important technologies of the future	such as high- and low-pressure membrane meral	on systems and teem	iiques.
Skills	The students are able to apply the rele	vant standards and guidelines for the design and	d operation of urban	water infrastructure
	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 a	nd solve biochemica
	problems in the filed of drinking water	and wastewater treatment. The students are a	lso able to develop i	deas of their own t
	improve the existing water related infra	structures, systems and concepts.		
Personal Competence				
Social Competence	The students are able to develop a spec	ific topic in a team and to work out milestones ac	cording to a given pla	an.
Autonomy	Students are in a position to work on	a subject and to organize their work flow indep	nendently. They can	also present on thi
Autonomy	subject.	a subject and to organize their work now mac	sendentry. They can t	
	Subject.			
Workload in Hours	Independent Study Time 124, Study Tim	ne in Lecture 56		
Credit points	6			
Course achievement	None			
Examination	Subject theoretical and practical work			
Examination duration and	Written-theoretical part and modelling			
scale				
Assignment for the	General Engineering Science (German	program, 7 semester): Specialisation Green Tech	nologies, Focus Water	r and Environmenta
-	Engineering: Elective Compulsory	· · · · · · · · · · · · · · · · · · ·		
<b>J</b>		pecialisation Water and Environment: Compulsory	v	
		pecialisation Civil Engineering: Elective Compulso	-	
		pecialisation Traffic and Mobility: Elective Computed	-	
		mate: Specialisation Water: Elective Compulsory		
	Green reenhologies. Energy, Water, Cill	nate. specialisation water. Elective compulsory		

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

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

# **Specialization Computer Science**

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

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

Courses				
Title		Тур	Hrs/wk	СР
Discrete Algebraic Structures (L016	54)	Lecture	2	3
Discrete Algebraic Structures (L016	65)	Recitation Section (small)	2	3
Module Responsible	Prof. Karl-Heinz Zimmermann			
Admission Requirements	None			
<b>Recommended Previous</b>	Mathematics from High School.			
Knowledge				
Educational Objectives	After taking part successfully, students have re	ached the following learning results		
Professional Competence				
Knowledge	The students know the important basics of discrete algebraic structures including elementary combinatorial structures, monoids groups, rings, fields, finite fields, and vector spaces. They also know specific structures like sub sum-, and quotient structures an homomorphisms.			
Skills	Students are able to formalize and analyze basic discrete algebraic structures.			
Personal Competence				
Social Competence	Students are able to solve specific problems al	one or in a group and to present the results	accordingly.	
Autonomy	Students are able to acquire new knowledge classes.	from specific standard books and to ass	ociate the acquired	knowledge to oth
Workload in Hours	Independent Study Time 124, Study Time in Le	cture 56		
Credit points	6			
Course achievement	None			
Examination	Written exam			
Examination duration and	120 min			
scale				
Assignment for the	General Engineering Science (German program	, 7 semester): Specialisation Computer Sci	ence: Compulsory	
Following Curricula	Computer Science: Core Qualification: Computer	sory		
	Data Science: Core Qualification: Compulsory			
	Computational Science and Engineering: Core	Qualification: Compulsory		
	Orientation Studies: Core Qualification: Elective	Compulsory		

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

Course L0165: Discrete Alge	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		

Courses				
Title		Тур	Hrs/wk	СР
Computer Engineering (L0321)		Lecture	3	4
Computer Engineering (L0324)		Recitation Section (small)	1	2
Module Responsible	Prof. Heiko Falk			
Admission Requirements	None			
<b>Recommended Previous</b>	Basic knowledge in electrical engineering			
Knowledge	<u> </u>			
-	After taking part successfully, students have reache	d the following learning results		
Professional Competence				
	This module deals with the foundations of the fun programming down to gates. The module includes t		rs the layers from	the assembly-le
	<ul> <li>Introduction</li> <li>Combinational logic: Gates, Boolean algebra, Boolean functions, hardware synthesis, combinational networks</li> <li>Sequential logic: Flip-flops, automata, systematic hardware design</li> <li>Technological foundations</li> <li>Computer arithmetic: Integer addition, subtraction, multiplication and division</li> <li>Basics of computer architecture: Programming models, MIPS single-cycle architecture, pipelining</li> <li>Memories: Memory hierarchies, SRAM, DRAM, caches</li> <li>Input/output: 1/0 from the perspective of the CPU principles of passing data, point to point connections, burses</li> </ul>			
	<ul> <li>Input/output: I/O from the perspective of the CPU, principles of passing data, point-to-point connections, busses</li> <li>The students perceive computer systems from the architect's perspective, i.e., they identify the internal structure and the physic composition of computer systems. The students can analyze, how highly specific and individual computers can be built based on collection of few and simple components. They are able to distinguish between and to explain the different abstraction layers to day's computing systems - from gates and circuits up to complete processors.</li> <li>After successful completion of the module, the students are able to judge the interdependencies between a physical computer system and the software executed on it. In particular, they shall understand the consequences that the execution of software has on the hardware-centric abstraction layers from the assembly language down to gates. This way, they will be enabled to evaluat the impact that these low abstraction levels have on an entire system's performance and to propose feasible options.</li> </ul>			
Demonstration of the second se				
Personal Competence	Students are able to calve similar problems along o	in a group and to procept the results are	ordingly	
Social Competence	Students are able to solve similar problems alone or	in a group and to present the results acc	Loraingly.	
Autonomy	Students are able to acquire new knowledge from s	pecific literature and to associate this kno	owledge with othe	classes.
Workload in Hours	Independent Study Time 124, Study Time in Lecture	56		
	6			
	Compulsory Bonus Form	Description		
	Yes 10 % Excercises			
Examination	Written exam			
Examination duration and	90 minutes, contents of course and labs			
scale	<u> </u>			
-				
-	General Engineering Science (German program, 7 s			
	General Engineering Science (German program, 7 s			
	General Engineering Science (German program,	7 semester): Specialisation Mechanica	al Engineering, F	ocus Mechatroni
	Compulsory	7 Maskaria	Facility of the second	Alizza fit. Country
	General Engineering Science (German program,	7 semester): Specialisation Mechanical	Engineering, Foc	us Aircraft Syste
	Engineering: Compulsory General Engineering Science (German program, 7 s	emester): Specialisation Mechanical Engi	neering Focus Th	eoretical Mechani
	Engineering: Compulsory	emestery. Specialisation mechanical Engl	neering, rocus rii	
	Engineering: comparisony			
	General Engineering Science (German program,	7 semester): Specialisation Mechanic	cal Engineering,	Focus Materials
	General Engineering Science (German program, Engineering Sciences: Compulsory	7 semester): Specialisation Mechani	cal Engineering,	Focus Materials
	Engineering Sciences: Compulsory			
	Engineering Sciences: Compulsory General Engineering Science (German program, 7 and Production: Compulsory General Engineering Science (German program,	semester): Specialisation Mechanical Eng	jineering, Focus P	roduct Developme
	Engineering Sciences: Compulsory General Engineering Science (German program, 7 and Production: Compulsory General Engineering Science (German program, Compulsory	semester): Specialisation Mechanical Eng 7 semester): Specialisation Mechanical	gineering, Focus P Engineering, Foc	roduct Developm us Energy Syster
	Engineering Sciences: Compulsory General Engineering Science (German program, 7 and Production: Compulsory General Engineering Science (German program,	semester): Specialisation Mechanical Eng 7 semester): Specialisation Mechanical	gineering, Focus P Engineering, Foc	roduct Developm us Energy Syster
	Engineering Sciences: Compulsory General Engineering Science (German program, 7 and Production: Compulsory General Engineering Science (German program, Compulsory General Engineering Science (German program,	semester): Specialisation Mechanical Eng 7 semester): Specialisation Mechanical 7 semester): Specialisation Mechanica emester): Specialisation Naval Architectu emester): Specialisation Biomedical Engir emester): Specialisation Bioprocess Engir emester): Specialisation Electrical Engine	gineering, Focus P Engineering, Foc al Engineering, F re: Compulsory neering: Compulsory neering: Compulsory	roduct Developm us Energy Syster ocus Biomechani ry ry
	Engineering Sciences: Compulsory General Engineering Science (German program, 7 s and Production: Compulsory General Engineering Science (German program, Compulsory General Engineering Science (German program, Compulsory General Engineering Science (German program, 7 s General Engineering Science (German program, 7 s	semester): Specialisation Mechanical Eng 7 semester): Specialisation Mechanical 7 semester): Specialisation Mechanica emester): Specialisation Naval Architectu emester): Specialisation Biomedical Engir emester): Specialisation Bioprocess Engir emester): Specialisation Electrical Engine	gineering, Focus P Engineering, Foc al Engineering, F re: Compulsory neering: Compulsory neering: Compulsory	roduct Developm us Energy Syster ocus Biomechani ry ry
	Engineering Sciences: Compulsory General Engineering Science (German program, 7 s and Production: Compulsory General Engineering Science (German program, Compulsory General Engineering Science (German program, Compulsory General Engineering Science (German program, 7 s General Engineering Science (German program, 7 s	semester): Specialisation Mechanical Eng 7 semester): Specialisation Mechanical 7 semester): Specialisation Mechanica emester): Specialisation Naval Architectu emester): Specialisation Biomedical Engir emester): Specialisation Bioprocess Engir emester): Specialisation Electrical Engine emester): Specialisation Green Technolog	gineering, Focus P Engineering, Foc al Engineering, F re: Compulsory neering: Compulsory neering: Compulsory	roduct Developm us Energy Syster ocus Biomechani ry ry
	Engineering Sciences: Compulsory General Engineering Science (German program, 7 s and Production: Compulsory General Engineering Science (German program, Compulsory General Engineering Science (German program, Compulsory General Engineering Science (German program, 7 s General Engineering Science (German program, 7 s Gompulsory Computer Science: Core Qualification: Compulsory	semester): Specialisation Mechanical Eng 7 semester): Specialisation Mechanical 7 semester): Specialisation Mechanica emester): Specialisation Naval Architectu emester): Specialisation Biomedical Engir emester): Specialisation Bioprocess Engir emester): Specialisation Electrical Engine emester): Specialisation Green Technolog	gineering, Focus P Engineering, Foc al Engineering, F re: Compulsory neering: Compulsory neering: Compulsory	roduct Developm us Energy Syster ocus Biomechani ry ry
	Engineering Sciences: Compulsory General Engineering Science (German program, 7 s and Production: Compulsory General Engineering Science (German program, Compulsory General Engineering Science (German program, Compulsory General Engineering Science (German program, 7 s General Engineering Science (German program, 7 s Gompulsory Computer Science: Core Qualification: Compulsory Data Science: Core Qualification: Elective Compulso	semester): Specialisation Mechanical Eng 7 semester): Specialisation Mechanical 7 semester): Specialisation Mechanica emester): Specialisation Naval Architectu emester): Specialisation Biomedical Engir emester): Specialisation Bioprocess Engir emester): Specialisation Electrical Engine emester): Specialisation Green Technolog ry ry mester): Specialisation Civil Engineering:	gineering, Focus P Engineering, Foc al Engineering, Foc al Engineering, F re: Compulsory neering: Compulsory gies, Focus Renew Compulsory	roduct Developm us Energy Syster ocus Biomechan ry ry able Energy: Elect

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

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

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

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Courses				
Title		Тур	Hrs/wk	СР
Graph Theory and Optimization (L10		Lecture	2	3
Graph Theory and Optimization (L10		Recitation Section (small)	2	3
Module Responsible				
•	None			
Recommended Previous	Discrete Algebraic Structures			
Knowledge	Mathematics I			
Educational Objectives	After taking part successfully, students have rea	ached the following learning results		
Professional Competence				
Knowledge	• Students can name the basic concepts ir	Graph Theory and Optimization. They are	able to explain the	em using appropria
	examples.			an asing appropria
	Students can discuss logical connections	between these concepts. They are capable	e of illustrating the	ese connections wi
	the help of examples.		5	
	• They know proof strategies and can repro	oduce them.		
Skills	Students can model problems in Graph	Theory and Optimization with the help of	the concepts stu	idied in this cours
	Moreover, they are capable of solving the			
	Students are able to discover and verify f	urther logical connections between the conc	epts studied in the	course.
	• For a given problem, the students can			
	results.			
Personal Competence				
Social Competence				
	Students are able to work together in tea			
	<ul> <li>In doing so, they can communicate new of design examples to shock and deepen th</li> </ul>		perating partners	. Moreover, they ca
	design examples to check and deepen the	e understanding of their peers.		
Autonomu				
Autonomy	Students are capable of checking their u	nderstanding of complex concepts on their	own. They can sp	ecify open question
	precisely and know where to get help in s	olving them.		
	<ul> <li>Students have developed sufficient pers</li> </ul>	istence to be able to work for longer period	ds in a goal-orien	ted manner on ha
	problems.			
Workload in Hours	ndependent Study Time 124, Study Time in Lec	ture 56		
Credit points	<u> </u>			
Course achievement	None			
Examination	Written exam			
Examination duration and	120 min			
scale				
			_	
-	General Engineering Science (German program,		ce: Compulsory	
-	Computer Science: Core Qualification: Compulso	bry		
	Data Science: Core Qualification: Compulsory	Colonaa, Flashiya Commission		
	ogistics and Mobility: Specialisation Engineerin			
	ogistics and Mobility: Specialisation Traffic Plan			
	ogistics and Mobility: Specialisation Information			
	Fechnomathematics: Specialisation I. Mathemat		a and Sustanas El	otivo Compulación
	Engineering and Management - Major in Logistic	s and Modility: Specialisation Traffic Plannin	y and Systems: Ele	cuve compulsory

Course L1046: Graph Theory	and Optimization
Тур	Lecture
Hrs/wk	2
CP	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Prof. Anusch Taraz
Language	DE/EN
Cycle	SoSe
Content	<ul> <li>Graphs, search algorithms for graphs, trees</li> <li>planar graphs</li> <li>shortest paths</li> <li>minimum spanning trees</li> <li>maximum flow and minimum cut</li> <li>theorems of Menger, König-Egervary, Hall</li> <li>NP-complete problems</li> <li>backtracking and heuristics</li> <li>linear programming</li> <li>duality</li> <li>integer linear programming</li> </ul>
Literature	<ul> <li>M. Aigner: Diskrete Mathematik, Vieweg, 2004</li> <li>T. Cormen, Ch. Leiserson, R. Rivest, C. Stein: Algorithmen - Eine Einführung, Oldenbourg, 2013</li> <li>J. Matousek und J. Nesetril: Diskrete Mathematik, Springer, 2007</li> <li>A. Steger: Diskrete Strukturen (Band 1), Springer, 2001</li> <li>A. Taraz: Diskrete Mathematik, Birkhäuser, 2012</li> <li>V. Turau: Algorithmische Graphentheorie, Oldenbourg, 2009</li> <li>KH. Zimmermann: Diskrete Mathematik, BoD, 2006</li> </ul>

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

Courses					
Title		Тур	Hrs/wk	СР	
Stochastics (L0777)		Lecture	2	4	
Stochastics (L0778)		Recitation Section (small)	2	2	
Module Responsible					
•	None				
Recommended Previous	Calculus				
Knowledge	Discrete algebraic structures (combinatorics)				
	Propositional logic				
	After taking part successfully, students have reached	d the following learning results			
Professional Competence					
Knowledge	<ul> <li>Students can name the basic concepts in Store</li> </ul>	hastics. They are able to explain them us	ing appropriate e	examples.	
	<ul> <li>Students can discuss logical connections between the second second</li></ul>	ween these concepts. They are capable	of illustrating th	ese connections w	
	the help of examples.				
	<ul> <li>They know proof strategies and can reproduce</li> </ul>	e them.			
Skills					
JKIIIS	<ul> <li>Students can model problems from stochast</li> </ul>	ics with the help of the concepts studie	ed in this course	. Moreover, they a	
	capable of solving them by applying establish	ed methods.			
	<ul> <li>Students are able to discover and verify furth</li> </ul>	er logical connections between the conce	pts studied in the	e course.	
	<ul> <li>For a given problem, the students can develop</li> </ul>	lop and execute a suitable approach, a	nd are able to c	ritically evaluate I	
	results.				
Personal Competence					
Social Competence					
	• Students are able to work together (e.g. on their regular home work) in heterogeneously composed teams (i.e., teams from				
	different study programs and background kno				
	In doing so, they can communicate new conc		perating partners	. Moreover, they c	
	design examples to check and deepen the un	derstanding of their peers.			
Autonomy					
	Students are capable of checking their under		wn. They can sp	ecify open questio	
	precisely and know where to get help in solvin				
	<ul> <li>Students can put their knowledge in relation t</li> <li>Students have developed sufficient persister</li> </ul>		c in a goal orign	tod mannar on ha	
	<ul> <li>Students have developed sufficient persister problems.</li> </ul>	ice to be able to work for longer period	s in a goal-onen		
Workload in Hours	Independent Study Time 124, Study Time in Lecture	56			
Credit points	6				
Course achievement	None				
Examination	Written exam				
Examination duration and	120 min				
scale					
-	General Engineering Science (German program, 7 se	emester): Specialisation Computer Scienc	e: Compulsory		
Following Curricula	Computer Science: Core Qualification: Compulsory				
	Data Science: Core Qualification: Compulsory Computational Science and Engineering: Core Qualif	ication: Compulson			
	Logistics and Mobility: Specialisation Engineering Sc				
	Logistics and Mobility: Specialisation Engineering Sc Logistics and Mobility: Specialisation Information Tec				
	Theoretical Mechanical Engineering: Core Qualificati	57 1 7			

Course L0777: Stochastics			
Тур	Lecture		
Hrs/wk			
CP	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	ourse L0778: Stochastics		
Тур	Recitation Section (small)		
Hrs/wk	2		
СР	2		
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28		
Lecturer	Prof. Matthias Schulte		
Language	DE/EN		
Cycle	SoSe		
Content	See interlocking course		
Literature	See interlocking course		

Courses				
Title		Тур	Hrs/wk	СР
Automata Theory and Formal Lang	uages (L0332)	Lecture	2	4
Automata Theory and Formal Lang	uages (L0507)	Recitation Section (small)	2	2
Module Responsible	Prof. Tobias Knopp			
Admission Requirements	None			
<b>Recommended Previous</b>	Participating students should be able to			
Knowledge	- specify algorithms for simple data strue	ctures (such as, e.g., arrays) to solve computational p	problems	
	- apply propositional logic and predicate	logic for specifying and understanding mathematical	l proofs	
	- apply the knowledge and skills taught	in the module Discrete Algebraic Structures		
Educational Objectives	After taking part successfully, students I	have reached the following learning results		
Professional Competence				
Skills	automata and can identify relationship deterministic and nondeterministic fini formalism for which nondeterminism is problems require which expressivity, an problems w.r.t. other formalisms. They to for specifying systems and their propert or grammars.	heir application areas. The participants of the cour is to logic and formal grammars. The spectrum the ite automata and pushdown automata to Turing n is more expressive than determinism. They are also d, in addition, students can transform decision proble understand that some formalisms easily induce algor ties. Students can describe the relationships between s well as predicate logic resolution to a given set of final logic prodicato logic or tomograp logic formulae	at students can nachines. Studem able to demons ems w.r.t. one for ithms whereas of n formalisms such ormulas. Student	explain ranges fi tts can name th trate which decis malism into decis thers are best sui h as logic, autom s analyze applica
	which formalism is best suited for a pa decision problems to specific formulas.	al logic, predicate logic, or temporal logic formulas t articular application problem, and they can demonst Students can also transform nondeterministic autom rsa. They can show how parsers work, and they ca rrds.	rate the applicat nata into determin	ion of algorithms nistic ones, or de
Personal Competence				
Social Competence				
Autonomy				
	Independent Study Time 124, Study Tim	ne in Lecture 56		
Credit points				
Course achievement	None			
Examination	Written exam			
Examination duration and	90 min			
scale				
Assignment for the	General Engineering Science (German p	rogram, 7 semester): Specialisation Computer Scienc	e: Compulsory	
Following Curricula				
	Data Science: Core Qualification: Compu	•		
	Engineering Science: Specialisation Mec			
		ogram, 7 semester): Specialisation Mechatronics: Electronics	ctive Compulsory	
	Computational Science and Engineering	. Core qualification: Compulsory		
	Orientation Studies: Core Qualification: I	Elective Compulsory		

-					
	Lecture				
Hrs/wk					
CP					
Workload in Hours	dependent Study Time 92, Study Time in Lecture 28				
Lecturer	rof. Tobias Knopp				
Language	EN				
Cycle	SoSe				
Content					
	1. Propositional logic, Boolean algebra, propositional resolution, SAT-2KNF				
	2. Predicate logic, unification, predicate logic resolution				
	3. Temporal Logics (LTL, CTL)				
	4. Deterministic finite automata, definition and construction				
	5. Regular languages, closure properties, word problem, string matching				
	6. Nondeterministic automata:				
	Rabin-Scott transformation of nondeterministic into deterministic automata				
	7. Epsilon automata, minimization of automata,				
	elimination of e-edges, uniqueness of the minimal automaton (modulo renaming of states)				
	8. Myhill-Nerode Theorem:				
	Correctness of the minimization procedure, equivalence classes of strings induced by automata				
	<ol><li>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 express</li></ol>				
	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, pump				
	lemma for context-free grammars, transformation of formalisms (from pushdown automata to context-free grammars				
	back)				
	12. Chomsky normal form				
	13. CYK algorithm for deciding the word problem for context-free grammrs				
	14. Deterministic pushdown automata				
	15. Deterministic vs. nondeterministic pushdown automata:				
	Application for parsing, LL(k) or LR(k) grammars and parsers vs. deterministic pushdown automata, compiler compiler				
	16. Regular grammars				
	17. Outlook: Turing machines and linear bounded automata vs general and context-sensitive grammars				
	18. Chomsky hierarchy				
	19. Mealy- and Moore automata:				
	Automata with output (w/o accepting states), infinite state sequences, automata networks				
	20. Omega automata: Automata for infinite input words, Büchi automata, representation of state transition systems, verifica				
	w.r.t. temporal logic specifications (in particular LTL)				
	21. LTL safety conditions and model checking with Büchi automata, relationships between automata and logic				
	22. Fixed points, propositional mu-calculus				
	23. Characterization of regular languages by monadic second-order logic (MSO)				
Literature	1. Levil für beformsetillen Lies Coloring - Coloring - Color				
	1. Logik für Informatiker Uwe Schöning, Spektrum, 5. Aufl.				
	2. Logik für Informatiker Martin Kreuzer, Stefan Kühling, Pearson Studium, 2006				
	Grundkurs Theoretische Informatik, Gottfried Vossen, Kurt-Ulrich Witt, Vieweg-Verlag, 2010.     Brinsiples of Medel Checking, Christel Paier, Less Pieter Katego, The MIT Proce, 2007.				
	<ol> <li>Principles of Model Checking, Christel Baier, Joost-Pieter Katoen, The MIT Press, 2007</li> </ol>				

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

Module M0803: Embe	edded Systems
Courses	
Title	Typ Hrs/wk CP
Embedded Systems (L0805)	Lecture 3 4
Embedded Systems (L0806)	Recitation Section (small) 1 2
Module Responsible	Prof. Heiko Falk
Admission Requirements	None
<b>Recommended Previous</b>	Computer Engineering
Knowledge	
Educational Objectives	After taking part successfully, students have reached the following learning results
Professional Competence	
Knowledge	Embedded systems can be defined as information processing systems embedded into enclosing products. This course teaches foundations of such systems. In particular, it deals with an introduction into these systems (notions, common characteristics) their specification languages (models of computation, hierarchical automata, specification of distributed systems, task gra specification of real-time applications, translations between different models).
Skills	Another part covers the hardware of embedded systems: Sonsors, A/D and D/A converters, real-time capable communical hardware, embedded processors, memories, energy dissipation, reconfigurable logic and actuators. The course also feature introduction into real-time operating systems, middleware and real-time scheduling. Finally, the implementation of embedd systems using hardware/software co-design (hardware/software partitioning, high-level transformations of specifications, energicient realizations, compilers for embedded processors) is covered.
	which areas of embedded system design specific risks exist.
Personal Competence	
Social Competence	Students are able to solve similar problems alone or in a group and to present the results accordingly.
Autonomy	Students are able to acquire new knowledge from specific literature and to associate this knowledge with other classes.
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56
Credit points	
Course achievement	Compulsory Bonus Form Description
	Yes 10 % Subject theoretical and
	practical work
Examination	Written exam
Examination duration and	90 minutes, contents of course and labs
scale	
Assignment for the	General Engineering Science (German program, 7 semester): Specialisation Computer Science: Compulsory
Following Curricula	Computer Science: Specialisation Computer and Software Engineering: Elective Compulsory
	Computer Science: Specialisation I. Computer and Software Engineering: Elective Compulsory
	Electrical Engineering: Core Qualification: Elective Compulsory
	Engineering Science: Specialisation Mechatronics: Elective Compulsory
	Aircraft Systems Engineering: Core Qualification: Elective Compulsory
	General Engineering Science (English program, 7 semester): Specialisation Mechatronics: Elective Compulsory
	Computational Science and Engineering: Core Qualification: Compulsory
	Mechatronics: Specialisation System Design: Elective Compulsory
	Mechatronics: Specialisation Intelligent Systems and Robotics: Elective Compulsory
	Mechatronics: Core Qualification: Elective Compulsory
	Microelectronics and Microsystems: Specialisation Embedded Systems: Elective Compulsory
Course L0805: Embedded Sy	/stems
Тур	Lecture
Hrs/wk	3
CP	4
Workload in Hours	Independent Study Time 78, Study Time in Lecture 42
Lecturer	Prof. Heiko Falk
Language	
• •	SoSe
eyele	1

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

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

Module M0731: Funct	ional Programı	ning				
Courses						
Title				Тур	Hrs/wk	СР
Functional Programming (L0624)				Lecture	2	2
Functional Programming (L0625)				Recitation Section (large)	2	2
Functional Programming (L0626)				Recitation Section (small)	2	2
Module Responsible	Prof. Sibylle Schupp					
Admission Requirements	None					
<b>Recommended Previous</b>	Discrete mathematics	at high-school	level			
Knowledge						
Educational Objectives	After taking part succ	essfully, studen	ts have reached the	following learning results		
Professional Competence						
Knowledge	Students apply the principles, constructs, and simple design techniques of functional programming. They demonstrate their ability to read Haskell programs and to explain Haskell syntax as well as Haskell's read-eval-print loop. They interpret warnings and find errors in programs. They apply the fundamental data structures, data types, and type constructors. They employ strategies for unit tests of functions and simple proof techniques for partial and total correctness. They distinguish laziness from other evaluation strategies.					
Skills	Students break a natural-language description down in parts amenable to a formal specification and develop a functional program in a structured way. They assess different language constructs, make conscious selections both at specification and implementations level, and justify their choice. They analyze given programs and rewrite them in a controlled way. They design and implement unit tests and can assess the quality of their tests. They argue for the correctness of their program.					
Personal Competence						
Social Competence	Students practice pe programs orally. They			s. They explain problems and solu	tions to their pee	er. They defend the
Autonomy	In programming labs, students learn under supervision (a.k.a. "Betreutes Programmieren") the mechanics of programming. In exercises, they develop solutions individually and independently, and receive feedback.					
Workload in Hours	Independent Study Ti	me 96, Study Ti	ime in Lecture 84			
Credit points	6					
Course achievement	Compulsory Bonus Yes 15 %	Form Excercises	Descri	otion		
Examination		LACEICISES				
Examination duration and scale	90 min					
	0 15 1 1					
-				ter): Specialisation Computer Sciene	ce: Elective Comp	uisory
Following Curricula	Computer Science: Co					
	Data Science: Core Q					
	Engineering Science:					
		-		er): Specialisation Computer Science	-	-
				er): Specialisation Mechatronics: Ele		
		-		Computer Science: Elective Compu	lsory	
	Technomathematics:	Specialisation II	I. Informatics: Electiv	ve Compulsory		

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

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

Courses		
Title	Typ Hrs/w	k CP
Numerical Mathematics I (L0417)	Lecture 2	3
Numerical Mathematics I (L0418)	Recitation Section (small) 2	3
Module Responsible	e Prof. Sabine Le Borne	
Admission Requirements	s None	
<b>Recommended Previous</b>	<ul> <li>Mathematik I + II for Engineering Students (german or english) or Analysis &amp; Linear Algebra I + II</li> </ul>	for Technomathema
Knowledge	<ul> <li>basic MATLAB/Python knowledge</li> </ul>	
-	s After taking part successfully, students have reached the following learning results	
Professional Competence		
Knowledge	e Students are able to	
	name numerical methods for interpolation, integration, least squares problems, eigenvalue proble	ems, nonlinear root f
	problems and to explain their core ideas,	
	<ul> <li>repeat convergence statements for the numerical methods,</li> </ul>	
	explain aspects for the practical execution of numerical methods with respect to computational an	d storage complexit
Skills	s Students are able to	
	<ul> <li>implement, apply and compare numerical methods using MATLAB/Python,</li> </ul>	
	<ul> <li>justify the convergence behaviour of numerical methods with respect to the problem and solution</li> </ul>	algorithm
	<ul> <li>select and execute a suitable solution approach for a given problem.</li> </ul>	algoriani,
Personal Competence	3	
Social Competence	e Students are able to	
	work together in heterogeneously composed teams (i.e., teams from different study programs and	d background know!
	explain theoretical foundations and support each other with practical aspects regarding the impler	
	· F	
Autonomy	y Students are capable	
	to assess whether the supporting theoretical and practical excercises are better solved individually	v or in a team.
	<ul> <li>to assess their individual progess and, if necessary, to ask questions and seek help.</li> </ul>	
Workload in Hours		
Credit points		
Course achievement	t None	
Examination	n Written exam	
Examination duration and	1 90 minutes	
scale		
	e General Engineering Science (German program, 7 semester): Specialisation Computer Science: Compulso	
Following Curricula	a General Engineering Science (German program, 7 semester): Specialisation Mechanical Enginee	ring, Focus Materi
	Engineering Sciences: Compulsory	
	General Engineering Science (German program, 7 semester): Specialisation Biomedical Engineering: Com	
	General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineeri	ng, Focus Biomecr
	Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Foc	us Theoretical Mech
	Engineering: Compulsory	us medical medi
	General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering	1 Focus Aircraft Sv
	Engineering: Elective Compulsory	,
	General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, For	cus Mechatronics: F
	Compulsory	
	General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering	, Focus Energy Sy
	Elective Compulsory	5, -,
	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 Computer Science: Compulso	
		ng, Focus Biomech
	General Engineering Science (English program, 7 semester): Specialisation Mechanical Engineeri	
	Compulsory	
	Compulsory General Engineering Science (English program, 7 semester): Specialisation Mechanical Engineering, Focu	ıs Materials in Engin
	Compulsory General Engineering Science (English program, 7 semester): Specialisation Mechanical Engineering, Focu Sciences: Compulsory	
	Compulsory General Engineering Science (English program, 7 semester): Specialisation Mechanical Engineering, Focu Sciences: Compulsory General Engineering Science (English program, 7 semester): Specialisation Mechanical Engineering, Foc	
	Compulsory General Engineering Science (English program, 7 semester): Specialisation Mechanical Engineering, Focu Sciences: Compulsory General Engineering Science (English program, 7 semester): Specialisation Mechanical Engineering, Focu Engineering: Compulsory	cus Theoretical Mech
	Compulsory General Engineering Science (English program, 7 semester): Specialisation Mechanical Engineering, Focu Sciences: Compulsory General Engineering Science (English program, 7 semester): Specialisation Mechanical Engineering, Focu Engineering: Compulsory General Engineering Science (English program, 7 semester): Specialisation Biomedical Engineering: Com	cus Theoretical Mech
	Compulsory General Engineering Science (English program, 7 semester): Specialisation Mechanical Engineering, Focu Sciences: Compulsory General Engineering Science (English program, 7 semester): Specialisation Mechanical Engineering, Focu Engineering: Compulsory	cus Theoretical Mech

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

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

Courses				
Title		Тур	Hrs/wk	СР
ntroductory Seminar Computer Sc	ence I (L2362)	Seminar	2	3
ntroductory Seminar Computer Sc	ence II (L2361)	Seminar	2	3
Module Responsible	Prof. Karl-Heinz Zimmermann			
Admission Requirements	None			
<b>Recommended Previous</b>	Basic knowledge of Computer Science and	Mathematics at the Bachelor's level.		
Knowledge				
Educational Objectives	After taking part successfully, students ha	ve reached the following learning results		
Professional Competence				
Knowledge	The students are able to			
	<ul> <li>explicate a specific topic in the field</li> </ul>	of Computer Science,		
	describe complex issues,			
	<ul> <li>present different views and evaluat</li> </ul>	e în a critical way.		
Skills	The students are able to			
		and a Calendar in Kinghad bina		
	familiarize in a specific topic of Com			
	realize a literature survey on the sp			
	elaborate a presentation and give a			
	<ul> <li>sum up the presentation in 10-15 lin</li> <li>approver questions in the final discussion</li> </ul>			
	<ul> <li>answer questions in the final discus</li> </ul>	5011.		
Personal Competence				
Social Competence	The students are able to			
	elaborate and introduce a topic for	a cortain audionco		
		ture of the presentation with the instructor,		
	<ul> <li>discuss certain aspects with the aud</li> </ul>			
	<ul> <li>as the lecturer listen and respond to</li> </ul>			
Autonomy	The students are able to			
	<ul> <li>define the task in question in an aut</li> </ul>	conomous way.		
	<ul> <li>develop the necessary knowledge,</li> </ul>			
	<ul> <li>use appropriate work equipment, ar</li> </ul>	nd		
	<ul> <li>guided by an instructor critically choose</li> </ul>			
	Independent Study Time 124, Study Time	IN Lecture 56		
Credit points	6			
Course achievement	None			
Examination	Presentation			
Examination duration and	x			
scale				
Assignment for the		gram, 7 semester): Specialisation Computer S	cience: Elective Compul	sory
Following Curricula				
		ram, 7 semester): Specialisation Computer So	cience: Elective Compuls	ory
	Computational Science and Engineering: C	Core Qualification: Compulsory		

Course L2362: Introductory	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	ourse L2361: Introductory Seminar Computer Science II	
Тур	Seminar	
Hrs/wk	2	
CP	3	
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28	
Lecturer	Prof. Karl-Heinz Zimmermann	
Language	DE/EN	
Cycle	WiSe/SoSe	
Content		
Literature		

Courses				
Title		Тур	Hrs/wk	СР
Computer Networks and Internet S	-	Lecture	3	5
Computer Networks and Internet S	-	Recitation Section (small)	1	1
	Prof. Andreas Timm-Giel			
Admission Requirements				
	Basics of Computer Science			
Knowledge				
Educational Objectives	After taking part successfully, students ha	ave reached the following learning results		
Professional Competence				
Knowledge	Students are able to explain important an	nd common Internet protocols in detail and clas	sify them, in order	to be able to anal
	and develop networked systems in further studies and job.			
Skills	Students are able to analyse common Internet protocols and evaluate the use of them in different domains.			
U.M.B				
Personal Competence				
Social Competence				
Autonomy	Students can select relevant parts out of I	high amount of professional knowledge and can	independently learn	and understand it
Autonomy	Students can select relevant parts out of	ingit amount of professional knowledge and car	independentity learn	
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 pro	ogram, 7 semester): Specialisation Computer Sci	ence: Elective Comp	ulsory
Following Curricula	Computer Science: Core Qualification: Con	mpulsory		
	Data Science: Core Qualification: Elective	Compulsory		
	Electrical Engineering: Core Qualification:	Elective Compulsory		
	Engineering Science: Specialisation Mecha	atronics: Elective Compulsory		
	General Engineering Science (English prog	gram, 7 semester): Specialisation Computer Scie	nce: Elective Compu	ulsory
	General Engineering Science (English prog	gram, 7 semester): Specialisation Mechatronics:	Elective Compulsory	1
	Computational Science and Engineering: (	Core Qualification: Compulsory		
	Technomathematics: Specialisation II. Info	armatics: Elective Compulsory		

Course L1098: Computer Net	tworks and Internet Security
Тур	Lecture
Hrs/wk	3
CP	5
Workload in Hours	Independent Study Time 108, Study Time in Lecture 42
Lecturer	Prof. Andreas Timm-Giel, 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 o 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	<ul> <li>Internet security: Firewalls</li> <li>Kurose, Ross, Computer Networking - A Top-Down Approach, 6th Edition, Addison-Wesley</li> <li>Kurose, Ross, Computernetzwerke - Der Top-Down-Ansatz, Pearson Studium; Auflage: 6. Auflage</li> <li>W. Stallings: Cryptography and Network Security: Principles and Practice, 6th edition</li> </ul> Further literature is announced at the beginning of the lecture.

Course L1099: Computer Net	ourse L1099: Computer Networks and Internet Security		
Тур	Recitation Section (small)		
Hrs/wk	1		
CP	1		
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14		
Lecturer	Prof. Andreas Timm-Giel, Prof. Dieter Gollmann		
Language	EN		
Cycle	WiSe		
Content	See interlocking course		
Literature	See interlocking course		

Courses						
<b>Fitle</b>			Тур		Hrs/wk	СР
Computer Architecture (L0793)			Lecture	2	2	3
Computer Architecture (L0794)			Project	-/problem-based Learning	2	2
Computer Architecture (L1864)			Recitat	ion Section (small)	1	1
Module Responsible	Prof. Heiko Falk					
Admission Requirements	None					
<b>Recommended Previous</b>	Module "Computer Engineering"	ı				
Knowledge						
Educational Objectives	After taking part successfully, s	tudents have re	eached the following learn	ning results		
Professional Competence						
Knowledge	This module presents advance	d concepts fror	n the discipline of comp	uter architecture. In the	beginning, a l	proad overview ov
	various programming models	is given, both	for general-purpose co	mputers and for specia	al-purpose ma	achines (e.g., sig
	processors). Next, foundational	aspects of the	micro-architecture of pro	cessors are covered. Here	e, the focus pa	articularly lies on t
	so-called pipelining and the me	thods used for	the acceleration of instr	uction execution used in	this context.	The students get
	know concepts for dynamic s	cheduling, bra	nch prediction, supersc	alar execution of machi	ne instructio	ns and for memo
	hierarchies.					
Skills	The students are able to descril	-				
	models. The students examine					
	analyze them w.r.t. criteria like,	÷ ,		-		-
	know parallel computer archited	tures and are a	able to distinguish betwee	en instruction- and data-le	evel parallelis	m.
Personal Competence						
Social Competence	Students are able to solve simil	ar problems ald	ne or in a group and to p	resent the results accord	ingly.	
Autonomy	Students are able to acquire ne	w knowledae fr	om specific literature and	I to associate this knowle	dae with othe	r classes.
					- y	
Workload in Hours	Independent Study Time 110, S	tudy Time in Le	ecture 70			
Credit points	6 Commulation Banua - Earm		Description			
Course achievement	Compulsory Bonus Form No 15 % Subject	theoretical	Description and			
	practica		anu			
Examination	Written exam	WOIK				
Examination duration and	90 minutes, contents of course	and 1 attestati	ons from the PBL "Compu	ter architecture"		
scale	so minutes, contents of course					
	General Engineering Science (G	erman program	7 semester): Specialisa	tion Computer Science: F	lective Comp	ilsory
Following Curricula	Computer Science: Specialisatio				lective comp	lisory
i onowing curricula	Computer Science: Specialisatio					
	Aircraft Systems Engineering: C			Elective compulsory		
	Aircraft Systems Engineering: S			ompulsory		
	General Engineering Science (E	-	-		ective Compu	lsony
	Computational Science and Eng					1301 y

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

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

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

Courses				
Title		Τγρ	Hrs/wk	СР
Computability and Complexity The	ary (10166)	Lecture	2	3
Computability and Complexity The		Recitation Section (small)	2	3
Module Responsible	Prof. Karl-Heinz Zimmermann			
Admission Requirements	None			
Recommended Previous	Discrete Algebraic Structures, Automata	Theory, Logic, and Formal Language Theory.		
Knowledge				
Educational Objectives	After taking part successfully, students h	have reached the following learning results		
Professional Competence				
Knowledge	The students known the important machine models of computability, the class of partial recursive functions, univers computability, Gödel numbering of computations, the theorems of Kleene, Rice, and Rice-Shapiro, the concept of decidable are undecidable sets, the word problems for semi-Thue systems, Thue systems, semi-groups, and Post correspondence system Hilbert's 10-th problem, and the basic concepts of complexity theory.			
Skills	Students are able to investigate the computability of sets and functions and to analyze the complexity of computable functions.			
Personal Competence				
Social Competence	Students are able to solve specific proble	ems alone or in a group and to present the result	accordingly.	
Autonomy	Students are able to acquire new knowle	edge from newer literature and to associate the a	cquired knowledge w	vith other classes.
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56			
Credit points	6			
Course achievement	None			
Examination	Written exam			
Examination duration and	60 min			
scale				
Assignment for the	General Engineering Science (German p	rogram, 7 semester): Specialisation Computer Sci	ence: Elective Comp	ulsory
Following Curricula	Computer Science: Core Qualification: Co	ompulsory		
	Data Science: Core Qualification: Electiv	e Compulsory		
		ogram, 7 semester): Specialisation Computer Scie		ulsory
	Computational Science and Engineering	: Specialisation I. Computer Science: Elective Com	pulsory	
	Technomathematics: Specialisation II. In	formatics: Elective Compulsory		

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

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

Module M0971: Opera	iting Systems			
Courses				
Title		Тур	Hrs/wk	СР
Operating Systems (L1153)		Lecture	2	3
Operating Systems (L1154)		Recitation Section (small)	2	3
Module Responsible	Prof. Volker Turau			
Admission Requirements	None			
Recommended Previous Knowledge	<ul> <li>Object-oriented programming, algorit</li> <li>Procedural programming</li> </ul>	hms, and data structures		
	1 5 5	perating systems such as editors, linkers, compile	ers	
Educational Objectives	After taking part successfully, students have	reached the following learning results		
Professional Competence				
	process states and their transitions, and paraphrase the architectural variants of operating systems. They give examples of existing operating systems and explain their architectures. The participants of the course write concurrent programs using thread conditional variables and semaphores. Students can describe the variants of realizing a file system. Students explain at least three 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 judge the efficiency of a scheduling algorithm for a given scheduling task in a given environment.			
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 progr	am, 7 semester): Specialisation Computer Scienc	e: Elective Comp	ulsory
Following Curricula	Computer Science: Specialisation I. Computer	er and Software Engineering: Elective Compulsory	4	
	General Engineering Science (English progra	m, 7 semester): Specialisation Computer Science	e: Elective Compu	Ilsory
	Computational Science and Engineering: Spe	ecialisation I. Computer Science: Elective Computer	sory	
	Technomathematics: Specialisation II. Inform	natics: Elective Compulsory		

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

Course L1154: Operating Systems	
Тур	Recitation Section (small)
Hrs/wk	2
CP	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Prof. Volker Turau
Language	DE
Cycle	SoSe
Content	See interlocking course
Literature	See interlocking course

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			
<b>Recommended Previous</b>	<ul> <li>Automata theory and formal languages</li> </ul>			
Knowledge	<ul> <li>Automata theory and formal languages</li> <li>Procedural programming or Functional program</li> </ul>	uming		
	<ul> <li>Object-oriented programming, algorithms, and</li> </ul>	-		
	• Object-oriented programming, algorithms, and			
Educational Objectives	After taking part successfully, students have reached	the following learning results		
Professional Competence				
Knowledge	Students explain the phases of the software life	cycle, describe the fundamental terr	minology and co	oncepts of softwa
	engineering, and paraphrase the principles of structure	ed software development. They give ex	amples of softwa	re-engineering tas
	of existing large-scale systems. They write test case	ses for different test strategies and de	evise specificatio	ns or models usi
	different notations, and critique both. They explain	simple design patterns and the majo	r activities in red	quirements analys
	maintenance, and project planning.			
C1:11-	For a since body in the orthogonal life and a shuden body			
SKIIIS	Skills For a given task in the software life cycle, students identify the corresponding phase and select an appropriate me choose the proper approach for quality assurance. They design tests for realistic systems, assess the quality of the test			
	errors at different levels. They apply and modify specifications.	non-executable artifacts. They integra	ate components	based on interna
	specifications.			
Personal Competence				
Social Competence	Students practice peer programming. They explain pr	oblems and solutions to their peer. They	communicate in	English.
Autonomy	Using on-line quizzes and accompanying material fo	r calf study, students can access their	level of knowled	ae continuously a
Autonomy	adjust it appropriately. Working on exercise problems		level of knowled	ge continuously a
	adjust it appropriately. Working on excicise problem.	, they receive additional recaback.		
Workload in Hours	Independent Study Time 124, Study Time in Lecture 5	6		
Credit points	6			
Course achievement		scription		
	Yes 15 % Excercises			
Examination	Written exam			
Examination duration and	90 min			
scale				
Assignment for the	General Engineering Science (German program, 7 ser	nester): Specialisation Computer Science	e: Elective Compu	ulsory
Following Curricula	Computer Science: Core Qualification: Compulsory			
	General Engineering Science (English program, 7 sem	ester): Specialisation Computer Science	: Elective Compu	lsory
	Computational Science and Engineering: Specialisatio	n I. Computer Science: Elective Compuls	sory	
	Technomathematics: Specialisation II. Informatics: Ele			

Course L0627: Software Engineering		
Тур	Lecture	
Hrs/wk	2	
CP	3	
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28	
Lecturer	Prof. Sibylle Schupp	
Language	EN	
Cycle	SoSe	
Content	<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	ourse L0628: Software Engineering	
Тур	Recitation Section (small)	
Hrs/wk	2	
CP	3	
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28	
Lecturer	Prof. Sibylle Schupp	
Language	EN	
Cycle	SoSe	
Content	See interlocking course	
Literature	See interlocking course	

ourses				
<b>itle</b> ab Cyber-Physical Systems (L174	D) Project_(problem	m-based Learning	Hrs/wk	<b>CP</b> 6
		n-based Learning	7	0
Module Responsible				
Admission Requirements				
Kecommended Previous Knowledge	Module "Embedded Systems"			
-	After taking part successfully, students have reached the following learning res	ulte		
Professional Competence		1105		
Knowledge		ironmont via con	ore A/D and I	D/A convortors
Knowledge	actors. Due to their particular application areas, highly specialized sensors, pro			
	is a large variety of different specification approaches for CPS - in contrast to cli			
			ingineering app	
	Based on practical experiments using robot kits and computers, the basics of			
	lab introduces into the area (basic notions, characteristical properties) and the			
	hierarchical automata, data flow models, petri nets, imperative approaches). S			
	experiments will base on simple control applications. The experiments will			
	(MATLAB/Simulink, LabVIEW, NXC) in order to model cyber-physical models th actors.	lat interact with t	ne environme	nt via sensors a
Skille	After successful attendance of the lab, students are able to develop simple CPS	They understand	the interdene	ndencies betwee
SKIIIS	CPS and its surrounding processes which stem from the fact that a CPS interact			
	digital processors, D/A converters and actors. The lab enables students to			
	advantages and limitations, and to decide which technique to use for a concret			
	to practical problems. They obtain first experiences in hardware-related softw	-		
	tools and in the area of simple control applications.			
Personal Competence				
Social Competence	Students are able to solve similar problems alone or in a group and to present t	he results accordi	ngly.	
Autonomy	Students are able to acquire new knowledge from specific literature and to asso	ciate this knowled	ige with other	classes.
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56			
Credit points	6			
Course achievement	None			
Examination	Written elaboration			
Examination duration and	Execution and documentation of all lab experiments			
scale				
Assignment for the	General Engineering Science (German program, 7 semester): Specialisation Cor	nputer Science: El	lective Compu	lsory
Following Curricula				
	Computer Science: Specialisation Computer and Software Engineering: Elective	1 3		
	General Engineering Science (English program, 7 semester): Specialisation Com			
	Computational Science and Engineering: Specialisation II. Mathematics & Engin		ective Compul	sory
	Mechatronics: Specialisation Intelligent Systems and Robotics: Elective Computer	sory		
	Mechatronics: Specialisation System Design: Elective Compulsory Mechatronics: Technical Complementary Course: Elective Compulsory			

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

#### **Specialization Mechanical Engineering**

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

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

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

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

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

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

#### Module M0598: Mechanical Engineering: Design

Courses							
Title				-	vp	Hrs/wk	СР
Embodiment Design and 3D-CAD (I	0268)				<b>yp</b> ecture	Hrs/wk 2	1
Mechanical Design Project I (L0695					roject-/problem-based Learning		2
Mechanical Design Project II (L0592					roject-/problem-based Learning		2
Team Project Design Methodology					roject-/problem-based Learning		1
Module Responsible	Prof. Dieter	r Krause					
Admission Requirements							
Recommended Previous							
Knowledge	<ul> <li>Fund</li> </ul>	lamentals	of Mechanical Engineerir	ng Design			
	<ul> <li>Mech</li> </ul>	nanics					
			of Materials Science				
	<ul> <li>Prod</li> </ul>	luction Eng	jineering				
Educational Objectives	After taking	a part succ	essfully, students have r	eached the following	learning results		
Professional Competence					-		
Knowledge	After passir	ng the mo	dule, students are able to	):			
				y parts e.g. considerir	ng load situation, materials a	nd manufactur	ing requirement
			s of 3D CAD,				
	• expla	ain basics	methods of engineering	designing.			
Skills	After passir	ng the mo	dule, students are able to	o:			
	a indo	popdoptly	croate clatches, technic	al drawings and docu	montations of using 2D CA	D	
					mentations e.g. using 3D CA	υ,	
			nents based on design gu		ıy,		
	<ul> <li>dimension (calculate) used components,</li> <li>use methods to design and solve engineering design tasks systamtically and solution-oriented,</li> </ul>				ented		
			y techniques in teams.	cering design dates s	ystamateury and solution one	cincea,	
	- H H .	,	,				
Personal Competence							
Social Competence	After passir	ng the mo	dule, students are able to	D:			
	• deve	elop and e	valuate solutions in group	os including making a	nd documenting decisions,		
			use of scientific methods,		, j,		
	<ul> <li>present and discuss solutions and technical drawings within groups,</li> </ul>						
	<ul> <li>reflect the own results in the work groups of the course.</li> </ul>						
Autonomy	Students ar	re able					
					ods within the lectures (e.g. w	vith clickers),	
	• 10 S0	sive engin	eering design tasks syste	ematically.			
Workload in Hours	Independer	nt Study T	me 40, Study Time in Le	cture 140			
Credit points	6						
Course achievement	Compulsory	Bonus	Form	Description			
	Yes	None	Written elaboration	Teamprojekt Ko	nstruktionsmethodik		
		None	Written elaboration	Konstruktionspr			
		None	Written elaboration	Konstruktionspr			
		None	Written elaboration	3D-CAD-Praktik	um		
Examination	Written exa	im					
Examination duration and	180						
scale							
		5 5			ialisation Mechanical Enginee	5 1	,
Assignment for the	a General Engineering Science (German program, 7 semester): Specialisation Biomedical Engineering: Compulsory						
Assignment for the Following Curricula	- · ·	General Engineering Science (German program, 7 semester): Specialisation Biomedical Engineering: Compulsory			ory		
-							
-	Digital Mec	hanical En	gineering: Core Qualifica	1 3			
-	Digital Mec Energy and	hanical En Environm	ental Engineering: Core (	Qualification: Compul	sory		
-	Digital Mec Energy and Engineering	hanical En I Environm g Science:	ental Engineering: Core ( Core Qualification: Comp	Qualification: Compul oulsory	sory alisation Biomedical Engineer	ing. Commuter	24

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

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

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

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

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

Courses				
Title		Тур	Hrs/wk	СР
Fundamentals of Materials Science	Lecture	2	2	
Fundamentals of Materials Science	Lecture	2	2	
Physical and Chemical Basics of Ma	terials Science (L1095)	Lecture	2	2
Module Responsible	Prof. Jörg Weißmüller			
Admission Requirements	None			
<b>Recommended Previous</b>	Highschool-level physics, chemistry und mathematics			
Knowledge				
Educational Objectives	After taking part successfully, students have reached the follow	ing learning results		
Professional Competence	The students have acquired a fundamental knowledge on n			alle e delle due erader
	comprehensively. Fundamental knowledge here means specific phase transformations, corrosion and mechanical properties. Th for materials and can identify relevant approaches for cha phenomena back to the underlying physical and chemical laws	ne students know abo racterizing specific p	ut the key aspects of char	acterization meth
Skills	The students are able to trace materials phenomena back to the underlying physical and chemical laws of nature. Materi phenomena here refers to mechanical properties such as strength, ductility, and stiffness, chemical properties such as corros resistance, and to phase transformations such as solidification, precipitation, or melting. The students can explain the relat between processing conditions and the materials microstructure, and they can account for the impact of microstructure on material's behavior.			
Personal Competence				
Social Competence	-			
Autonomy	-			
	Independent Study Time 96, Study Time in Lecture 84			
Credit points				
Course achievement				
Examination				
Examination duration and				
scale	100 11111			
	General Engineering Science (German program, 7 semester): S	necialisation Mechani	cal Engineering: Compulse	)ry
-	General Engineering Science (German program, 7 semester): S			-
· · · · · · · · · · · · · · · · · · ·	General Engineering Science (German program, 7 semester): S			. ,
	Data Science: Specialisation Materials Science: Compulsory			
	Digital Mechanical Engineering: Core Qualification: Compulsory			
	Energy and Environmental Engineering: Core Qualification: Com	pulsory		
	Green Technologies: Energy, Water, Climate: Specialisation Ene	ergy Technology: Elect	tive Compulsory	
	Logistics and Mobility: Specialisation Engineering Science: Elect	ive Compulsory		
	Logistics and Mobility: Specialisation Production Management a	nd Processes: Elective	e Compulsory	
	Mechanical Engineering: Core Qualification: Compulsory			
	Mechatronics: Core Qualification: Compulsory			
	Naval Architecture: Core Qualification: Compulsory			
	Technomathematics: Specialisation III. Engineering Science: Ele	ctive Compulsory		
	Technomathematics: Specialisation III. Engineering Science: Ele Engineering and Management - Major in Logistics and Mobilit		duction Management and	Processes: Elect

	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-

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

Course L1095: Physical and C	Chemical Basics of Materials Science		
Тур	Lecture		
Hrs/wk	2		
СР	2		
Workload in Hours	lependent Study Time 32, Study Time in Lecture 28		
Lecturer	Gregor Vonbun-Feldbauer, 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	<ul> <li>Für den Elektromagnetismus:</li> <li>Bergmann-Schäfer: "Lehrbuch der Experimentalphysik", Band 2: "Elektromagnetismus", de Gruyter</li> <li>Für die Atomphysik:</li> <li>Haken, Wolf: "Atom- und Quantenphysik", Springer</li> <li>Für die Materialphysik und Elastizität:</li> <li>Hornbogen, Warlimont: "Metallkunde", Springer</li> </ul>		

Courses				
Title		Turn	Hire /w/c	СР
		<b>Typ</b> Lecture	Hrs/wk 2	2
Advanced Mechanical Engineering I Advanced Mechanical Engineering I		Recitation Section (large)	2	2
Advanced Mechanical Engineering I		Lecture	2	2
Advanced Mechanical Engineering I	-	Recitation Section (large)	2	1
Module Responsible				
Admission Requirements				
Recommended Previous				
Knowledge	<ul> <li>Fundamentals of Mechanical Engineering</li> </ul>	g Design		
Kilowieuge	Mechanics			
	Fundamentals of Materials Science			
	Production Engineering			
-	After taking part successfully, students have re	ached the following learning results		
Professional Competence				
Knowledge	After passing the module, students are able to:			
	explain complex working principles and	functions of machine elements and of basic el	ements of fluidics	ō,
	<ul> <li>explain requirements, selection criteria,</li> </ul>	application scenarios and practical examples	of complex machi	ine elements,
	<ul> <li>indicate the background of dimensioning</li> </ul>	calculations.		
Skills	s After passing the module, students are able to:			
	<ul> <li>accomplish dimensioning calculations of</li> </ul>			
		le to new requirements and tasks (problem so	iving skills),	
	<ul> <li>recognize the content of technical drawi</li> </ul>	ngs and schematic sketches,		
	<ul> <li>evaluate complex designs, technically.</li> </ul>			
Personal Competence				
Social Competence				
Social competence	<ul> <li>Students are able to discuss technical in</li> </ul>	formation in the lecture supported by activation	ng methods.	
A				
Autonomy	<ul> <li>Students are able to independently deepen their acquired knowledge in exercises.</li> </ul>			
		knowledge and to recapitulate poorly under	stood content e.c	a, by using the vio
	recordings of the lectures.	······································		,,
Workload in Hours	Independent Study Time 68, Study Time in Lec	ture 112		
Credit points	6			
Course achievement	None			
Examination				
Examination duration and	120			
scale				
-	General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering: Compulsory			
Following Curricula	a General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Energy Syste			cus Energy Syster
	Compulsory			
	Energy and Environmental Engineering: Core Q	ualification: Elective Compulsory		
	Energy Systems: Technical Complementary Con	urse Core Studies: Elective Compulsory		
	Engineering Science: Specialisation Mechanical	Engineering: Compulsory		
	General Engineering Science (English program,	7 semester): Specialisation Mechanical Engin	eering: Compulso	ory
	General Engineering Science (English progra	m, 7 semester): Specialisation Mechanical	Engineering, Foc	us Energy Syster
	Scherdi Engliseering Science (English produ			
	Compulsory		5 5.	5, ,
			5 5.	5, ,

Course L0264: Advanced Med	chanical Engineering Design II			
Тур	Lecture			
Hrs/wk	2			
CP	2			
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28			
Lecturer	Prof. Dieter Krause, Prof. Otto von Estorff			
Language	DE			
Cycle	SoSe			
Content	Advanced Mechanical Engineering Design I & II			
	Lecture			
	Fundamentals of the following machine elements:			
	Linear rolling bearings			
	Axes & shafts			
	• Seals			
	Clutches & brakes			
	• Belt & chain drives			
	Gear drives			
	• Epicyclic gears			
	Crank drives			
	Sliding bearings			
	Elements of fluidics			
	Exercise			
	Calculation methods of the following machine elements:			
	Linear rolling bearings			
	Axes & shafts			
	Clutches & brakes			
	Belt & chain drives			
	Gear drives			
	Epicyclic gears			
	Crank gears			
	Sliding bearings			
	Calculations of hydrostatic systems (fluidics)			
Literature				
	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.     Konstruktionaleken Patha G. Patie W. Geningen Verlag, alterative Auflagen			
	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			
	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		
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 Me	chanical Engineering Design I
Тур	Lecture
Hrs/wk	2
СР	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	
Language	
Cycle	WiSe
Content	
	Lecture
	Fundamentals of the following machine elements:
	Linear rolling bearings
	• Axes & shafts
	• Seals
	Clutches & brakes
	Belt & chain drives
	Gear drives
	• Epicyclic gears
	Crank drives
	Sliding bearings
	Elements of fluidics
	Exercise
	Calculation methods of the following machine elements:
	Linear rolling bearings
	• Axes & shafts
	Clutches & brakes
	Belt & chain drives
	Gear drives
	• Epicyclic gears
	Crank gears
	<ul> <li>Sliding bearings</li> <li>Calculations of hydrostatic systems (fluidics)</li> </ul>
	• Calculations of hydrostatic systems (numers)
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> </ul>
	<ul> <li>Maschinen- und Konstruktionselemente, Steinniper, W., Köper, K., Springer Verlag, aktuelle Auhage.</li> <li>Einführung in die DIN-Normen; Klein, M., Teubner-Verlag.</li> </ul>
	<ul> <li>Konstruktionslehre, Pahl, G.; Beitz, W., Springer-Verlag, aktuelle Auflage.</li> </ul>
	<ul> <li>Maschinenelemente 1-2; Schlecht, B., Pearson Verlag, aktuelle Auflage.</li> </ul>
	<ul> <li>Maschinenelemente - Gestaltung, Berechnung, Anwendung; Haberhauer, H., Bodenstein, F., Springer-Verlag, aktuelle</li> </ul>
	Auflage.
	<ul> <li>Roloff/Matek Maschinenelemente; Wittel, H., Muhs, D., Jannasch, D., Voßiek, J., Springer Vieweg, aktuelle Auflage.</li> </ul>
	Sowie weitere Bücher zu speziellen Themen
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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 Sec	ction (large)	2	2
Module Responsible	Prof. Thomas Rung				
Admission Requirements	None				
<b>Recommended Previous</b>	Sound knowledge of engineering mather	matics, engineering mechanics and th	ermodynamics.		
Knowledge					
Educational Objectives	After taking part successfully, students h	nave reached the following learning re	sults		
Professional Competence					
Knowledge	Students will have the required sound knowledge to explain the general principles of fluid engineering and physics of fluids. Students can scientifically outline the rationale of flow physics using mathematical models and are familiar with methods for the performance analysis and the prediciton of fluid engineering devices.				
Skills	Students are able to apply fluid-engineering principles and flow-physics models for the analysis of technical systems. The lecture enables the student to carry out all necessary theoretical calculations for the fluid dynamic design of engineering devices on a scientific level.				
Personal Competence					
Social Competence	The students are able to discuss problen	ns and jointly develop solution strateg	ies.		
Autonomy	The students are able to develop solution strategies for complex problems self-consistent and crtically analyse results.				
Workload in Hours	Independent Study Time 110, Study Tim	e in Lecture 70			
Credit points					
Course achievement					
Examination	Written exam				
Examination duration and	180 min				
scale					
Assignment for the	General Engineering Science (German p	rogram, 7 semester): Specialisation M	echanical Engineer	ring: Compuls	ory
-	General Engineering Science (German p	-	-		-
-	General Engineering Science (German p	-	-	÷ .	-
	Mechanical Engineering: Core Qualificati	-			
	Naval Architecture: Core Qualification: C	ompulsory			
	Technomathematics: Specialisation III. E	ngineering Science: Elective Compuls	ory		

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

Course L0455: Fluid Mechani	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		

Courses					
Title		Тур	Hrs/wk	СР	
Mechanics IV (Oscillations, Analytic	al Mechanics, Numerical Mechanics) (L1137)	Lecture	3	3	
Mechanics IV (Oscillations, Analytic	Recitation Section (small)	2	2		
Mechanics IV (Oscillations, Analytic	al Mechanics, Numerical Mechanics) (L1139)	Recitation Section (large)	1	1	
Module Responsible	Prof. Robert Seifried				
Admission Requirements	None				
<b>Recommended Previous</b>	Mathematics I-III and Mechanics I-III				
Knowledge					
Educational Objectives	After taking part successfully, students have reach	ed the following learning results			
Professional Competence					
Knowledge	The students can				
	- describe the evidence is recording to the	achanical contractor			
	<ul> <li>describe the axiomatic procedure used in m</li> <li>explain important steps in model design;</li> </ul>	echanical contexts;			
	<ul> <li>explain important steps in model design;</li> <li>present technical knowledge.</li> </ul>				
	<ul> <li>present technical knowledge.</li> </ul>				
Skills	The students can				
	<ul> <li>explain the important elements of mathematical / mechanical analysis and model formation, and apply it to the context their own problems;</li> <li>apply basic methods to apply problems;</li> </ul>				
	<ul> <li>apply basic methods to engineering problems;</li> <li>estimate the reach and boundaries of the methods and extend them to be applicable to wider problem sets.</li> </ul>				
	• estimate the reach and boundaries of the m	ethous and extend them to be applicable t	o wider problem	3613.	
Personal Competence					
	The students can work in groups and support each	other to overcome difficulties			
Social Competence	The students can work in groups and support each	other to overcome anneattes.			
Autonomy	Students are capable of determining their own stre	engths and weaknesses and to organize the	eir time and lear	ning based on those	
Workload in Hours	Independent Study Time 96, Study Time in Lecture	2 84			
Credit points	6				
Course achievement	None				
Examination	Written exam				
Examination duration and	120 min				
scale					
Assignment for the	General Engineering Science (German program, 7	semester): Specialisation Mechanical Engir	neering: Compuls	sory	
Following Curricula	General Engineering Science (German program, 7	semester): Specialisation Biomedical Engir	eering: Compuls	sory	
	General Engineering Science (German program, 7	semester): Specialisation Naval Architectu	re: Compulsory		
	Energy Systems: Technical Complementary Course	e Core Studies: Elective Compulsory			
	Mechanical Engineering: Core Qualification: Compu	ulsory			
	Mechatronics: Core Qualification: Compulsory				
	Naval Architecture: Core Qualification: Compulsory	,			
	Technomathematics: Specialisation III. Engineering	Science: Elective Compulsory			
	Theoretical Mechanical Engineering: Technical Con				

Course L1137: Mechanics IV	(Oscillations, Analytical Mechanics, Numerical Mechanics)
Тур	Lecture
Hrs/wk	3
СР	3
Workload in Hours	Independent Study Time 48, Study Time in Lecture 42
Lecturer	Prof. Robert Seifried
Language	DE
Cycle	SoSe
Content	
	<ul> <li>Elements of vibration theory</li> <li>Vibration of Multi-degree of freedom systems</li> <li>Analytical Mechanics</li> <li>Multibody Systems</li> <li>Numerical methods for time integration</li> <li>Introduction to Matlab</li> </ul>
Literature	K. Magnus, H.H. Müller-Slany: Grundlagen der Technischen Mechanik. 7. Auflage, Teubner (2009). D. Gross, W. Hauger, J. Schröder, W. Wall: Technische Mechanik 1-4. 11. Auflage, Springer (2011). W. Schiehlen, P. Eberhard: Technische Dynamik, Springer (2012).

Course L1138: Mechanics IV	(Oscillations, Analytical Mechanics, Numerical Mechanics)
Тур	Recitation Section (small)
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Prof. Robert Seifried
Language	DE
Cycle	SoSe
Content	See interlocking course
Literature	See interlocking course
Course L1139: Mechanics IV	(Oscillations, Analytical Mechanics, Numerical Mechanics)
Тур	Recitation Section (large)
Hrs/wk	1
CP	1
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14
Lecturer	Prof. Robert Seifried
l anguage	DE

Language	DE
Cycle	SoSe
Content	See interlocking course
Literature	See interlocking course

Courses					
Title			Tree	I lan (acle	CD.
	Control Systems (1111)	0)	<b>Typ</b> Practical Course	Hrs/wk 2	<b>CP</b> 2
Practical Course: Measurement and Control Systems (L1119) Measurement Technology for Mechanical Engineering (L1116)			Lecture	2	3
Measurement Technology for Mech			Recitation Section (large)	1	1
Module Responsible					
Admission Requirements	None				
Recommended Previous		hysics, chemistry and electrica	al engineering		
Knowledge	busic knowledge of p	ingsies, enemisely und electric	arengineering		
	After taking part succ	cessfully, students have reache	ed the following learning results		
Professional Competence	Filter taking part back				
-		name the most important fun nd Dynamic Properties of Senso	ndmentals of the Measurement Technol ors and Systems).	ogy (Quantities an	d Units, Uncertair
	They can outline the most important measuring methods for different kinds of quantities to be maesured (Electrical Quan Temperature, mechanical quantities, Flow, Time, Frequency).				(Electrical Quantit
	They can describe im	nportant methods of chemical A	Analysis (Gas Sensors, Spectroscopy, Ga	is Chromatography	)
Skills	Students can select s	suitable measuring methods to	given problems and can use refering m	easurement device	es in practice.
		e to orally explain issues in th the right context and applicati	e subject area of measurement techno on area.	logy and solution a	pproaches as we
Personal Competence					
Social Competence	Students can arrive a	at work results in groups and d	ocument them in a common report.		
Autonomy	Students are able to	familiarize themselves with ne	w measurement technologies.		
Workload in Hours	Independent Study T	ime 110, Study Time in Lectur	e 70		
Credit points	6				
Course achievement	Compulsory Bonus	Form	Description		
	Yes None	Subject theoretical and			
		practical work			
Examination	Subject theoretical an	nd practical work			
Examination duration and	105 minutes				
scale					
Assignment for the	General Engineering	Science (German program, 7 s	emester): Specialisation Mechanical Eng	gineering: Compuls	ory
Following Curricula	General Engineering	Science (German program, 7 s	emester): Specialisation Biomedical Eng	gineering: Compuls	ory
	General Engineering	Science (German program, 7 s	emester): Specialisation Energy and En	viromental Enginee	ering: Compulsory
	Digital Mechanical En	ngineering: Core Qualification:	Compulsory		
	Energy and Environm	nental Engineering: Core Qualif	ication: Compulsory		
	Engineering Science:	Specialisation Mechatronics: 0	Compulsory		
	Engineering Science:	Specialisation Mechanical Eng	ineering: Compulsory		
	Engineering Science:	Specialisation Biomedical Eng	ineering: Elective Compulsory		
	General Engineering	Science (English program, 7 se	emester): Specialisation Energy and Env	iromental Engineer	ring: Compulsory
	General Engineering	Science (English program, 7 se	emester): Specialisation Mechanical Eng	ineering: Compulso	ory
	General Engineering	Science (English program, 7 se	emester): Specialisation Biomedical Eng	ineering: Compulso	iry
	General Engineering	Science (English program, 7 se	emester): Specialisation Mechatronics: C	Compulsory	
			emester): Specialisation Mechanical Eng		-
			emester): Specialisation Biomedical Eng	-	Compulsory
			nagement and Processes: Elective Com	pulsory	
	-	ing: Core Qualification: Compu	lsory		
		Qualification: Compulsory			
		nagement - Major in Logistics	and Mobility: Specialisation Production	n Management and	d Processes: Elec
			and Mobility: Specialisation Production	n Management and	d Processes:

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

Course L1116: Measurement	Technology for Mechanical Engineering
Тур	Lecture
Hrs/wk	2
СР	3
	Independent Study Time 62, Study Time in Lecture 28
	Prof. Thorsten Kern, Dennis Kähler
Language	
Cycle	WiSe 1 Fundamentals
Content	1.1 Quantities and Units 1.2 Uncertainty
	1.3 Calibration 1.4 Static and Dynamic Properties of Sensors and Systems
	2 Measurement of Electrical Quantities
	2.1 Current and Voltage 2.2 Impedance
	2.3 Amplification
	2.4 Oscilloscope
	2.5 Analog-to-Digital Conversion
	2.6 Data Transmission
	3 Measurement of Nonelectric Quantities
	3.1 Temperature
	3.2 Length, Displacement, Angle
	3.3 Strain, Force, Pressure
	3.4 Flow
	3.5 Time, Frequency
Literature	Lerch, R.: "Elektrische Messtechnik; Analoge, digitale und computergestützte Verfahren", Springer, 2006, ISBN: 978-3-540-34055- 3.
	Profos, P. Pfeifer, T.: "Handbuch der industriellen Messtechnik", Oldenbourg, 2002, ISBN: 978-3486217940.

Course L1118: Measurement	ourse L1118: Measurement Technology for Mechanical Engineering	
Тур	Recitation Section (large)	
Hrs/wk	1	
CP	1	
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14	
Lecturer	Thorsten Kern	
Language	EN	
Cycle	WiSe	
Content	See interlocking course	
Literature	See interlocking course	

### Focus Biomechanics

	-	engineering skills, a basic understandin anning as well as research and developm	-	-
Module M1277: MED	: Introduction to Anatomy			
Courses				
Title		Тур	Hrs/wk	СР
Introduction to Anatomy (L0384)		Lecture	2	3
Module Responsible	Prof. Udo Schumacher			
Admission Requirements	None			
<b>Recommended Previous</b>	None			
Knowledge				
Educational Objectives	After taking part successfully, students have	ve reached the following learning results		
Professional Competence				
Knowledge	The students can describe basal structures	and functions of internal organs and the m	usculoskeletal system.	
	The students can describe the basic macro	scopy and microscopy of those systems.		
Skills	The students can recognize the relationshi	p between given anatomical facts and the d	evelopment of some co	mmon diseases: the
		d their functions in the context of widesprea		
Personal Competence				
Social Competence	The students can participate in current disc	cussions in biomedical research and medicin	ne on a professional leve	el.
Autonomy	The students are able to access anatomic	al knowledge by themselves, can participa	te in conversations on t	he topic and acqui
	the relevant knowledge 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	90 minutes			
scale				
Assignment for the	General Engineering Science (German prog	gram, 7 semester): Specialisation Biomedica	al Engineering: Compulso	ory
Following Curricula	General Engineering Science (German p	program, 7 semester): Specialisation Med	chanical Engineering, F	ocus Biomechanic
	Compulsory			
	Data Science: Specialisation Medicine: Con			
	Electrical Engineering: Specialisation Medio			
	Engineering Science: Specialisation Biomed			
		ram, 7 semester): Specialisation Biomedical	Engineering: Compulso	ry
	Mechanical Engineering: Specialisation Bio			
		dical Technology and Control Theory: Electiv		
		nagement and Business Administration: Elec		
		ficial Organs and Regenerative Medicine: El		
		plants and Endoprostheses: Elective Compul	sory	
	Technomathematics: Specialisation III. Eng	ineering Science: Elective Compulsory		

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

Courses					
Title		Тур	Hrs/wk	СР	
ntroduction to Radiology and Radi	ation Therapy (L0383)	Lecture	2	3	
Module Responsible	Prof. Ulrich Carl				
Admission Requirements	None				
Recommended Previous	None				
Knowledge Educational Objectives	After taking part successfully students h	nave reached the following learning results			
Professional Competence	Arter taking part successiony, scolents in	ave reached the following learning results			
Knowledge	Therapy				
	The students can distinguish different ty	pes of currently used equipment with respect	to its use in radiation the	erapy.	
	The students can explain treatment plan	is used in radiation therapy in interdisciplinary	y contexts (e.g. surgery,	internal medicine).	
	The students can describe the patie	nts' passage from their initial admittanc	e through to follow-up	care.	
	Diagnostics				
	The students can illustrate the technica well as sectional imaging techniques (CT	I base concepts of projection radiography, in , MRT, US).	cluding angiography and	d mammography, a	
	The students can explain the diagnostic techniques.	as well as therapeutic use of imaging techni	ques, as well as the tech	nnical basis for thos	
	The students can choose the right treatn	nent method depending on the patient's clinic	al history and needs.		
	The student can explain the influence of	technical errors on the imaging techniques.			
			or the error protocol		
	The student can draw the right conclusions based on the images' diagnostic findings or the error protocol.				
Skills	s <b>Therapy</b> The students can distinguish curative and palliative situations and motivate why they came to that conclusion.				
	The students can develop adequate therapy concepts and relate it to the radiation biological aspects.				
	The students can use the therapeutic pri	nciple (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 indivi groups, self-help groups, social services,	dual psychosocial service should look like ( psycho-oncology).	e.g. follow-up treatment	t, sports, social he	
	Diagnostics				
	The students can suggest solutions for re	epairs of imaging instrumentation after having	n done error analyses		
	The students can classify results of ima anatomy, pathology and pathophysiology	aging techniques according to different grou y.	ps of diseases based or	n their knowledge	
Personal Competence					
Social Competence		al situation of tumor patients and interact wit I, often fear-dominated behavior of sick pe tely.		-	
Autonomy	The students can apply their new knowle	edge and skills to a concrete therapy case.			
Autonomy	The students can introduce younger students				
	The students are able to access anatom and acquire the relevant knowledge ther	nical knowledge by themselves, can participal mselves.	te competently in conve	rsations on the top	
Workload in Hours	Independent Study Time 62, Study Time	in Lecture 28			
Credit points					
Course achievement	None				
Examination					
Examination duration and scale	90 minutes				
	General Engineering Science (German pr	rogram, 7 semester): Specialisation Biomedica	al Engineering: Compulso	ory	
Following Curricula		program, 7 semester): Specialisation Me			
	Compulsory				
	Data Science: Specialisation Medicine: Co Electrical Engineering: Specialisation Medicine				
	Engineering Science: Specialisation Biom				
		ogram, 7 semester): Specialisation Biomedica	l Engineering: Compulsor	ry	
	Mechanical Engineering: Specialisation B Biomedical Engineering: Specialisation M	Biomechanics: Compulsory Aedical Technology and Control Theory: Electiv	ve Compulsory		
		lanagement and Business Administration: Electro			
	bioinedical Engineering. Specialisation is	landgement and business Administration. Ele			
	Biomedical Engineering: Specialisation A	rtificial Organs and Regenerative Medicine: El mplants and Endoprostheses: Elective Comput	lective Compulsory		

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

Courses				
Title	Туј	p	Hrs/wk	СР
Numerical Mathematics I (L0417)		cture	2	3
Numerical Mathematics I (L0418)	Rec	citation Section (small)	2	3
Module Responsible	Prof. Sabine Le Borne			
Admission Requirements	None			
<b>Recommended Previous</b>	<ul> <li>Mathematik I + II for Engineering Students (german or english</li> </ul>	a) <b>or</b> Analysis & Linear Alo	ebra I + II for Te	chnomathematic
Knowledge	<ul> <li>basic MATLAB/Python knowledge</li> </ul>	if of Analysis a Einear Aig		ennomathematik
-	After taking part successfully, students have reached the following le	earning results		
Professional Competence				
Knowledge	Students are able to			
	name numerical methods for interpolation, integration, least s	squares problems, eigenv	alue problems, n	onlinear root fin
	problems and to explain their core ideas,			
	<ul> <li>repeat convergence statements for the numerical methods,</li> </ul>			
	<ul> <li>explain aspects for the practical execution of numerical method</li> </ul>	ods with respect to compu	itational and stor	rage complexitx.
Skills	Students are able to			
	<ul> <li>implement, apply and compare numerical methods using MAT</li> </ul>	I AB/Python		
	<ul> <li>justify the convergence behaviour of numerical methods with</li> </ul>		nd solution algori	thm
	<ul> <li>select and execute a suitable solution approach for a given pro</li> </ul>		la solution algon	,
Personal Competence				
Social Competence	Students are able to			
	<ul> <li>work together in heterogeneously composed teams (i.e., tean</li> </ul>	ns from different study pr	ograms and back	karound knowled
	explain theoretical foundations and support each other with p			
	. F			
Autonomy	Students are capable			
	<ul> <li>to assess whether the supporting theoretical and practical exc</li> </ul>	cercises are better solved	individually or in	a team.
	<ul> <li>to assess their individual progess and, if necessary, to ask que</li> </ul>		, <b>,</b> .	
Workload in Hours				
Credit points				
Course achievement	None			
Examination	Written exam			
Examination duration and	90 minutes			
scale				
	General Engineering Science (German program, 7 semester): Specia			
Following Curricula	General Engineering Science (German program, 7 semester):	Specialisation Mechanica	al Engineering,	Focus Material
	Engineering Sciences: Compulsory			
	General Engineering Science (German program, 7 semester): Specia			
	General Engineering Science (German program, 7 semester): S	pecialisation Mechanical	Engineering, F	ocus Biomecna
	Compulsory General Engineering Science (German program, 7 semester): Specia	alisation Mechanical Engin	eering Focus Th	enetical Mecha
	General Engineering Science (German program, 7 semester): Specia Engineering: Compulsory	maation meenanical Englit	comig, rocus III	corectar Metrid
	General Engineering Science (German program, 7 semester): Sp	ecialisation Mechanical F	Engineering Foc	us Aircraft Svet
	Engineering: Elective Compulsory	Leansacon meenamed L		
	General Engineering Science (German program, 7 semester): Specia	alisation Mechanical Engir	neerina. Focus M	echatronics: Elec
	Compulsory	in the second second	J, . 2 240 M	
	General Engineering Science (German program, 7 semester): Sp	ecialisation Mechanical E	ngineering, Foc	us Energy Syste
	Elective Compulsory		-	
	Bioprocess Engineering: Specialisation A - General Bioprocess Engine	eering: Elective Compulso	ry	
	Computer Science: Specialisation Computational Mathematics: Election	ive Compulsory		
	Computer Science: Specialisation II. Mathematics and Engineering Science	cience: Elective Compulso	ry	
	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 Qu			
	General Engineering Science (English program, 7 semester): Speciali			
		pecialisation Mechanical	Engineering, F	ocus Biomecha
	General Engineering Science (English program, 7 semester): S			
	Compulsory			
	Compulsory General Engineering Science (English program, 7 semester): Special	isation Mechanical Engine	ering, Focus Mat	erials in Enginee
	Compulsory General Engineering Science (English program, 7 semester): Special Sciences: Compulsory			
	Compulsory General Engineering Science (English program, 7 semester): Special Sciences: Compulsory General Engineering Science (English program, 7 semester): Specia			
	Compulsory General Engineering Science (English program, 7 semester): Special Sciences: Compulsory General Engineering Science (English program, 7 semester): Specia Engineering: Compulsory	lisation Mechanical Engine	eering, Focus Th	eoretical Mecha
	Compulsory General Engineering Science (English program, 7 semester): Special Sciences: Compulsory General Engineering Science (English program, 7 semester): Specia Engineering: Compulsory General Engineering Science (English program, 7 semester): Special	lisation Mechanical Engine	eering, Focus Th ering: Compulsor	eoretical Mecha
	Compulsory General Engineering Science (English program, 7 semester): Special Sciences: Compulsory General Engineering Science (English program, 7 semester): Specia Engineering: Compulsory	lisation Mechanical Engine	eering, Focus Th ering: Compulsor	eoretical Mecha

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

Course L0418: Numerical Ma	urse 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	Sabine Le Borne, Dr. Jens-Peter Zemke		
Language			
Cycle	WiSe		
Content	See interlocking course		
Literature	See interlocking course		

Courses				
Title		Түр	Hrs/wk	СР
Introduction to Biochemistry and M	olecular Biology (L0386)	Lecture	2	3
Module Responsible	Prof. Hans-Jürgen Kreienkamp			
Admission Requirements	None			
<b>Recommended Previous</b>	None			
Knowledge				
Educational Objectives	After taking part successfully, studer	nts have reached the following learning results		
Professional Competence				
Knowledge	The students can			
	<ul> <li>describe basic biomolecules;</li> </ul>			
	explain how genetic information	on is coded in the DNA;		
	explain the connection between	en DNA and proteins;		
Chille	The students can			
SKIIIS	The students can			
	<ul> <li>recognize the importance of n</li> </ul>	nolecular parameters for the course of a disease;		
	<ul> <li>describe selected molecular-d</li> </ul>	5 1 .		
	<ul> <li>explain the relevance of these</li> </ul>	e procedures for some diseases		
Personal Competence				
Social Competence	The students can participate in discu	ussions in research and medicine on a technical leve	el.	
Autonomy	The students can develop understan	ding of topics from the course, using technical liter	ature, by themselves.	
Workload in Hours	Independent Study Time 62, Study T	ime in Lecture 28		
Credit points	3			
Course achievement	None			
Examination	Written exam			
Examination duration and	60 minutes			
scale				
Assignment for the	General Engineering Science (Germa	an program, 7 semester): Specialisation Biomedical	Engineering: Compulsory	у
Following Curricula	General Engineering Science (Ger	man program, 7 semester): Specialisation Mech	hanical Engineering, Fo	cus Biomechani
	Compulsory			
	Data Science: Specialisation Medicin			
		Medical Technology: Elective Compulsory		
	Engineering Science: Specialisation I		Fraincering, Compulsor	
		h program, 7 semester): Specialisation Biomedical I Ilish program, 7 semester): Specialisation Mech		
	Compulsory	insi program, 7 semestery. Specialisation meet	lanical Engineering, 10	biomeename
	Mechanical Engineering: Specialisati	on Biomechanics: Compulsory		
		on Management and Business Administration: Elect	ive Compulsory	
	Biomedical Engineering: Specialisation	on Artificial Organs and Regenerative Medicine: Ele	ctive Compulsory	
	Biomedical Engineering: Specialisation	on Medical Technology and Control Theory: Elective	e Compulsory	
	Biomedical Engineering: Specialisation	on Implants and Endoprostheses: Elective Compulse	ory	

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

Courses				
Courses Title		Tun	Hrs/wk	СР
Incle Implants and Fracture Healing (L03	76)	<b>Typ</b> Lecture	<b>нг5/wк</b> 2	3
Module Responsible				
Admission Requirements	None			
<b>Recommended Previous</b>	It is recommended to participate in "Intro	duction into Anatomie" before attending "Imp	plants and Fracture Heal	ing".
Knowledge				
Educational Objectives	After taking part successfully, students h	ave reached the following learning results		
Professional Competence				
Knowledge	The students can describe the different w	ays how bones heal, and the requirements fo	or their existence.	
	The students can name different treatme	nts for the spine and hollow bones under give	en fracture morphologies	i.
Skills	The students can determine the forces a	ting within the human body under quasi-stati	ic situations under speci	fic assumptions.
Personal Competence				
Social Competence	The students can, in groups, solve basic r	numerical modeling tasks for the calculation o	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 Med	chanical Engineering, F	ocus Biomechani
Following Curricula	Compulsory			
	General Engineering Science (German pro	ogram, 7 semester): Specialisation Biomedica	al Engineering: Compulso	ory
	Engineering Science: Specialisation Biom			
		gram, 7 semester): Specialisation Biomedical		-
		program, 7 semester): Specialisation Mec	hanical Engineering, F	ocus Biomechani
	Compulsory			
	Mechanical Engineering: Specialisation Bi	omechanics: Compulsory		
	Biomedical Engineering: Specialisation In	plants and Endoprostheses: Elective Compute	sory	
		tificial Organs and Regenerative Medicine: El		
	Biomedical Engineering: Specialisation M	anagement and Business Administration: Elec	tive Compulsory	
	Biomedical Engineering: Specialisation M	edical Technology and Control Theory: Electiv	e Compulsory	
	Orientation Studies: Core Qualification: El	lective Compulsory		

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

Courses				
Title		Тур	Hrs/wk	СР
Introduction to Physiology (L0385)		Lecture	2	3
Module Responsible	Dr. Roger Zimmermann			
Admission Requirements	None			
<b>Recommended Previous</b>	None			
Knowledge				
Educational Objectives	After taking part successfully, students h	nave reached the following learning results		
<b>Professional Competence</b>				
Knowledge	The students can			
	<ul> <li>describe the basics of the energy</li> </ul>	metabolism:		
		selected fields of muscle, heart/circulation, r	neuro- and sensory physic	oloav.
Skills		basic bodily functions (sensory, transmission	n and processing of infor	mation, developm
	of forces and vital functions) and relate t	hem to similar technical systems.		
Personal Competence				
Social Competence		research and medicine on a technical level.		
	The students can find solutions to proble	ems in the field of physiology, both analytical	and metrological.	
Autonomy	The students can derive answers to qu	estions arising in the course and other phys	siological areas, using te	chnical literature
	themselves.			
	Independent Study Time 62, Study Time	in Lecture 28		
Credit points				
Course achievement				
Examination	Written exam			
Examination duration and	60 minutes			
scale				
Assignment for the		rogram, 7 semester): Specialisation Biomedic		
Following Curricula		program, 7 semester): Specialisation Me	echanical Engineering, I	-ocus Biomechan
	Compulsory			
	Data Science: Specialisation Medicine: C			
	Electrical Engineering: Specialisation Me	nedical Engineering: Elective Compulsory		
		program, 7 semester): Specialisation Me	chanical Engineering	- ocus Biomechan
	Compulsory		ienamear Engineering, i	Biomeentan
		ogram, 7 semester): Specialisation Biomedica	al Engineering: Compulso	rv
		ogram, 7 semester): Specialisation Biomedica		
	Mechanical Engineering: Specialisation E		5 5	
		ledical Technology and Control Theory: Electi	ve Compulsory	
	Biomedical Engineering: Specialisation M	lanagement and Business Administration: Ele	ctive Compulsory	
	Biomedical Engineering: Specialisation A	rtificial Organs and Regenerative Medicine: E	lective Compulsory	
	Biomedical Engineering: Specialisation In	mplants and Endoprostheses: Elective Compu	llsory	
	Technomathematics: Specialisation III. E	naineering Science: Elective Compulsory		

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

Courses					
Title		Тур	Hrs/wk	СР	
Experimental Methods in Biomecha	anics (L0377)	Lecture	2	3	
Module Responsible	Prof. Michael Morlock				
Admission Requirements	None				
<b>Recommended Previous</b>	It is recommended to participate in "Impla	antate und Frakturheilung" before attending	"Experimentelle Methode	en".	
Knowledge					
Educational Objectives	After taking part successfully, students ha	ve reached the following learning results			
Professional Competence					
Knowledge	The students can describe the different w	ays how bones heal, and the requirements f	or their existence.		
	The students can name different treatmen	nts for the spine and hollow bones under giv	en fracture morphologies	5.	
	The students can describe different measure	urement techniques for forces and moveme	nts. and choose the adeo	uate technique fo	
	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 e	xperimental tasks.			
Workload in Hours	Independent Study Time 62, Study Time i	n Lecture 28			
Credit points	3				
Course achievement	None				
Examination	Written exam				
Examination duration and	90 min				
scale					
Assignment for the	General Engineering Science (German	program, 7 semester): Specialisation Me	chanical Engineering, F	ocus Biomechani	
Following Curricula	Compulsory				
	General Engineering Science (German program, 7 semester): Specialisation Biomedical Engineering: Compulsory				
	Engineering Science: Specialisation Biomedical Engineering: Elective Compulsory				
	General Engineering Science (English program, 7 semester): Specialisation Mechanical Engineering, Focus Biomecha				
	Compulsory				
		gram, 7 semester): Specialisation Biomedica		-	
	General Engineering Science (English prog	gram, 7 semester): Specialisation Biomedica	I Engineering: Elective C	ompulsory	
	Mechanical Engineering: Specialisation Big	omechanics: Compulsory			
	Technomathematics: Specialisation III. En	gineering Science: Elective Compulsory			

Course L0377: Experimental Methods in Biomechanics		
Тур	Lecture	
Hrs/wk	2	
СР	3	
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28	
Lecturer	Prof. Michael Morlock	
Language	DE	
Cycle	SoSe	
Content		
Literature	Wird in der Veranstaltung bekannt gegeben	

Module M0934: Advai	and Materials			
Courses				
Title		Тур	Hrs/wk	СР
Advanced Materials Characterizatio	n (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			
<b>Recommended Previous</b>	Fundamentals of Materials Science (I and II)	)		
Knowledge				
Educational Objectives	After taking part successfully, students have	e reached the following learning results		
Professional Competence				
Knowledge		operties of advanced materials along with thei or, modern composite materials (biomaterials) a		hnology, in particul
Skills	The students will be able to select material configurations according to the technical needs and, if necessary, to design n materials considering architectural principles from the micro- to the macroscale. The students will also gain an overview modern materials science, which enables them to select optimum materials combinations depending on the technical application			
Personal Competence Social Competence	The students are able to present solutions to specialists and to develop ideas further.			
Autonomy	The students are able to			
	<ul> <li>assess their own strengths and weak</li> </ul>	knesses.		
	define tasks independently.			
Workload in Hours	Independent Study Time 96, Study Time in	Lecture 84		
Credit points	6			
	None			
Examination	Written exam			
Examination duration and	90 min			
scale				
Assignment for the	General Engineering Science (German p	program, 7 semester): Specialisation Mechar	nical Engineering. I	ocus Biomechanio
Following Curricula		5 , . <sub>P</sub>	5	
<b>,</b>		program, 7 semester): Specialisation Mecha	anical Engineering,	Focus Materials
	Engineering Sciences: Compulsory			
	Data Science: Specialisation Materials Scien	nce: Compulsory		
	General Engineering Science (English progr	am, 7 semester): Specialisation Mechanical En	gineering: Elective C	compulsory
	Mechanical Engineering: Core Qualification:			

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	
CP	2	
Workload in Hours	ndependent Study Time 32, Study Time in Lecture 28	
Lecturer	Prof. Patrick Huber, Prof. Stefan Müller, Prof. Patrick Huber, Prof. Gerold Schneider, Prof. Jörg Weißmüller	
Language	nguage DE/EN	
Cycle	SoSe	
Content		
Literature	Vorlesungsunterlagen	

Course L1092: Advanced Ma	ourse L1092: Advanced Materials Design		
Тур	Recitation Section (large)		
Hrs/wk	2		
CP	2		
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28		
Lecturer	Prof. Bodo Fiedler, Prof. 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						
Title				Turn	Hrs/wk	СР
Computer Science for Engineers - F	Programming Concepts. '	Data Handling & Communicati	on (L2689)	<b>Typ</b> Lecture	3	3
Computer Science for Engineers - P				Recitation Section (small)	2	3
Module Responsible	Prof. Sibylle Fröschle					
Admission Requirements	None					
<b>Recommended Previous</b>						
Knowledge						
Educational Objectives	After taking part succ	essfully, students have read	ched the follow	ing learning results		
Professional Competence						
Knowledge						
Skills						
Personal Competence						
Social Competence						
Autonomy						
	Independent Study T	ime 110, Study Time in Lect	ture 70			
Credit points	, ,					
Course achievement		Form	Description			
	No 10 %	Attestation	Testate find	en semesterbegleitend statt.		
Examination	Written exam					
Examination duration and	120 min					
scale						
		Science (German progra	m, 7 semeste	r): Specialisation Mechanica	I Engineering, F	ocus Biomechan
Following Curricula						
				pecialisation Process Engineer		
	General Engineering	Science (German program,	7 semester): Sp	pecialisation Biomedical Engin	eering: Compulso	bry
	General Engineering	Science (German program,	7 semester): S	pecialisation Green Technolog	ies, Focus Renew	able Energy: Elect
	Compulsory	Compulsory				
		Science (German program	n, 7 semester)	: Specialisation Mechanical	Engineering, Foc	us Energy Syster
	Compulsory					
			n, 7 semester	: Specialisation Mechanical	Engineering, Foo	us Aircraft Syste
	Engineering: Compute		m 7 comost	or), Enocialization Machanic		Focus Matarials
	Engineering Sciences		am, 7 semest	er): Specialisation Mechanic	ai Engineering,	FOCUS Materials
			um 7 semeste	er): Specialisation Mechanica	al Engineering I	Focus Mechatron
	Compulsory	belence (bernan progra	, , , , , , , , , , , , , , , , , , , ,		in Engineering, i	
		Science (German program,	7 semester): S	pecialisation Mechanical Engi	neering, Focus Th	eoretical Mechan
	Engineering: Compuls	sory				
	General Engineering	Science (German program,	7 semester): 9	Specialisation Mechanical Eng	ineering, Focus F	roduct Developm
	and Production: Elect	ive Compulsory				
	General Engineering	Science (German program,	7 semester): Sp	pecialisation Electrical Engine	ering: Elective Co	mpulsory
		Science (German program,	7 semester): Sp	pecialisation Green Technolog	ies, Focus Renew	able Energy: Elect
	Compulsory					
		ng: Core Qualification: Com				
		g: Core Qualification: Compu				
		iental Engineering: Core Qui		ipuisory ecialisation Process Engineeri	ng, Elective Com	aulcon
				: Specialisation Energy and		-
	Compulsory	cenere (English program	., , semester	. specialisation Energy and		
		Energy, Water, Climate: Spe	ecialisation Ene	rgy Systems: Elective Compul	lsory	
		: Core Qualification: Compu				
			-			
	Logistics and Mobility	: Specialisation Information	Technology: C	ompulsory		
		y: Specialisation Information Qualification: Compulsory	Technology: C	ompulsory		
	Mechatronics: Core Q			ompulsory		

Course L2689: Computer Science for Engineers - Programming Concepts, Data Handling & Communication			
Тур	ecture		
Hrs/wk	3		
CP	3		
Workload in Hours	Independent Study Time 48, Study Time in Lecture 42		
Lecturer	rof. Sibylle Fröschle		
Language			
Cycle	oSe		
Content	Content		
Literature	e 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	
CP	3	
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28	
Lecturer	Prof. Sibylle Fröschle	
Language	DE	
Cycle	SoSe	
Content	See interlocking course	
Literature	See interlocking course	

## Focus Energy Systems

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

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

Module M0684: Heat	Transfer			
Courses				
Title 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	Reclation Section (large)	L	L
Admission Requirements	None			
	Technical Thermodynamics I, II and Fluid Dynamics			
Knowledge				
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.			
Personal Competence				
Social Competence	The students are able to discuss in small groups and develop a	n approach.		
Autonomy	The students are able to develop a complex problem self-consi	stent and analyse the results in	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	Control Family Colored (Control and Total	) Constaliantian March 1 1 5		. Francisco Curt
Assignment for the Following Curricula	General Engineering Science (German program, 7 semester Compulsory	): Specialisation Mechanical E	ingineering, Focu	is energy Systems:
r onothing curriculu	General Engineering Science (German program, 7 semester): S	pecialisation Biomedical Engine	eering: Compulso	ry
	General Engineering Science (German program, 7 semester): S			
	Engineering: Compulsory			
	Energy Systems: Technical Complementary Course Core Studie			
	General Engineering Science (English program, 7 semester)	: Specialisation Mechanical E	ingineering, Focu	is Energy Systems:
	Compulsory	ocialization Riomodical Engine	oring: Compulser	
	General Engineering Science (English program, 7 semester): Sp Mechanical Engineering: Specialisation Energy Systems: Compu		enny: compuisor	у
	Mechanical Engineering: Specialisation Theoretical Mechanical		ory	
		compuls	- ,	

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

-				
Courses				
Title		Тур	Hrs/wk	СР
	ines and Turbomachinery - Part Reciprocating Engines (L0633)	Lecture	1	1
	ines and Turbomachinery - Part Reciprocating Engines (L0634)	Recitation Section (large)	1	1
Internal Combustion Engines I (L00		Lecture	2	2
Internal Combustion Engines I (L06		Recitation Section (large)	L	Z
Module Responsible	Prof. Christopher Friedrich Wirz			
Admission Requirements	None			
Recommended Previous	Thermodynamics, Mechanics, Machine Elements			
Knowledge				
Educational Objectives	After taking part successfully, students have reached the following part successfully, students have reached the following part successfully and the students have been successfully and the students have bee	owing learning results		
Professional Competence				
Knowledge	As a result of the part module "Fundamentals of Reciprocatin	ng Machinery", the students are a	able to reflect fur	ndamentals regardi
	power and working machinery and describe the qualitative a	and quantitative correlations of o	operating method	ds and efficiencies
	multiple types of engines, compressors and pumps. They a	re able to utilize technical term	s and parameter	rs as well as aspec
	regarding the development of power density and efficienc	y, furthermore to give an over	view of charging	systems, fuels a
	emissions. The students are able to select specific types of m	nachinery and assess design rela	ted and operation	nal problems.
	As a result of the part module "Internal Compustion Engi	noc l" the students are able r	affect and utilize	the state of the s
	As a result of the part module "Internal Combustion Engines I", the students are able reflect and utilize the state-of-the-ard			
	regarding efficiency limits. In addition, they are able to utilize their knowledge of design, mechanical and thermodynami characteristics and the approach of similarity. They are able to explain, assess and develop engines as well as charging systems			
			engines as well a	as charging system
	Detailed knowledge is present regarding computer-aided pro			
Skills	The students are skilled to employ basic and detail knowled	dge regarding reciprocating mac	hinery, their sele	ection and operation
	They are further able to assess, analyse and solve tec	hnical and operational problen	ns and to perfo	orm mechanical a
	thermodynamic design.			
Personal Competence				
Social Competence	The students are able to communicate and cooperate in	a professional environment in	the field of ma	achinery design a
	application.			, ,
	and the second se			
Διιτοροφγ	The widespread scope of gained knowledge enables the stud	lents to handle situations in thei	r future professio	n independently a
Autonomy	confidently.		r luture professio	in independently d
	connuently.			
Werkland in Heure	Independent Study Time 110 Study Time in Lecture 70			
	Independent Study Time 110, Study Time in Lecture 70			
Credit points				
Course achievement				
Examination	Written exam			
Examination duration and	120 min			
scale				
Assignment for the	General Engineering Science (German program, 7 semest	er): Specialisation Mechanical	Engineering, Foc	us Energy System
Following Curricula	Compulsory			
	Energy and Environmental Engineering: Core Qualification: E	lective Compulsory		
	Energy Systems: Technical Complementary Course Core Stud	dies: Elective Compulsory		
	General Engineering Science (English program, 7 semest	er): Specialisation Mechanical I	Engineering, Foc	us Energy System
	Compulsory			
	Green Technologies: Energy, Water, Climate: Specialisation E	Energy Technology: Elective Com	pulsory	

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

Course L0634: Fundamentals	ourse L0634: Fundamentals of Reciprocating Engines and Turbomachinery - Part Reciprocating Engines	
Тур	Recitation Section (large)	
Hrs/wk	1	
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 Comb	Course L0059: Internal Combustion Engines I	
Тур	Lecture	
Hrs/wk		
CP	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	<ul> <li>Vorlesungsskript</li> <li>Übungsaufgaben mit Lösungsweg</li> <li>Literaturliste</li> </ul>	

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

Courses				
Title		Turn	Hrs/wk	СР
Computational Fluid Dynamics I (L	235)	<b>Typ</b> Lecture	2	3
Computational Fluid Dynamics I (LC		Recitation Section (large)	2	3
Module Responsible	Prof. Thomas Rung			
Admission Requirements	None			
<b>Recommended Previous</b>				
Knowledge	Mathematical Methods for Engineers			
	<ul> <li>Fundamentals of Differential/integral calculation</li> </ul>	Ilus and series expansions		
Educational Objectives	After taking part successfully, students have read	ched the following learning results		
Professional Competence				
Knowledge	The students are able to list the basic numerics of	of partial differential equations.		
Skills	The students are able develop appropriate nume	erical integration in space and time for the g	overning partial d	ifferential equatio
	They can code computational algorithms in a stru	uctured way.		
Borconal Compotonco				
Personal Competence	The students can arrive at work results in groups	and document them		
Social Competence	The students can arrive at work results in groups	and document them.		
Automore	The students can independently analyze annual	has to colving specific problems		
Autonomy	The students can independently analyse approac	thes to solving specific problems.		
Workload in Hours	Independent Study Time 124, Study Time in Lect	cure 56		
Credit points	6			
Course achievement	None			
Examination	Written exam			
Examination duration and	2h			
scale				
Assignment for the	General Engineering Science (German program,	7 semester): Specialisation Mechanical Engi	neering, Focus Th	eoretical Mechani
Following Curricula	Engineering: Elective Compulsory			
	General Engineering Science (German program	n, 7 semester): Specialisation Mechanical	Engineering, Foc	us Aircraft Syste
	Engineering: Elective Compulsory			
	General Engineering Science (German program	n, 7 semester): Specialisation Mechanical	Engineering, Foc	us Energy Syster
	Elective Compulsory			
	General Engineering Science (German program,			
	General Engineering Science (German program, Energy Systems: Technical Complementary Court		omental Engineer	ring: Compulsory
	Energy Systems: Technical Complementary Cour General Engineering Science (English program, 7		mental Engineeri	ing: Compulsory
	General Engineering Science (English program, 7		-	• • •
	Elective Compulsory	,	, 100	
	General Engineering Science (English program, 7	semester): Specialisation Naval Architecture	e: Compulsory	
	General Engineering Science (English program			us Aircraft Syste
	Engineering: Elective Compulsory		5 5, 55	
	Mechanical Engineering: Specialisation Energy Sy	ystems: Elective Compulsory		
	Mechanical Engineering: Specialisation Aircraft S	ystems Engineering: Elective Compulsory		
	Naval Architecture: Core Qualification: Compulso			

Course L0235: Computationa	al Fluid Dynamics I
Тур	Lecture
Hrs/wk	2
CP	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Prof. Thomas Rung
Language	DE
Cycle	WiSe
Content	Fundamentals of computational modelling of thermofluid dynamic problems. Development of numerical algorithms.
	<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

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

Courses				
Title		Тур	Hrs/wk	СР
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	<ul> <li>Mathematik I + II for Engineering Students (</li> </ul>	german or english) <b>or</b> Analysis & Linear Ald	gebra I + II for Te	chnomathematio
Knowledge	basic MATLAB/Python knowledge			
-	After taking part successfully, students have reach	ied the following learning results		
Professional Competence	Students are able to			
Knowledge	Students are able to			
	<ul> <li>name numerical methods for interpolation,</li> </ul>	integration, least squares problems, eigenv	value problems, r	ionlinear root fin
	problems and to explain their core ideas,			
	repeat convergence statements for the num			
	<ul> <li>explain aspects for the practical execution of</li> </ul>	of numerical methods with respect to compi	utational and stor	age complexitx.
CL 11				
SKIIIS	Students are able to			
	<ul> <li>implement, apply and compare numerical m</li> </ul>	nethods using MATLAB/Python,		
	<ul> <li>justify the convergence behaviour of numer</li> </ul>	ical methods with respect to the problem a	nd solution algori	thm,
	<ul> <li>select and execute a suitable solution approx</li> </ul>	bach for a given problem.		
Personal Competence				
•	Students are able to			
boelar competence				
	<ul> <li>work together in heterogeneously compose</li> </ul>	d teams (i.e., teams from different study pr	ograms and bac	kground knowled
	explain theoretical foundations and support	each other with practical aspects regarding	g the implementa	tion of algorithm
Autonomv	Students are capable			
	<ul> <li>to assess whether the supporting theoretical</li> </ul>		individually or in	a team,
	<ul> <li>to assess their individual progess and, if neo</li> </ul>	cessary, to ask questions and seek help.		
Workload in Hours	Independent Study Time 124, Study Time in Lectur	re 56		
Credit points	6			
Course achievement	None			
Examination	Written exam			
Examination duration and	90 minutes			
scale				
Assignment for the	General Engineering Science (German program, 7	semester): Specialisation Computer Science	e: Compulsory	
Following Curricula	General Engineering Science (German program	n, 7 semester): Specialisation Mechanic	al Engineering,	Focus Material
	Engineering Sciences: Compulsory			
	General Engineering Science (German program, 7			
	General Engineering Science (German program	, 7 semester): Specialisation Mechanica	l Engineering, F	ocus Biomecha
	Compulsory			
	General Engineering Science (German program, 7 Engineering: Compulsory	semester): Specialisation Mechanical Engir	ieering, Focus In	eoretical Mechai
		7 semester): Specialisation Mechanical	Engineoring Ess	us Aircraft Suct
	General Engineering Science (German program,	7 semester): Specialisation Mechanical	Engineering, Foc	us Aircraft Syst
	General Engineering Science (German program, Engineering: Elective Compulsory			
	General Engineering Science (German program, Engineering: Elective Compulsory General Engineering Science (German program, 7			
	General Engineering Science (German program, Engineering: Elective Compulsory	semester): Specialisation Mechanical Engli	neering, Focus M	echatronics: Elec
	General Engineering Science (German program, Engineering: Elective Compulsory General Engineering Science (German program, 7 Compulsory	semester): Specialisation Mechanical Engli	neering, Focus M	echatronics: Elec
	General Engineering Science (German program, Engineering: Elective Compulsory General Engineering Science (German program, 7 Compulsory General Engineering Science (German program,	semester): Specialisation Mechanical Engin 7 semester): Specialisation Mechanical I	neering, Focus M Engineering, Foc	echatronics: Elec
	General Engineering Science (German program, Engineering: Elective Compulsory General Engineering Science (German program, 7 Compulsory General Engineering Science (German program, Elective Compulsory	semester): Specialisation Mechanical Engin 7 semester): Specialisation Mechanical I Bioprocess Engineering: Elective Compulse	neering, Focus M Engineering, Foc	echatronics: Elec
	General Engineering Science (German program, Engineering: Elective Compulsory General Engineering Science (German program, 7 Compulsory General Engineering Science (German program, Elective Compulsory Bioprocess Engineering: Specialisation A - General	semester): Specialisation Mechanical Engli 7 semester): Specialisation Mechanical I Bioprocess Engineering: Elective Compulso lathematics: Elective Compulsory	neering, Focus M Engineering, Foc Pry	echatronics: Elec
	General Engineering Science (German program, Engineering: Elective Compulsory General Engineering Science (German program, 7 Compulsory General Engineering Science (German program, Elective Compulsory Bioprocess Engineering: Specialisation A - General Computer Science: Specialisation Computational M	semester): Specialisation Mechanical Engli 7 semester): Specialisation Mechanical I Bioprocess Engineering: Elective Compulso lathematics: Elective Compulsory	neering, Focus M Engineering, Foc Pry	echatronics: Elec
	General Engineering Science (German program, Engineering: Elective Compulsory General Engineering Science (German program, 7 Compulsory General Engineering Science (German program, Elective Compulsory Bioprocess Engineering: Specialisation A - General Computer Science: Specialisation Computational M Computer Science: Specialisation II. Mathematics a Data Science: Core Qualification: Compulsory Electrical Engineering: Core Qualification: Elective	semester): Specialisation Mechanical Engli 7 semester): Specialisation Mechanical I Bioprocess Engineering: Elective Compulso lathematics: Elective Compulsory and Engineering Science: Elective Compulso Compulsory	neering, Focus M Engineering, Foc Pry	echatronics: Elec
	General Engineering Science (German program, Engineering: Elective Compulsory General Engineering Science (German program, 7 Compulsory General Engineering Science (German program, Elective Compulsory Bioprocess Engineering: Specialisation A - General Computer Science: Specialisation Computational M Computer Science: Specialisation II. Mathematics a Data Science: Core Qualification: Compulsory Electrical Engineering: Core Qualification: Elective Engineering Science: Core Qualification: Compulso	semester): Specialisation Mechanical Engli 7 semester): Specialisation Mechanical I Bioprocess Engineering: Elective Compulso lathematics: Elective Compulsory and Engineering Science: Elective Compulso Compulsory ry	neering, Focus M Engineering, Foc Pry	echatronics: Elec
	General Engineering Science (German program, Engineering: Elective Compulsory General Engineering Science (German program, 7 Compulsory General Engineering Science (German program, Elective Compulsory Bioprocess Engineering: Specialisation A - General Computer Science: Specialisation Computational M Computer Science: Specialisation II. Mathematics a Data Science: Core Qualification: Compulsory Electrical Engineering: Core Qualification: Elective Engineering Science: Core Qualification: Compulso Engineering Science: Core Qualification: Compulso	semester): Specialisation Mechanical Engli 7 semester): Specialisation Mechanical I Bioprocess Engineering: Elective Compulso lathematics: Elective Compulsory and Engineering Science: Elective Compulsor Compulsory ry ry	neering, Focus M Engineering, Foc Pry	echatronics: Elec
	General Engineering Science (German program, Engineering: Elective Compulsory General Engineering Science (German program, 7 Compulsory General Engineering Science (German program, Elective Compulsory Bioprocess Engineering: Specialisation A - General Computer Science: Specialisation Computational M Computer Science: Specialisation II. Mathematics a Data Science: Core Qualification: Elective Engineering Science: Core Qualification: Elective Engineering Science: Core Qualification: Compulso Engineering Science: Core Qualification: Compulso Engineering Science: Core Qualification: Compulso General Engineering Science (English program, 7 s	semester): Specialisation Mechanical Engli 7 semester): Specialisation Mechanical I Bioprocess Engineering: Elective Compulso tathematics: Elective Compulsory and Engineering Science: Elective Compulsor Compulsory ry ry semester): Core Qualification: Compulsory	neering, Focus M Engineering, Foc ny pry	echatronics: Elec
	General Engineering Science (German program, Engineering: Elective Compulsory General Engineering Science (German program, 7 Compulsory General Engineering Science (German program, Elective Compulsory Bioprocess Engineering: Specialisation A - General Computer Science: Specialisation Computational M Computer Science: Specialisation II. Mathematics a Data Science: Core Qualification: Elective Engineering Science: Core Qualification: Elective Engineering Science: Core Qualification: Compulso Electrical Engineering: Core Qualification: Compulso Engineering Science: Core Qualification: Compulso General Engineering Science (English program, 7 S General Engineering Science (English program, 7 Science) Science (English program) Science) Science (English program) Science) Science) Science (English program) Science) Science) Science) Science (English program) Science)	semester): Specialisation Mechanical Engli 7 semester): Specialisation Mechanical I Bioprocess Engineering: Elective Compulso tathematics: Elective Compulsory and Engineering Science: Elective Compulsor Compulsory ry ry semester): Core Qualification: Compulsory semester): Specialisation Computer Science	neering, Focus M Engineering, Foc nry ory : Compulsory	echatronics: Elec
	General Engineering Science (German program, Engineering: Elective Compulsory General Engineering Science (German program, 7 Compulsory General Engineering Science (German program, Elective Compulsory Bioprocess Engineering: Specialisation A - General Computer Science: Specialisation Computational M Computer Science: Specialisation II. Mathematics a Data Science: Core Qualification: Elective Engineering Science: Core Qualification: Elective Engineering Science: Core Qualification: Compulsory Electrical Engineering: Core Qualification: Compulso Engineering Science: Core Qualification: Compulso General Engineering Science (English program, 7 General Engineering Science (English program, 7 General Engineering Science (English program, 7	semester): Specialisation Mechanical Engli 7 semester): Specialisation Mechanical I Bioprocess Engineering: Elective Compulso tathematics: Elective Compulsory and Engineering Science: Elective Compulsor Compulsory ry ry semester): Core Qualification: Compulsory semester): Specialisation Computer Science	neering, Focus M Engineering, Foc nry ory : Compulsory	echatronics: Elec
	General Engineering Science (German program, Engineering: Elective Compulsory General Engineering Science (German program, 7 Compulsory General Engineering Science (German program, Elective Compulsory Bioprocess Engineering: Specialisation A - General Computer Science: Specialisation Computational M Computer Science: Specialisation II. Mathematics a Data Science: Core Qualification: Elective Engineering Science: Core Qualification: Elective Engineering Science: Core Qualification: Compulso Electrical Engineering: Core Qualification: Compulso Engineering Science: Core Qualification: Compulso General Engineering Science (English program, 7 General Engineering Science (English program, Compulsory	semester): Specialisation Mechanical Engli 7 semester): Specialisation Mechanical I Bioprocess Engineering: Elective Compulso lathematics: Elective Compulsory and Engineering Science: Elective Compulsor Compulsory ry ry semester): Core Qualification: Compulsory semester): Specialisation Computer Science , 7 semester): Specialisation Mechanical	neering, Focus M Engineering, Foc nry pry : Compulsory Engineering, F	echatronics: Elec us Energy Syste ocus Biomechae
	General Engineering Science (German program, Engineering: Elective Compulsory General Engineering Science (German program, 7 Compulsory General Engineering Science (German program, Elective Compulsory Bioprocess Engineering: Specialisation A - General Computer Science: Specialisation Computational M Computer Science: Specialisation II. Mathematics a Data Science: Core Qualification: Elective Engineering Science: Core Qualification: Elective Engineering Science: Core Qualification: Compulsory Electrical Engineering: Core Qualification: Compulso Engineering Science: Core Qualification: Compulso General Engineering Science (English program, 7 General Engineering Science (English program, 7 Seneral Engineering Science (English program)	semester): Specialisation Mechanical Engli 7 semester): Specialisation Mechanical I Bioprocess Engineering: Elective Compulso lathematics: Elective Compulsory and Engineering Science: Elective Compulsor Compulsory ry ry semester): Core Qualification: Compulsory semester): Specialisation Computer Science , 7 semester): Specialisation Mechanical	neering, Focus M Engineering, Foc nry pry : Compulsory Engineering, F	echatronics: Elec us Energy Syste ocus Biomechae
	General Engineering Science (German program, Engineering: Elective Compulsory General Engineering Science (German program, 7 Compulsory General Engineering Science (German program, Elective Compulsory Bioprocess Engineering: Specialisation A - General Computer Science: Specialisation Computational M Computer Science: Specialisation II. Mathematics a Data Science: Core Qualification: Elective Engineering Science: Core Qualification: Elective Engineering Science: Core Qualification: Compulso Electrical Engineering: Core Qualification: Compulso Engineering Science: Core Qualification: Compulso General Engineering Science (English program, 7 General Engineering Science (English program, 7 General Engineering Science (English program, 7 General Engineering Science (English program, 7 Sciences: Compulsory	semester): Specialisation Mechanical Engli 7 semester): Specialisation Mechanical I Bioprocess Engineering: Elective Compulso lathematics: Elective Compulsory and Engineering Science: Elective Compulsor Compulsory ry ry semester): Core Qualification: Compulsory semester): Specialisation Computer Science , 7 semester): Specialisation Mechanical semester): Specialisation Mechanical Engine	neering, Focus M Engineering, Foc ory ory : Compulsory Engineering, F eering, Focus Mat	echatronics: Elec us Energy Syste ocus Biomechae erials in Enginee
	General Engineering Science (German program, Engineering: Elective Compulsory General Engineering Science (German program, 7 Compulsory General Engineering Science (German program, Elective Compulsory Bioprocess Engineering: Specialisation A - General Computer Science: Specialisation Computational M Computer Science: Specialisation II. Mathematics a Data Science: Core Qualification: Compulsory Electrical Engineering: Core Qualification: Elective Engineering Science: Core Qualification: Compulso Engineering Science: Core Qualification: Compulso General Engineering Science (English program, 7 General Engineering Science (English program, 7 General Engineering Science (English program, 7 Sciences: Compulsory General Engineering Science (English program, 7 Sciences: Compulsory General Engineering Science (English program, 7 Sciences: Compulsory General Engineering Science (English program, 7	semester): Specialisation Mechanical Engli 7 semester): Specialisation Mechanical I Bioprocess Engineering: Elective Compulso lathematics: Elective Compulsory and Engineering Science: Elective Compulsor Compulsory ry ry semester): Core Qualification: Compulsory semester): Specialisation Computer Science , 7 semester): Specialisation Mechanical semester): Specialisation Mechanical Engine	neering, Focus M Engineering, Foc ory ory : Compulsory Engineering, F eering, Focus Mat	echatronics: Elec us Energy Syste ocus Biomechae erials in Enginee
	General Engineering Science (German program, Engineering: Elective Compulsory General Engineering Science (German program, 7 Compulsory General Engineering Science (German program, Elective Compulsory Bioprocess Engineering: Specialisation A - General Computer Science: Specialisation Computational M Computer Science: Specialisation II. Mathematics a Data Science: Core Qualification: Elective Engineering Science: Core Qualification: Elective Engineering Science: Core Qualification: Compulso Electrical Engineering: Core Qualification: Compulso Engineering Science: Core Qualification: Compulso General Engineering Science (English program, 7 General Engineering Science (English program, 7 General Engineering Science (English program, 7 General Engineering Science (English program, 7 Sciences: Compulsory	semester): Specialisation Mechanical Engli 7 semester): Specialisation Mechanical I Bioprocess Engineering: Elective Compulso lathematics: Elective Compulsory and Engineering Science: Elective Compulsor Compulsory ry ry semester): Core Qualification: Compulsory semester): Specialisation Computer Science , 7 semester): Specialisation Mechanical semester): Specialisation Mechanical Engine	neering, Focus M Engineering, Foc ory ory : Compulsory Engineering, F eering, Focus Mat eering, Focus Th	echatronics: Elec us Energy Syste ocus Biomechan erials in Enginee eoretical Mechan
	General Engineering Science (German program, Engineering: Elective Compulsory General Engineering Science (German program, 7 Compulsory General Engineering Science (German program, Elective Compulsory Bioprocess Engineering: Specialisation A - General Computer Science: Specialisation Computational M Computer Science: Specialisation II. Mathematics a Data Science: Core Qualification: Compulsory Electrical Engineering: Core Qualification: Elective Engineering Science: Core Qualification: Compulso General Engineering Science (English program, 7 General Engineering Science (English program, 7 General Engineering Science (English program, 7 Sciences: Compulsory General Engineering Science (English program, 7 Engineering: Compulsory	semester): Specialisation Mechanical Engli 7 semester): Specialisation Mechanical I Bioprocess Engineering: Elective Compulso lathematics: Elective Compulsory and Engineering Science: Elective Compulsor Compulsory ry ry semester): Core Qualification: Compulsory semester): Specialisation Computer Science , 7 semester): Specialisation Mechanical Engine semester): Specialisation Mechanical Engine semester): Specialisation Mechanical Engine	neering, Focus M Engineering, Foc ory ory : Compulsory Engineering, F eering, Focus Mat eering, Focus Th eering: Compulsor	echatronics: Elec us Energy Syste ocus Biomechai erials in Enginee eoretical Mechai

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

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

Courses				
Title		Тур	Hrs/wk	СР
Electrical Machines and Actuators (	L0293)	Lecture	3	4
Electrical Machines and Actuators (	L0294)	Recitation Section (large)	2	2
Module Responsible	Prof. Thorsten Kern			
Admission Requirements	None			
<b>Recommended Previous</b>	Basics of mathematics, in particular comp	exe numbers, integrals, differentials		
Knowledge	Basics of electrical engineering and mecha	anical engineering		
Educational Objectives	After taking part successfully, students ha	ve reached the following learning results		
Professional Competence				
Knowledge	Students can to draw and explain the basi	c principles of electric and magnetic fields.		
	They can describe the function of the	standard turnes of clastic machines and pro	cont the correspond	dina aquationa a
	-	standard types of electric machines and pre ives they can explain the major parameters of th		
	from the power grid to the driven engine.	ives they can explain the major parameters of th	le energy enterency	of the whole syste
Skills	Students are able to calculate two-dimen	sional electric and magnetic fields in particular	ferromagnetic circu	uits with air gap.
	this they apply the usual methods of the d	esign auf electric machines.		
	They can calulate the operational perform	nance of electric machines from their given cha	racteristic data and	d selected quantit
		usual equivalent circuits and graphical methods.		
Personal Competence				
Social Competence	none			
Autonomy	Students are able independently to calculate electric and magnatic fields for applications. They are able to analyse independe			nalyse independer
	the operational performance of electric machines from the characteristic data and theycan calculate thereof selected q			
	and characteristic curves.			
Workload in Hours	Independent Study Time 110, Study Time	in Lecture 70		
Credit points	6			
Course achievement	None			
Examination	Subject theoretical and practical work			
Examination duration and	Design of four machines and actuators, re-	view of design files		
scale				
Assignment for the	General Engineering Science (German pro	gram, 7 semester): Specialisation Electrical Engi	neering: Elective Co	mpulsory
Following Curricula	General Engineering Science (German p	rogram, 7 semester): Specialisation Mechanica	al Engineering, Foc	us Energy Syster
	Compulsory			
		program, 7 semester): Specialisation Mechan	ical Engineering, I	Focus Mechatron
	Compulsory	gram, 7 semester): Specialisation Mechanical En	ginopring Focus Th	anatical Machani
	Engineering: Elective Compulsory	gram, 7 semester). Specialisation Mechanical En	gineering, rocus ri	
	Digital Mechanical Engineering: Core Qual	fication: Compulsory		
	Electrical Engineering: Core Qualification:			
	Energy and Environmental Engineering: Co			
	General Engineering Science (English prog	ram, 7 semester): Specialisation Mechanical Eng	ineering: Elective C	ompulsory
	Green Technologies: Energy, Water, Clima	te: Specialisation Energy Technology: Elective Co	ompulsory	
	Logistics and Mobility: Specialisation Engir	eering Science: Elective Compulsory		
	5 , 1	c Planning and Systems: Elective Compulsory		
		uction Management and Processes: Elective Com	pulsory	
	Mechanical Engineering: Core Qualification			
	Mechatronics: Core Qualification: Compuls	•		
	Technomathematics: Specialisation III. Eng	ineering Science: Elective Compulsory		
	Engineering and Management - Major in Lo	ogistics and Mobility: Specialisation Traffic Planni Logistics and Mobility: Specialisation Productio		

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

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

Courses						
Title				Tur	Hrs/wk	<b>CD</b>
Computer Science for Engineers - F	Programming Concepts, (	Data Handling & Communication	(L2689)	<b>Typ</b> Lecture	Hrs/wk 3	<b>СР</b> 3
Computer Science for Engineers - P				Recitation Section (small)	2	3
Module Responsible	Prof. Sibylle Fröschle					
Admission Requirements						
Recommended Previous						
Knowledge						
Educational Objectives	After taking part succ	essfully, students have reache	ed the followi	ng learning results		
Professional Competence						
Knowledge	1					
Skills						
Demonstration of the second						
Personal Competence						
Social Competence Autonomy						
Workload in Hours		me 110, Study Time in Lectur	0.70			
Credit points		The 110, Study Time in Lectur	e 70			
Course achievement		Form	Description			
course achievement	No 10 %	Attestation		en semesterbegleitend statt.		
Examination	Written exam					
Examination duration and	120 min					
scale						
Assignment for the	General Engineering	Science (German program,	7 semeste	r): Specialisation Mechanica	I Engineering, F	ocus Biomechani
Following Curricula	Compulsory					
	General Engineering	Science (German program, 7 s	emester): Sp	ecialisation Process Engineer	ing: Compulsory	
	General Engineering	Science (German program, 7 s	emester): Sp	ecialisation Biomedical Engin	eerina: Compulso	prv
		Science (German program, 7 s				
	Compulsory	Science (German program, 7 a	semester). Sp	ecialisation oreen recimolog	ies, rocus nenew	able Energy. Elect
		Science (German program,	7 comostor)	Specialisation Mechanical	Engineering Foc	us Energy System
	Compulsory	Science (German program,	/ semester).		Lingineering, Too	us Lifergy Syster
		Science (German program,	7 semester)	: Specialisation Mechanical	Engineering, Foo	us Aircraft Syste
	Engineering: Compuls					-
	General Engineering	Science (German program	, 7 semeste	er): Specialisation Mechanic	al Engineering,	Focus Materials
	Engineering Sciences	: Compulsory				
	General Engineering	Science (German program,	7 semeste	r): Specialisation Mechanica	al Engineering, I	ocus Mechatroni
	Compulsory					
	General Engineering	Science (German program, 7 s	semester): Sp	pecialisation Mechanical Engi	neering, Focus Th	eoretical Mechani
	Engineering: Compuls	sory				
	General Engineering	Science (German program, 7	semester): S	pecialisation Mechanical Eng	ineering, Focus F	roduct Developm
	and Production: Elect					
		Science (German program, 7 s				
		Science (German program, 7 s	semester): Sp	ecialisation Green Technolog	ies, Focus Renew	able Energy: Elect
	Compulsory					
	Bioprocess Engineerin	ng: Core Qualification: Compu				
	Electrical Excitor environments	Come Que lification Comenda				
		: Core Qualification: Compulse	•	pulcon		
	Energy and Environm	ental Engineering: Core Quali	fication: Com		ng: Elective Com	
	Energy and Environm General Engineering	ental Engineering: Core Quali Science (English program, 7 se	fication: Com emester): Spe	ecialisation Process Engineeri		
	Energy and Environm General Engineering General Engineering	ental Engineering: Core Quali	fication: Com emester): Spe	ecialisation Process Engineeri		
	Energy and Environm General Engineering General Engineering Compulsory	ental Engineering: Core Quali Science (English program, 7 sc Science (English program,	fication: Com emester): Spe 7 semester)	ecialisation Process Engineeri : Specialisation Energy and	Enviromental E	
	Energy and Environm General Engineering General Engineering Compulsory Green Technologies:	ental Engineering: Core Quali Science (English program, 7 se	fication: Com emester): Spe 7 semester) alisation Ener	ecialisation Process Engineeri : Specialisation Energy and	Enviromental E	
	Energy and Environm General Engineering General Engineering Compulsory Green Technologies: Logistics and Mobility	ental Engineering: Core Quali Science (English program, 7 sc Science (English program, Energy, Water, Climate: Speci	emester): Spe 7 semester) alisation Ener pry	ecialisation Process Engineeri : Specialisation Energy and rgy Systems: Elective Compu	Enviromental E	
	Energy and Environm General Engineering General Engineering Compulsory Green Technologies: Logistics and Mobility Logistics and Mobility	ental Engineering: Core Quali Science (English program, 7 sc Science (English program, Energy, Water, Climate: Speci : Core Qualification: Compulso	emester): Spe 7 semester) alisation Ener pry	ecialisation Process Engineeri : Specialisation Energy and rgy Systems: Elective Compu	Enviromental E	
	Energy and Environm General Engineering Compulsory Green Technologies: Logistics and Mobility Logistics and Mobility Mechatronics: Core Q	ental Engineering: Core Qualit Science (English program, 7 sc Science (English program, Energy, Water, Climate: Speci :: Core Qualification: Compulso :: Specialisation Information Te	fication: Com emester): Spe 7 semester) alisation Ener ory echnology: Co	ecialisation Process Engineeri : Specialisation Energy and rgy Systems: Elective Compu	Enviromental E	

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

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

Courses					
courses					
Title		Тур	Hrs/wk	СР	
Power Industry (L0316)		Lecture	1	1	
Energy Systems and Energy Indust	ry (L0315)	Lecture	2	2	
Renewable Energy (L0313) Renewable Energy (L1434)		Lecture Recitation Section (small)	2 1	2 1	
	Prof. Martin Kaltschmitt	Rectation Section (Small)	Ŧ	1	
Module Responsible					
Admission Requirements					
Recommended Previous					
Knowledge		reached the following learning results			
Educational Objectives		reached the following learning results			
Professional Competence					
Knowledge		s can provide an overview of characteristics of			
		ing in this context. Furthermore, they can explain			
		to subject-related contexts. The students ca			
	the students can explain the environmental b	al, especially for renewable energy systems ar	ia critical discuss	them. Furthermo	
	the students can explain the environmental b	enents nom the use of such systems.			
Skills	Students are able to apply methodologies for	detailed determination of energy demand or e	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 n				
	standardized solutions of a problem.				
	The shudents are able to contain successions a		the field of some of		
		nd possible approaches to its processing from	the field of renew	able energies of	
	and to put them them into the right context.				
Personal Competence					
Social Competence	The students are able to analyze suitable te	echnical alternatives and to assess them with	technical, econor	mical and ecolog	
	criteria under sustainability aspects. This allow	ws them to make an effective contribuition to a	more sustainable	power supply.	
Autonomy		, acquire the particular knowledge about the s	subject area and	transform it to	
	questions.				
Workload in Hours	Independent Study Time 96, Study Time in Le	cture 84			
Credit points					
Course achievement					
Evamination					
Examination					
Examination duration and					
Examination duration and scale		7 competer), Chasialization Dracoss Engineer	ing Compulsory		
Examination duration and scale Assignment for the	General Engineering Science (German program	m, 7 semester): Specialisation Process Engineer			
Examination duration and scale	General Engineering Science (German progra General Engineering Science (German progra	m, 7 semester): Specialisation Process Engineer	ing: Compulsory	is Energy Syste	
Examination duration and scale Assignment for the	General Engineering Science (German progra General Engineering Science (German progra General Engineering Science (German prog		ing: Compulsory	us Energy Syste	
Examination duration and scale Assignment for the	General Engineering Science (German progra General Engineering Science (German progra General Engineering Science (German prog Elective Compulsory	m, 7 semester): Specialisation Process Engineer ram, 7 semester): Specialisation Mechanical	ing: Compulsory	us Energy Syste	
Examination duration and scale Assignment for the	General Engineering Science (German progra General Engineering Science (German progra General Engineering Science (German prog Elective Compulsory Civil- and Environmental Engineering: Special	m, 7 semester): Specialisation Process Engineer ram, 7 semester): Specialisation Mechanical isation Civil Engineering: Elective Compulsory	ing: Compulsory Engineering, Foc	us Energy Syste	
Examination duration and scale Assignment for the	General Engineering Science (German progra General Engineering Science (German progra General Engineering Science (German prog Elective Compulsory Civil- and Environmental Engineering: Special Civil- and Environmental Engineering: Special	m, 7 semester): Specialisation Process Engineer ram, 7 semester): Specialisation Mechanical isation Civil Engineering: Elective Compulsory isation Traffic and Mobility: Elective Compulsory	ing: Compulsory Engineering, Foc	us Energy Syste	
Examination duration and scale Assignment for the	General Engineering Science (German progra General Engineering Science (German progra General Engineering Science (German prog Elective Compulsory Civil- and Environmental Engineering: Special Civil- and Environmental Engineering: Special Civil- and Environmental Engineering: Special	m, 7 semester): Specialisation Process Engineer ram, 7 semester): Specialisation Mechanical isation Civil Engineering: Elective Compulsory isation Traffic and Mobility: Elective Compulsory isation Water and Environment: Elective Compu	ing: Compulsory Engineering, Foc	us Energy Syste	
Examination duration and scale Assignment for the	General Engineering Science (German progra General Engineering Science (German progra General Engineering Science (German prog Elective Compulsory Civil- and Environmental Engineering: Special Civil- and Environmental Engineering: Special Civil- and Environmental Engineering: Special Civil- and Environmental Engineering: Special	m, 7 semester): Specialisation Process Engineer ram, 7 semester): Specialisation Mechanical isation Civil Engineering: Elective Compulsory isation Traffic and Mobility: Elective Compulsory isation Water and Environment: Elective Compu Qualification: Compulsory	ing: Compulsory Engineering, Foci J		
Examination duration and scale Assignment for the	General Engineering Science (German progra General Engineering Science (German progra General Engineering Science (German prog Elective Compulsory Civil- and Environmental Engineering: Special Civil- and Environmental Engineering: Special Civil- and Environmental Engineering: Special Civil- and Environmental Engineering: Special	m, 7 semester): Specialisation Process Engineer ram, 7 semester): Specialisation Mechanical isation Civil Engineering: Elective Compulsory isation Traffic and Mobility: Elective Compulsory isation Water and Environment: Elective Compu	ing: Compulsory Engineering, Foci J		

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 <ul> <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></li></ul>
Literature	Folien der Vorlesung

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

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

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

## **Focus Aircraft Systems Engineering**

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

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

Courses				
Title		Тур	Hrs/wk	СР
Advanced Mechanical Design Proje	ct (L0266)	Project-/problem-based Learning	4	6
Module Responsible	Dr. Jens Schmidt			
Admission Requirements	None			
<b>Recommended Previous</b>				
Knowledge	Mechanical Engineering: Design			
	Advanced Mechanical Engineering Design			
Educational Objectives	After taking part successfully, students have reach	hed the following learning results		
Professional Competence				
Knowledge	After passing the module, students are able to:			
		and the superference of		
	<ul> <li>express the procedure for systematically have a complex decign tasks</li> </ul>	andling of		
	<ul> <li>complex design tasks ,</li> <li>describe working principles, their use and c</li> </ul>	combination possibilitios		
	<ul> <li>explain guidelines for designing for function</li> </ul>			
	<ul> <li>explain guidelines for designing for function</li> <li>explain advanced use-oriented knowledge</li> </ul>			
Skills	After passing the module, students are able to:			
	<ul> <li>analyze complex tasks and develop princip</li> </ul>	le solutions using sketches,		
	<ul> <li>convert principle solutions into a detailed d</li> </ul>			
		ng design tasks systematically and solution-ori	ented,	
	create a technical documentation including	all necessary technical drawings to understand	the function	s of the system,
	<ul> <li>document calculations of selected machine</li> </ul>	elements clearly and in detail.		
Personal Competence				
•	After passing the module, students are able to:			
Social competence	Arter passing the module, students are able to.			
	<ul> <li>present and discuss solutions and technical</li> </ul>	l drawings within groups,		
	<ul> <li>reflect the own results in the work groups of</li> </ul>	of the course		
Autonomv	After passing the module, students are able to:			
,				
		cts, while motivating themselves, acquiring ne	ecessary knov	ledge and selecti
	appropriate methods,			
	<ul> <li>to independently solve problems.</li> </ul>			
Workload in Hours	Independent Study Time 124, Study Time in Lectu	ıre 56		
Credit points	6			
Course achievement	Compulsory Bonus Form	Description		
	Yes None Attestation			
Examination	Written exam			
Examination duration and	180			
scale				
-	General Engineering Science (German program	, 7 semester): Specialisation Mechanical Eng	ineering, Foc	us Aircraft Syster
Following Curricula	Engineering: Compulsory			
	General Engineering Science (German program, 3	/ semester): Specialisation Mechanical Engine	ering, Focus P	roduct Developme
	and Production: Compulsory	7 competer), Specialization Machanical Fra	incoring Ess	us Aircraft Suctor
	General Engineering Science (English program, Engineering: Compulsory	, semester), specialisation Mechanical Eng	теениу, гос	us Alleralt Syster
	General Engineering Science (English program, 7	semester): Specialisation Mechanical Engine	ring Focus P	roduct Developm
	and Production: Compulsory	semestery, specialisation mechanical Enginee		. sauce bevelopine
	General Engineering Science (English program, 7	semester): Specialisation Mechanical Engineer	ring, Focus Th	eoretical Mechani
	Engineering: Compulsory		5, . 5665 11	
	Mechanical Engineering: Core Qualification: Comp	ulson/		

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

Courses				
Title	17751	<b>Typ</b> Lecture	Hrs/wk	<b>СР</b> 3
Computational Fluid Dynamics I (L Computational Fluid Dynamics I (L		Recitation Section (large)	2 2	3
Module Responsible	Prof. Thomas Rung	neeration Section (large)	-	5
Admission Requirements	None			
Recommended Previous	None			
Knowledge	<ul> <li>Mathematical Methods for Engineers</li> </ul>			
Riomeuge	<ul> <li>Fundamentals of Differential/integral calculus</li> </ul>	and series expansions		
Educational Objectives	After taking part successfully, students have reache	d the following learning results		
Professional Competence	After taking pare successivity, statents have reache			
-	The students are able to list the basic numerics of pa	artial differential equations		
Knowledge	The stadents are use to list the basic numeries of p			
Skills	The students are able develop appropriate numerica	al integration in space and time for the or	werning partial d	ifferential equatio
Skiils	They can code computational algorithms in a structu		verning partial a	incremation equation
		ica way.		
Personal Competence				
Social Competence	The students can arrive at work results in groups an	d document them.		
Autonomy	The students can independently analyse approaches	to solving specific problems.		
Workload in Hours	Independent Study Time 124, Study Time in Lecture	56		
Credit points	Independent Study Time 124, Study Time in Lecture	20		
Course achievement				
	None			
	Written exam			
Examination duration and	2h			
scale				
-	General Engineering Science (German program, 7 se	emester): Specialisation Mechanical Engir	eering, Focus Th	eoretical Mechani
Following Curricula	Engineering: Elective Compulsory	(		Aliana (h. Caraba
	General Engineering Science (German program, 7	semester): specialisation Mechanical	Engineering, Foc	us Aircrait Syste
	Engineering: Elective Compulsory General Engineering Science (German program, 7	(semester): Specialization Mochanical	Engineering Foo	us Energy System
	Elective Compulsory	semestery. Specialisation mechalilital	ingineering, root	as Energy Syster
	General Engineering Science (German program, 7 se	mester): Specialisation Naval Architectur	e: Compulsory	
	General Engineering Science (German program, 7 se			ring: Compulsory
	Energy Systems: Technical Complementary Course (			5
	General Engineering Science (English program, 7 se		mental Engineeri	ng: Compulsory
	General Engineering Science (English program, 7		-	
	Elective Compulsory	•	5.	_, , ,
	General Engineering Science (English program, 7 se	mester): Specialisation Naval Architecture	: Compulsory	
	General Engineering Science (English program, 7			us Aircraft Syste
	Engineering: Elective Compulsory			
	Mechanical Engineering: Specialisation Energy Syste	ms: Elective Compulsory		
	Mechanical Engineering: Specialisation Aircraft Syste	ems Engineering: Elective Compulsory		
	Naval Architecture: Core Qualification: Compulsory			

Course L0235: Computationa	al Fluid Dynamics I
Тур	Lecture
Hrs/wk	2
CP	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Prof. Thomas Rung
Language	DE
Cycle	WiSe
Content	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

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

Courses				
Title		Тур	Hrs/wk	СР
Numerical Mathematics I (L0417)		Lecture	2	3
Numerical Mathematics I (L0418)		Recitation Section (small)	2	3
Module Responsible	Prof. Sabine Le Borne			
Admission Requirements	None			
Recommended Previous	Mathematik I + II for Engineering Students (	german or english) <b>or</b> Analysis & Linear Alg	gebra I + II for Te	chnomathematic
Knowledge	basic MATLAB/Python knowledge	g,,,	<u> </u>	
	After taking part successfully, students have reach	ed the following learning results		
Professional Competence				
Knowleage	Students are able to			
	<ul> <li>name numerical methods for interpolation, i</li> </ul>	ntegration, least squares problems, eigenv	value problems, r	onlinear root fin
	problems and to explain their core ideas,			
	<ul> <li>repeat convergence statements for the num</li> </ul>	erical methods,		
	<ul> <li>explain aspects for the practical execution or</li> </ul>	f numerical methods with respect to comp	utational and sto	rage complexitx.
Skills	Students are able to			
	<ul> <li>implement, apply and compare numerical m</li> </ul>	ethods using MATLAB/Pvthon.		
	<ul> <li>justify the convergence behaviour of numeri</li> </ul>		nd solution algori	thm,
	<ul> <li>select and execute a suitable solution appro</li> </ul>			
Personal Competence				
Social Competence	Students are able to			
	<ul> <li>work together in heterogeneously composed</li> </ul>	d teams (i.e., teams from different study p	rograms and bac	kground knowled
	explain theoretical foundations and support			
Autonomy	Students are capable			
	<ul> <li>to assess whether the supporting theoretica</li> </ul>	l and practical excercises are better solved	l individually or ir	i a team,
	<ul> <li>to assess their individual progess and, if nec</li> </ul>			
	Independent Study Time 124, Study Time in Lectur	e 56		
Credit points				
Course achievement				
Examination	Written exam			
Examination duration and	90 minutes			
scale				
	General Engineering Science (German program, 7 s			
Following Curricula	General Engineering Science (German program	n, 7 semester): Specialisation Mechanic	al Engineering,	Focus Material
	Engineering Sciences: Compulsory		e e nimero Como e de	
	General Engineering Science (German program, 7 s			
	General Engineering Science (German program, Compulsory	, 7 semester). Specialisation Mechanica	i Eligineering, r	ocus biomecnai
	General Engineering Science (German program, 7	semester): Specialisation Mechanical Engin	peering Focus Th	eoretical Mecha
	Engineering: Compulsory	semistery, specialisation rechanical Eligi		illini interildi
	General Engineering Science (German program,	7 semester): Specialisation Mechanical	Engineering. For	us Aircraft Svst
	Engineering: Elective Compulsory	, specification recharded	J	
			neering, Focus M	echatronics: Elec
	General Engineering Science (German program, 7	semester): Specialisation Mechanical Endi		
	General Engineering Science (German program, 7 Compulsory	semester): Specialisation Mechanical Engli		
			Engineering, Foc	us Energy Syste
	Compulsory		Engineering, Foc	us Energy Syste
	Compulsory General Engineering Science (German program,	7 semester): Specialisation Mechanical I		us Energy Syste
	Compulsory General Engineering Science (German program, Elective Compulsory	7 semester): Specialisation Mechanical I Bioprocess Engineering: Elective Compulse		us Energy Syste
	Compulsory General Engineering Science (German program, Elective Compulsory Bioprocess Engineering: Specialisation A - General	7 semester): Specialisation Mechanical I Bioprocess Engineering: Elective Compulso athematics: Elective Compulsory	ory	us Energy Syste
	Compulsory General Engineering Science (German program, Elective Compulsory Bioprocess Engineering: Specialisation A - General Computer Science: Specialisation Computational M	7 semester): Specialisation Mechanical I Bioprocess Engineering: Elective Compulso athematics: Elective Compulsory	ory	us Energy Syste
	Compulsory General Engineering Science (German program, Elective Compulsory Bioprocess Engineering: Specialisation A - General Computer Science: Specialisation Computational M Computer Science: Specialisation II. Mathematics a	7 semester): Specialisation Mechanical I Bioprocess Engineering: Elective Compulso athematics: Elective Compulsory nd Engineering Science: Elective Compulso	ory	us Energy Syste
	Compulsory General Engineering Science (German program, Elective Compulsory Bioprocess Engineering: Specialisation A - General Computer Science: Specialisation Computational M Computer Science: Specialisation II. Mathematics a Data Science: Core Qualification: Compulsory	7 semester): Specialisation Mechanical I Bioprocess Engineering: Elective Compulso athematics: Elective Compulsory nd Engineering Science: Elective Compulso Compulsory	ory	us Energy Syste
	Compulsory General Engineering Science (German program, Elective Compulsory Bioprocess Engineering: Specialisation A - General Computer Science: Specialisation Computational M Computer Science: Specialisation II. Mathematics a Data Science: Core Qualification: Compulsory Electrical Engineering: Core Qualification: Elective Engineering Science: Core Qualification: Compulsory Engineering Science: Core Qualification: Compulsory	7 semester): Specialisation Mechanical I Bioprocess Engineering: Elective Compulso athematics: Elective Compulsory nd Engineering Science: Elective Compulso Compulsory TY	ory	us Energy Syste
	Compulsory General Engineering Science (German program, Elective Compulsory Bioprocess Engineering: Specialisation A - General Computer Science: Specialisation Computational M Computer Science: Specialisation II. Mathematics a Data Science: Core Qualification: Compulsory Electrical Engineering: Core Qualification: Elective Engineering Science: Core Qualification: Compulsor Engineering Science: Core Qualification: Compulsor Engineering Science: Core Qualification: Compulsor Engineering Science: Core Qualification: Compulsor General Engineering Science (English program, 7 s	7 semester): Specialisation Mechanical I Bioprocess Engineering: Elective Compulso athematics: Elective Compulsory nd Engineering Science: Elective Compulso Compulsory TY emester): Core Qualification: Compulsory	ory	us Energy Syste
	Compulsory General Engineering Science (German program, Elective Compulsory Bioprocess Engineering: Specialisation A - General Computer Science: Specialisation Computational M Computer Science: Specialisation II. Mathematics a Data Science: Core Qualification: Compulsory Electrical Engineering: Core Qualification: Elective Engineering Science: Core Qualification: Compulsor Engineering Science: Core Qualification: Compulsor Engineering Science: Core Qualification: Compulsor General Engineering Science (English program, 7 s General Engineering Science (English program, 7 s	7 semester): Specialisation Mechanical I Bioprocess Engineering: Elective Compulso athematics: Elective Compulsory nd Engineering Science: Elective Compulso Compulsory ry emester): Core Qualification: Compulsory emester): Specialisation Computer Science	pry pry :: Compulsory	
	Compulsory General Engineering Science (German program, Elective Compulsory Bioprocess Engineering: Specialisation A - General Computer Science: Specialisation Computational M Computer Science: Specialisation II. Mathematics a Data Science: Core Qualification: Compulsory Electrical Engineering: Core Qualification: Elective Engineering Science: Core Qualification: Compulsor Engineering Science: Core Qualification: Compulsor General Engineering Science (English program, 7 sc General Engineering Science (English program, 7 sc)	7 semester): Specialisation Mechanical I Bioprocess Engineering: Elective Compulso athematics: Elective Compulsory nd Engineering Science: Elective Compulso Compulsory ry emester): Core Qualification: Compulsory emester): Specialisation Computer Science	pry pry :: Compulsory	
	Compulsory General Engineering Science (German program, Elective Compulsory Bioprocess Engineering: Specialisation A - General Computer Science: Specialisation Computational M Computer Science: Specialisation II. Mathematics a Data Science: Core Qualification: Compulsory Electrical Engineering: Core Qualification: Elective f Engineering Science: Core Qualification: Compulsor Engineering Science: Core Qualification: Compulsor General Engineering Science (English program, 7 s General Engineering Science (English program, Compulsory	7 semester): Specialisation Mechanical I Bioprocess Engineering: Elective Compulso athematics: Elective Compulsory nd Engineering Science: Elective Compulsor Compulsory ry emester): Core Qualification: Compulsory emester): Specialisation Computer Science 7 semester): Specialisation Mechanical	pry pry :: Compulsory I Engineering, F	ocus Biomechai
	Compulsory General Engineering Science (German program, Elective Compulsory Bioprocess Engineering: Specialisation A - General Computer Science: Specialisation Computational M Computer Science: Specialisation II. Mathematics a Data Science: Core Qualification: Compulsory Electrical Engineering: Core Qualification: Elective G Engineering Science: Core Qualification: Compulson Engineering Science: Core Qualification: Compulson General Engineering Science (English program, 7 s General Engineering Science (English program, 7 s General Engineering Science (English program, Compulsory General Engineering Science (English program, 7 s	7 semester): Specialisation Mechanical I Bioprocess Engineering: Elective Compulso athematics: Elective Compulsory nd Engineering Science: Elective Compulsor Compulsory ry emester): Core Qualification: Compulsory emester): Specialisation Computer Science 7 semester): Specialisation Mechanical	pry pry :: Compulsory I Engineering, F	ocus Biomechai
	Compulsory General Engineering Science (German program, Elective Compulsory Bioprocess Engineering: Specialisation A - General Computer Science: Specialisation Computational M Computer Science: Specialisation II. Mathematics a Data Science: Core Qualification: Compulsory Electrical Engineering: Core Qualification: Elective G Engineering Science: Core Qualification: Compulson Engineering Science: Core Qualification: Compulson General Engineering Science (English program, 7 s General Engineering Science (English program, 7 s General Engineering Science (English program, Compulsory General Engineering Science (English program, Sciences: Compulsory	7 semester): Specialisation Mechanical I Bioprocess Engineering: Elective Compulso athematics: Elective Compulsory nd Engineering Science: Elective Compulsor Compulsory ry ry emester): Core Qualification: Compulsory emester): Specialisation Computer Science 7 semester): Specialisation Mechanical emester): Specialisation Mechanical Engine	bry bry :: Compulsory I Engineering, F eering, Focus Mat	ocus Biomechai
	Compulsory General Engineering Science (German program, Elective Compulsory Bioprocess Engineering: Specialisation A - General Computer Science: Specialisation Computational M Computer Science: Specialisation II. Mathematics a Data Science: Core Qualification: Compulsory Electrical Engineering: Core Qualification: Elective G Engineering Science: Core Qualification: Compulsor Engineering Science: Core Qualification: Compulsor General Engineering Science (English program, 7 s General Engineering Science (English program, 7 s General Engineering Science (English program, Compulsory General Engineering Science (English program, 7 s Sciences: Compulsory General Engineering Science (English program, 7 s Sciences: Compulsory	7 semester): Specialisation Mechanical I Bioprocess Engineering: Elective Compulso athematics: Elective Compulsory nd Engineering Science: Elective Compulsor Compulsory ry ry emester): Core Qualification: Compulsory emester): Specialisation Computer Science 7 semester): Specialisation Mechanical emester): Specialisation Mechanical Engine	bry bry :: Compulsory I Engineering, F eering, Focus Mat	ocus Biomechai
	Compulsory General Engineering Science (German program, Elective Compulsory Bioprocess Engineering: Specialisation A - General Computer Science: Specialisation Computational M Computer Science: Specialisation II. Mathematics a Data Science: Core Qualification: Compulsory Electrical Engineering: Core Qualification: Elective G Engineering Science: Core Qualification: Compulsor Engineering Science: Core Qualification: Compulsor General Engineering Science (English program, 7 s General Engineering Science (English program, 7 s General Engineering Science (English program, Compulsory General Engineering Science (English program, 7 s Sciences: Compulsory General Engineering Science (English program, 7 s Sciences: Compulsory General Engineering Science (English program, 7 s Sciences: Compulsory	7 semester): Specialisation Mechanical I Bioprocess Engineering: Elective Compulso athematics: Elective Compulsory nd Engineering Science: Elective Compulsor Compulsory Ty emester): Core Qualification: Compulsory emester): Specialisation Computer Science 7 semester): Specialisation Mechanical emester): Specialisation Mechanical Engine semester): Specialisation Mechanical Engine	bry bry E: Compulsory I Engineering, F eering, Focus Mat heering, Focus Th	ocus Biomechai erials in Enginee eoretical Mechai
	Compulsory General Engineering Science (German program, Elective Compulsory Bioprocess Engineering: Specialisation A - General Computer Science: Specialisation Computational M Computer Science: Specialisation II. Mathematics a Data Science: Core Qualification: Compulsory Electrical Engineering: Core Qualification: Elective G Engineering Science: Core Qualification: Compulsor Engineering Science: Core Qualification: Compulsor General Engineering Science (English program, 7 s General Engineering Science (English program, 7 s General Engineering Science (English program, Compulsory General Engineering Science (English program, 7 s Sciences: Compulsory General Engineering Science (English program, 7 s Sciences: Compulsory	7 semester): Specialisation Mechanical I Bioprocess Engineering: Elective Compulso athematics: Elective Compulsory nd Engineering Science: Elective Compulsor Compulsory Ty emester): Core Qualification: Compulsory emester): Specialisation Computer Science 7 semester): Specialisation Mechanical Engine semester): Specialisation Mechanical Engine	ering: Compulsory	ocus Biomechai erials in Enginee eoretical Mechai

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

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

Courses				
Title		Тур	Hrs/wk	СР
Simulation and Design of Mechatro	nic Systems (L1822)	Lecture	2	2
Simulation and Design of Mechatro	nic Systems (L1823)	Recitation Section (large)	1	2
Simulation and Design of Mechatro	nic Systems (L1824)	Practical Course	1	2
Module Responsible	NN			
Admission Requirements	None			
<b>Recommended Previous</b>	Fundatmentals of mechanics, control theory and e	electrical engineering		
Knowledge				
Educational Objectives	After taking part successfully, students have reac	hed the following learning results		
Professional Competence				
Knowledge	Students are able to describe methods and calcul	ations for design, modeling, simulation and	optimization of n	nechatronic syster
Chille	Chudente ave able to apply medane algorithms for	medaling of machatrania systems. They as	a idontific aimeula	to and design sine
SKIIIS	Students are able to apply modern algorithms for systems and implement those in laboratory condi		n identify, simula	ite and design sim
	systems and implement those in laboratory condi-	lions.		
Personal Competence				
Social Competence	Students are able to work goal-oriented in small n	nixed groups and present results to target g	roups.	
Autonomy	Students are able to recognize and improve knowledge deficits independently.			
	With instructor assistance, students are able to ev	valuate their own knowledge level and defin	e a further cours	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	90 min			
scale				
Assignment for the	General Engineering Science (German program,	semester): Specialisation Mechanical Engi	neering, Focus M	lechatronics: Elect
Following Curricula	Compulsory			
	General Engineering Science (German program	, 7 semester): Specialisation Mechanical	Engineering, Fo	cus Aircraft Syste
	Engineering: Elective Compulsory			
	Digital Mechanical Engineering: Core Qualification	: Compulsory		
	General Engineering Science (English program, 7	semester): Specialisation Mechanical Engir	neering, Focus Th	neoretical Mechani
	Engineering: Elective Compulsory			
	General Engineering Science (English program,	7 semester): Specialisation Mechanical	Engineering, Foo	cus Aircraft Syste
	Engineering: Elective Compulsory			
	General Engineering Science (English program, 7	semester): Specialisation Mechanical Engi	neering, Focus M	lechatronics: Elect
	Compulsory		5.	
	Mechanical Engineering: Specialisation Theoretica	I Mechanical Engineering: Elective Compute	orv	
	Mechanical Engineering: Specialisation Aircraft Sy		- 3	
	Mechanical Engineering: Specialisation Aircraft Sy			
	Mechanical Engineering: Specialisation Arctart Sy Mechanical Engineering: Specialisation Mechatror			
	Mechanical Engineering: Specialisation Mechatron			
	Mechatronics: Core Qualification: Compulsory	iest Elective compulsory		
	incentationics, core quantication, compuisory			

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

Course L1823: Simulation and Design of Mechatronic Systems	
Тур	Recitation Section (large)
Hrs/wk	1
CP	2
Workload in Hours	Independent Study Time 46, Study Time in Lecture 14
Lecturer	NN
Language	DE
Cycle	WiSe
Content	See interlocking course
Literature	See interlocking course
Course L1824: Simulation 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	d Lightweigh	t Design		
Courses						
Title				Тур	Hrs/wk	СР
CAE-Team Project (L0271)				Project-/problem-based Learning	2	2
Development of Lightweight Design	n Products (L0270)			Lecture	2	2
Integrated Product Development I	(L0269)			Lecture	2	2
Module Responsible	Prof. Dieter Krause					
Admission Requirements	None					
Recommended Previous	Advanced Knowledge	about engineering desig	gn:			
Knowledge	Fundamentals of Mec	hanical Engineering Des	ign			
	Mechanical Engineerin	ng: Design				
	Advanced Mechanical					
Educational Objectives	After taking part succ	essfully, students have	reached the followi	ng learning results		
Professional Competence						
Knowledge	After completing the i	module, students are ca	pable of:			
	<ul> <li>explaining the</li> </ul>	functional principle of 3I	D-CAD-Systems, PD	M- and FEM-Systems		
				the product development proces	SS	
Skills						
	After completing the	module, students are ab	le to:			
	evaluate differ	ent CAD- and PDM-Syst	ems with regards	to the desired requirements su	ich as classific	ation schemes and
	product structu	ıring				
	<ul> <li>design an exen</li> </ul>	nplary product using CA	D-,PDM- and/or FEM	1-Systems with shared workload		
Personal Competence						
Social Competence	After completing the i	module, students are ab	le to:			
	<ul> <li>To develop a pr</li> </ul>	roject plan and allocate	work appropriate w	ork packages in the framework	of aroun discu	ssions
		results as a team for in			or group discu.	3310113
	· Tresent project		stance in a present			
Autonomy	Students are capable	of:				
	independently	adapt to a CAE-Tool and	complete a given	practical task with it		
	· independentity		complete a given			
Workload in Hours	Independent Study Ti	me 96, Study Time in Le	cture 84			
Credit points	6					
Course achievement		Form	Description			
	Yes 20 %		andCAE-Teampro	ojekt inkl. Vortrag und Ausarbeitu	ung	
		practical work				
	Written exam					
Examination duration and	90					
scale Assignment for the	Conoral Engineering	Science (Cormon prog	ram 7 competer)	: Specialisation Mechanical End	incoring Foc	Aircraft Systems
Following Curricula	Engineering: Compuls		rani, / semester/	. Specialisation Mechanical Ling	jineering, rocc	is Allerait Systems
ronowing curricula			am 7 semester): S	pecialisation Mechanical Engine	erina Focus Pr	oduct Development
	and Production: Comp		ini, / semestery. s	pecialisation mechanical Engine	ening, rocus rr	ouder Development
		Specialisation Mechanic	al Engineering: Ele	ctive Compulsory		
				Specialisation Mechanical Eng	ineerina. Focu	s Aircraft Systems
	Engineering: Compuls		,			
	5 5 1	5	m, 7 semester): S	pecialisation Mechanical Enginee	ering, Focus Pr	oduct Development
	and Production: Comp	oulsory				
	General Engineering	Science (English program	n, 7 semester): Spe	ecialisation Mechanical Engineeri	ng: Elective Co	mpulsory
	Mechanical Engineeri	ng: Specialisation Produ	ct Development an	d Production: Compulsory		
	Mechanical Engineeri	ng: Specialisation Aircra	ft Systems Enginee	ering: Compulsory		
	Product Development	, Materials and Producti	on: Technical Comp	plementary Course Core Studies:	Elective Comp	ulsory

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

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

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

Module M0865: Funda	mentals 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				
<b>Recommended Previous</b>	None			
Knowledge				
Educational Objectives	After taking part successfully, students	have reached the following learning results		
Professional Competence				
Knowledge	Students are able to explain the conten	ts of the lecture of the module.		
Skills	Students are able to apply the methods	and models in the module to industrial problem	S.	
Personal Competence				
Social Competence	-			
Autonomy	-			
Workload in Hours	Independent Study Time 124, Study Tin	ne in Lecture 56		
Credit points	6			
Course achievement	None			
Examination	Written exam			
Examination duration and	180 Minuten			
scale				
Assignment for the	General Engineering Science (German	program, 7 semester): Specialisation Mecha	nical Engineering, Foo	us Aircraft Systems
Following Curricula	Engineering: Compulsory			
	General Engineering Science (German	program, 7 semester): Specialisation Mechanica	I Engineering, Focus P	Product Development
	and Production: Compulsory			
	Engineering Science: Core Qualification	1 ,		
		rogram, 7 semester): Specialisation Mechanical B		ompulsory
		rogram, 7 semester): Core Qualification: Compul	-	
		oduction Management and Processes: Compulso	ry	
	Logistics and Mobility: Specialisation En			
	Mechanical Engineering: Core Qualificat			
	Engineering and Management - Major in	Logistics and Mobility: Specialisation Production	n 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	
Content	(A) Introduction
	(B) Product planning
	(C) Process planning
	(D) Procurement
	(E) Manufacturing
	(F) Production planning and control (PPC)
	(G) Distribution
	(H) Cooperation
Literature	Wiendahl, HP.: Betriebsorganisation für Ingenieure
	Vorlesungsskript

Course L0926: Quality Manag	gement
Тур	Lecture
Hrs/wk	2
CP	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Prof. Hermann Lödding
Language	EN
Cycle	SoSe
Content	<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: Aeror	autical Systems			
Module Moror: Aeror	lautical Systems			
Courses				
Title		Тур	Hrs/wk	СР
Fundamentals of Aircraft Systems (	L0741)	Lecture	2	2
Fundamentals of Aircraft Systems (	L0742)	Recitation Section (small)	1	1
Air Transportation Systems (L0591)		Lecture	2	2
Air Transportation Systems (L0816)		Recitation Section (large)	1	1
Module Responsible	Prof. Frank Thielecke			
Admission Requirements	None			
<b>Recommended Previous</b>	Basics of mathematics, mechanics and thermody	namics		
Knowledge				
Educational Objectives	After taking part successfully, students have read	hed the following learning results		
Professional Competence				
Knowledge	Students get a basic understanding of the struc	ture and design of an aircraft, as well as a	an overview of th	ne systems inside a
	aircraft. In addition, a basic knowledge of the rela	ationchips, the key parameters, roles and wa	ays of working in	different subsyster
	in the air transport is acquired.			
Skills	Due to the learned cross-system thinking stud	ents can gain a deeper understanding of	different system	concepts and th
	technical system implementation. In addition, the		-	
	the air transportation system in the context of th			
Personal Competence				
-	Students are made aware of interdisciplinary con	nmunication in groups.		
	Students are able to independently analyze dif		l implementation	n as well as to thi
Autonomy	system oriented.	terene system concepts and their teenined	i inpicification	
Workload in Hours	Independent Study Time 96, Study Time in Lectu	re 84		
Credit points				
Course achievement				
Examination	Written exam			
Examination duration and				
scale				
Assignment for the	General Engineering Science (German program	n, 7 semester): Specialisation Mechanical	Engineering, Foo	cus Aircraft Syster
-	Engineering: Compulsory	· ·		,
5	General Engineering Science (English program	. 7 semester): Specialisation Mechanical	Engineering, Foo	us Aircraft Syster
	Engineering: Compulsory		3 3,	
	Logistics and Mobility: Specialisation Logistics an	d Mobility: Elective Compulsory		
	Logistics and Mobility: Specialisation Traffic Plan			
	Mechanical Engineering: Specialisation Aircraft S			
			and Systems, FI	octivo Compulson
	Engineering and Management - Major in Logistics	and Mobility: Specialisation Tranific Planning	and Systems: El	ective compuisory

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

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

6						
Courses						
Title	)		12000)	Тур	Hrs/wk	СР
Computer Science for Engineers - F Computer Science for Engineers - F				Lecture Recitation Section (small)	3 2	3
Module Responsible			22030)	Reclation Section (Small)	-	5
Admission Requirements	None					
Recommended Previous	None					
Knowledge						
Educational Objectives	After taking part succ	essfully, students have reache	d the followi	na learning results		
Professional Competence	Arter taking part succ	essiany, statents have reache	a the followi	ng learning results		
Knowledge						
Skills						
Personal Competence						
Social Competence						
Autonomy						
Workload in Hours	Independent Study Ti	me 110, Study Time in Lecture	2 70			
Credit points						
Course achievement	Compulsory Bonus		Description	n competerboalaitand statt		
Eveningtion		Allestation	restate inde	en semesterbegleitend statt.		
Examination						
Examination duration and scale	120 min					
Assignment for the	Conoral Engineering	Science (German program,	7 comosto	r): Specialization Mechanica		ocus Riomochani
Following Curricula	Compulsory	Science (German program,	/ semester	). Specialisation Mechanica	i Engineering, r	ocus biomecham
Following curricula		Science (German program, 7 se				
	Compulsory General Engineering Engineering: Compuls General Engineering Engineering Sciences General Engineering Compulsory	Science (German program, : Compulsory Science (German program, Science (German program, 7 s	7 semester) 7 semeste 7 semeste	: Specialisation Mechanical er): Specialisation Mechanic r): Specialisation Mechanica	Engineering, Foo al Engineering, I Engineering,	cus Aircraft Syste Focus Materials Focus Mechatroni
	and Production: Elect General Engineering 5 General Engineering 5 Compulsory Bioprocess Engineering Electrical Engineering Energy and Environm	Science (German program, 7 s ive Compulsory Science (German program, 7 s Science (German program, 7 s ng: Core Qualification: Compulso : Core Qualification: Compulso ental Engineering: Core Qualifi Science (English program, 7 se	emester): Sp emester): Sp sory ry cation: Com	ecialisation Electrical Enginee ecialisation Green Technologi pulsory	ering: Elective Co es, Focus Renew	mpulsory able Energy: Elect
	Compulsory Green Technologies: Logistics and Mobility Logistics and Mobility Mechatronics: Core Q Process Engineering:	Science (English program, Energy, Water, Climate: Specia : Core Qualification: Compulso : Specialisation Information Te ualification: Compulsory Core Qualification: Compulsory agement - Major in Logistics ar	llisation Ener ry chnology: Co	rgy Systems: Elective Compul	sory	

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

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

## **Focus Materials in Engineering Sciences**

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

Module M0662: Nume	erical Mathematics I			
Courses				
Title	Тур		Hrs/wk	СР
Numerical Mathematics I (L0417)	Lecture		2	3
Numerical Mathematics I (L0418)	Recitation Section	on (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 Analysi</li> </ul>	s & Linear Algel	bra I + II for Te	chnomathematicians
	basic MATLAB/Python knowledge			
Educational Objectives	After taking part successfully, students have reached the following lawring resu	lte		
Educational Objectives		ILS		
Professional Competence				
Knowledge	Students are able to			
	<ul> <li>name numerical methods for interpolation, integration, least squares prot</li> </ul>	blems, eigenval	ue problems, r	onlinear root finding
	problems and to explain their core ideas,			
	<ul> <li>repeat convergence statements for the numerical methods,</li> </ul>			
	<ul> <li>explain aspects for the practical execution of numerical methods with resp</li> </ul>	pect to compute	ational and sto	rage complexity
	• explain aspects for the practical execution of numerical methods with resp	Sect to compute		age complexity.
Skills	Students are able to			
	<ul> <li>implement, apply and compare numerical methods using MATLAB/Python,</li> </ul>	,		
	<ul> <li>justify the convergence behaviour of numerical methods with respect to the</li> </ul>		solution algor	ithm.
	<ul> <li>select and execute a suitable solution approach for a given problem.</li> </ul>		5	
Personal Competence				
Social Competence	Students are able to			
	work together in heterogeneously composed teams (i.e., teams from diffe		-	
	explain theoretical foundations and support each other with practical aspe	ects regarding t	he implementa	tion of algorithms.
Autonomy	Students are capable			
	to assess whether the supporting theoretical and practical excercises are	better solved in	idividually or ir	ı a team,
	<ul> <li>to assess their individual progess and, if necessary, to ask questions and s</li> </ul>	seek help.		
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56			
Credit points				
Course achievement				
Examination				
Examination duration and	90 minutes			
scale				
Assignment for the	General Engineering Science (German program, 7 semester): Specialisation Com	puter Science:	Compulsory	
Following Curricula	General Engineering Science (German program, 7 semester): Specialisation	on Mechanical	Engineering,	Focus Materials in
	Engineering Sciences: Compulsory			
	General Engineering Science (German program, 7 semester): Specialisation Bion	nedical Enginee	ring: Compulso	ory
	General Engineering Science (German program, 7 semester): Specialisation	n Mechanical I	Engineering, F	ocus Biomechanics:
	Compulsory			
	General Engineering Science (German program, 7 semester): Specialisation Mec	hanical Engine	ering, Focus Th	eoretical Mechanical
	Engineering: Compulsory			
	General Engineering Science (German program, 7 semester): Specialisation	Mechanical En	gineering, Foo	us Aircraft Systems
	Engineering: Elective Compulsory			
	General Engineering Science (German program, 7 semester): Specialisation Med	chanical Engine	ering, Focus M	echatronics: Elective
	Compulsory			
	General Engineering Science (German program, 7 semester): Specialisation	Mechanical En	gineering, Foc	us Energy Systems:
	Elective Compulsory			
	Bioprocess Engineering: Specialisation A - General Bioprocess Engineering: Elect	ive Compulsory	,	
	Computer Science: Specialisation Computational Mathematics: Elective Compuls	ory		
	Computer Science: Specialisation II. Mathematics and Engineering Science: Elect	ive 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 Comp		Compulsory	
	General Engineering Science (English program, 7 semester): Specialisation			ocus Biomechanics:
	Compulsory		, .	
1	1 · · · · ·			I

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

Course L0418: Numerical Mathematics I	
Тур	Recitation Section (small)
Hrs/wk	2
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
Fundamentals of Mechanical Propert	ties of Materials (L1090)	Lecture	2	3
Welding Technology (L1123)		Lecture	3	3
Module Responsible	Prof. Claus Emmelmann			
Admission Requirements	None			
<b>Recommended Previous</b>	Fundamentals of Materials Science			
Knowledge				
Educational Objectives	After taking part successfully, students hav	ve reached the following learning results		
<b>Professional Competence</b>				
Knowledge	The students get to know the principles the	at are responsible for the mechanical behav	iour of metals. They acq	uire basic knowleg
	in modelling of the materials behaviour. Fu	urthermore, the students learn about the be	haviour of metals under	r static and dynan
	loads. The students get to know the most	important welding technologies and the co	orresponding systems. T	They learn about t
	influence of welding on the materials and c	lesign.		
Chille	The students know the mechanical properties of metals and the underlying principles. They are able to name the influencin			
			les. They are able to h	ame the innuenc
	factors on the welding behaviour of steel m	laterials.		
	The students are able to select between al	loys according to the desired mechaincal pr	operties and welability.	They can distingu
	between different welding techniques and	select the suitable technique and system co	mponents for a defined	application. They
	able to dimension weld joints within design	tasks.		
Personal Competence				
Social Competence	none			
Autonomy	none			
Workload in Hours	Independent Study Time 110, Study Time i	n Lecture 70		
Credit points	6			
Course achievement	None			
Examination	Written exam			
Examination duration and	90 min			
scale				
	General Engineering Science (German	program, 7 semester): Specialisation Me	echanical Engineering,	Focus Materials
Assignment for the	Engineering Sciences: Compulsory		5 5.	
5			Engineering Focus Mat	orials in Engineer
Following Curricula	General Engineering Science (English prog	ram, 7 semester): Specialisation Mechanica	i Liigineenng, Locus Mai	
Following Curricula	General Engineering Science (English prog Sciences: Compulsory	ram, 7 semester): Specialisation Mechanica	r Engineering, rocus Mai	Lendis in Engineer
Following Curricula	5 5 7 5	ram, 7 semester): Specialisation Mechanica	Lingineering, rocus Ma	
Following Curricula	5 5 7 5	ram, 7 semester): Specialisation Mechanica		

Тур	Lecture	
Hrs/wk	2	
CP	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	
	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)	

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

Courses				
litle		Тур	Hrs/wk	СР
Companion Lecture for Materials Sc	ience Laboratory (L1088)	Lecture	2	2
Aaterial Science Laboratory (L1235		Practical Course	4	4
Module Responsible	Prof. Bodo Fiedler			
Admission Requirements	None			
<b>Recommended Previous</b>	none			
Knowledge				
Educational Objectives	After taking part successfully, students ha	ve reached the following learning results		
Professional Competence				
Knowledge	Students are able to give a summary or	f the technical details of experiments in the	area of materials so	iences and illust
	respective relationships. They are capabl	e of describing and communicating relevant	problems and questio	ns using approp
	technical language. They can explain the	typical process of solving practical problems a	nd present related res	ults.
CL ''			<i>c</i>	
SKIIIS		ntal knowledge on material sciences to the p		
	identity and overcome typical problems of	uring the realization of experiments in the con	lext of material scienc	es.
Personal Competence				
Social Competence	e Students are able to cooperate in small groups in order to conduct experiments in the context of materials sciences. They are			ences. They are
	to effectively present and explain their res	sults alone or in groups in front of a qualified a	udience.	
Autonomy		in the context of materials sciences using pr		y are able to fill g
		the literature and other sources provided by t	ne supervisor.	
	Independent Study Time 96, Study Time in	n Lecture 84		
Credit points				
Course achievement	None			
Examination	Subject theoretical and practical work			
Examination duration and	Test reports on the respective tests and o	nline learning modules with integrated succes	s control	
scale				
Assignment for the	General Engineering Science (German	program, 7 semester): Specialisation Med	hanical Engineering,	Focus Material
Following Curricula	Engineering Sciences: Compulsory			
	General Engineering Science (German pro	ogram, 7 semester): Specialisation Mechanica	I Engineering, Focus I	Product Developr
	and Production: Elective Compulsory			
		gram, 7 semester): Specialisation Mechanical I	Engineering, Focus Ma	terials in Enginee
	Sciences: Compulsory			
		oduct Development and Production: Compulso	ry	
	Mechanical Engineering: Specialisation Ma	terials in Engineering Sciences: Compulsory		

Тур	Lecture			
Hrs/wk	2			
СР	2			
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28			
Lecturer	Prof. Kaline Pagnan Furlan			
Language	DE			
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 Scien	urse L1235: Material Science Laboratory		
Тур	Practical Course		
Hrs/wk	4		
CP	4		
Workload in Hours	Independent Study Time 64, Study Time in Lecture 56		
Lecturer	Prof. Kaline Pagnan Furlan, Prof. Stefan Müller, Prof. Patrick Huber, Prof. Bodo Fiedler, Prof. Gerold Schneider, Prof. Jörg Weißmüller		
Language	DE		
Cycle	WiSe		
Content			
Literature	Vorlesungsunterlagen Grundlagen der Werkstoffwissenschaft I & II		

Courses					
litle .			Тур	Hrs/wk	СР
Materials and Process Modeling (L2			Lecture	3	3
Materials Selection and Processing	(L2861)		Lecture	3	3
Module Responsible	Prof. Norbert Huber				
Admission Requirements	None				
<b>Recommended Previous</b>					
Knowledge					
Educational Objectives	After taking part suc	cessfully, students hav	ve reached the following learning results		
Professional Competence					
	covered in the sense In parallel to the ma laws for plasticity ur also plays a major	aterial-technological co nder monotonic and cyo role in manufacturing	mic efficiency. Metallic materials are in the vailable materials. nsideration, the modeling of material beha clic loading is worked out. In addition to the processes and thus provides the basis	avior by means of phenor e evaluation of componen	menological materia
	Simulation methods	for selected manufactu	uring processes, such as rolling or forming,	are presented for this to	pic area.
Skills	Simulation methods	for selected manufactu	rring processes, such as rolling or forming,	are presented for this to	pic area.
Personal Competence	Sindeton nechods	for selected manufactu	rring processes, such as rolling or forming,	are presented for this to	pic area.
Personal Competence Social Competence	Simulation methods	for selected manufactu	ring processes, such as rolling or forming,	are presented for this to	pic area.
<b>Personal Competence</b> Social Competence Autonomy				are presented for this to	pic area.
<b>Personal Competence</b> Social Competence Autonomy		for selected manufactu Fime 96, Study Time in		are presented for this to	pic area.
Personal Competence Social Competence Autonomy Workload in Hours Credit points	Independent Study 1	Time 96, Study Time in	Lecture 84	are presented for this to	pic area.
Personal Competence Social Competence Autonomy Workload in Hours Credit points Course achievement	Independent Study 1 6 Compulsory Bonus Yes 20 %			, die während des Semes Jestellt werden. Diese kör	sters erbracht und i
Personal Competence Social Competence Autonomy Workload in Hours Credit points Course achievement	Independent Study 1 6 Compulsory Bonus	Fime 96, Study Time in	Lecture 84 Description Wir stellen Übungsaufgaben (ÜA), den wöchentlichen Übungen vorg	, die während des Semes Jestellt werden. Diese kör	sters erbracht und i
Personal Competence Social Competence Autonomy Workload in Hours Credit points Course achievement	Independent Study 1 6 Compulsory Bonus Yes 20 % Written exam	Fime 96, Study Time in	Lecture 84 Description Wir stellen Übungsaufgaben (ÜA), den wöchentlichen Übungen vorg	, die während des Semes Jestellt werden. Diese kör	sters erbracht und i
Personal Competence Social Competence Autonomy Workload in Hours Credit points Course achievement Examination duration and scale	Independent Study 1 6 Compulsory Bonus Yes 20 % Written exam 120 min	Fime 96, Study Time in Form Excercises	Lecture 84 Description Wir stellen Übungsaufgaben (ÜA), den wöchentlichen Übungen vorg	, die während des Semes lestellt werden. Diese kör ssichtigt werden.	sters erbracht und i nnen im Umfang vo
Personal Competence Social Competence Autonomy Workload in Hours Credit points Course achievement Examination duration and scale	Independent Study 1 6 Compulsory Bonus Yes 20 % Written exam 120 min General Engineerin Engineering Science	Fime 96, Study Time in Form Excercises g Science (German s: Compulsory	Lecture 84 Description Wir stellen Übungsaufgaben (ÜA) den wöchentlichen Übungen vorg bis zu 20% bei der Prüfung berück	, die während des Semes lestellt werden. Diese kör ssichtigt werden. Mechanical Engineering,	sters erbracht und i nnen im Umfang vo
Personal Competence Social Competence Autonomy Workload in Hours Credit points Course achievement Examination Examination duration and scale Assignment for the	Independent Study 1 6 Compulsory Bonus Yes 20 % Written exam 120 min General Engineerin Engineering Science Mechanical Engineer	Fime 96, Study Time in Form Excercises g Science (German s: Compulsory	Lecture 84 Description Wir stellen Übungsaufgaben (ÜA), den wöchentlichen Übungen vorg bis zu 20% bei der Prüfung berück program, 7 semester): Specialisation M	, die während des Semes lestellt werden. Diese kör ssichtigt werden. Mechanical Engineering,	sters erbracht und i nnen im Umfang vo
Personal Competence Social Competence Autonomy Workload in Hours Credit points Course achievement Examination Examination duration and scale Assignment for the Following Curricula	Independent Study 1 6 Compulsory Bonus Yes 20 % Written exam 120 min General Engineerin Engineering Science Mechanical Engineer	Fime 96, Study Time in Form Excercises g Science (German s: Compulsory	Lecture 84 Description Wir stellen Übungsaufgaben (ÜA), den wöchentlichen Übungen vorg bis zu 20% bei der Prüfung berück program, 7 semester): Specialisation M	, die während des Semes lestellt werden. Diese kör ssichtigt werden. Mechanical Engineering,	sters erbracht und i nnen im Umfang vo
Personal Competence Social Competence Autonomy Workload in Hours Credit points Course achievement Examination duration and scale Assignment for the Following Curricula	Independent Study 1 6 Compulsory Bonus Yes 20 % Written exam 120 min General Engineerin Engineering Science Mechanical Engineer Process Modeling Lecture	Fime 96, Study Time in Form Excercises g Science (German s: Compulsory	Lecture 84 Description Wir stellen Übungsaufgaben (ÜA), den wöchentlichen Übungen vorg bis zu 20% bei der Prüfung berück program, 7 semester): Specialisation M	, die während des Semes lestellt werden. Diese kör ssichtigt werden. Mechanical Engineering,	sters erbracht und nnen im Umfang vo

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

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

Fiodule Fizoost Elina	nced Fundamentals of Materia	is belence			
Courses					
Title		т	ур	Hrs/wk	СР
Enhanced Fundamentals: Ceramics			ecture	2	2
Enhanced Fundamentals: Ceramics	-		ecitation Section (large)	1	1
Enhanced Fundamentals: Metals (L		L	ecture	2	3
Module Responsible					
Admission Requirements	None				
	Module "Fundamentals of Materials Science"				
Knowledge	Module "Materials Science Laboratory"				
	·····				
	Module "Advanced Materials"				
Educational Objectives	After taking part successfully, students have	e reached the following	learning results		
Professional Competence			<b>U</b> · ·		
	The students are able to give an enhanced of	overview over the follo	wing topics		
	in metals, polymers and ceramics: Atomic			fects , electrical	and mass transpor
	microstructure and phase diagrams. They a				
Skills	The students are able to apply the appropria	ate physical and chemi	cal methods for the above	e mentioned subie	ects.
	·····				
Personal Competence					
Social Competence					
Autonomy	The students are capable to understand ind		re and propeties of ceram	nics, metals and p	olymers. They shoul
	be able to critally evaluate the profoundness	s of their knowledge.			
Workload in Hours	Independent Study Time 110, Study Time in	Lecture 70			
Credit points	6				
Course achievement					
Examination	Written exam				
Examination duration and	180 min				
scale					
Assignment for the	General Engineering Science (German p	orogram, 7 semester)	: Specialisation Mechani	ical Engineering,	Focus Materials
Following Curricula	Engineering Sciences: Compulsory				
	Data Science: Core Qualification: Elective Co				
	General Engineering Science (English progra	am, 7 semester): Speci	alisation Mechanical Engir	neering, Focus Ma	terials in Engineerir
	Sciences: Compulsory				
	General Engineering Science (English progr	ram, 7 semester): Spe	cialisation Mechanical Eng	gineering, Focus F	Product Developme
	and Production: Compulsory				
	Mechanical Engineering: Specialisation Mate				
	Technomathematics: Specialisation III. Engin	neering Science: Electiv	ve Compulsory		

	damentals: Ceramics and Polymers
Тур	Lecture
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
	Prof. Gerold Schneider, Prof. Robert Meißner
Language	
Cycle	SoSe
	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
	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
	Ionische 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 €
	G.Menges; Hanser Verlag; ISBN 3-446-15612-7; ca. 25 € Kunststoff-Kompendium

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	

rse L1086: Enhanced Fun	ndamentals: Metals
Тур	Lecture
Hrs/wk	2
CP	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Language	
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     Cheichean stand
	o Stainless steel
	o sacrificial anodes
	o Passivation and Pourbaix diagrams
	o Corrosion through gas reduction
	Crevice corrosion     Strong correspondences
	Stress corrosion cracking
	o Alloy corrosion and nanoporous metals
	Electrochemical energy storage
	O How a battery works     O Lead accumulators
	o Alkaline batteries
	Nickel-metal hydride accumulators     Flux batteries
	o Flux batteries o Lithium-ion accumulators
	<ul> <li>Electrolytic and super capacitors</li> </ul>
	o Fuel cells
	Materials for hydrogen storage
	State of the art
	Magnetism and magnetic materials     Decomposition field and magnetization
	Phenomenology: magnetic field and magnetization     Para force aptiferromagnetic Curic transition
	Para-, ferro-, antiferromagnets; Curie transition
	<ul> <li>Magnetism at the atomic scale; exchange coupling</li> <li>Magnetization isothermal densities</li> </ul>
	o Magnetization isotherms, domains
	o Measurement methods

- o Measurement methods
- o Magnetocrystalline anisotropy and domain walls
- o Hard magnetic materials and their applications

o Soft magnetic materials and their applications
- 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)
<ul> <li>- B. D. Cullity, C.D. Graham, "Introduction to magnetic materials", John Wiley &amp; Sons, 2011</li> <li>- D. Jiles, "Introduction to magnetism and magnetic materials", CRC press, 2015</li> </ul>

Module M0934: Advai	and Materials			
Courses				
Title		Тур	Hrs/wk	СР
Advanced Materials Characterizatio	n (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			
<b>Recommended Previous</b>	Fundamentals of Materials Science (I and II)	)		
Knowledge				
Educational Objectives	After taking part successfully, students have	e reached the following learning results		
Professional Competence				
Knowledge		operties of advanced materials along with thei or, modern composite materials (biomaterials) a		nnology, in particul
Skills	The students will be able to select material configurations according to the technical needs and, if necessary, to design ne materials considering architectural principles from the micro- to the macroscale. The students will also gain an overview or modern materials science, which enables them to select optimum materials combinations depending on the technical application			
Personal Competence Social Competence	The students are able to present solutions to specialists and to develop ideas further.			
Autonomy	The students are able to			
	<ul> <li>assess their own strengths and weak</li> </ul>	knesses.		
	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 p	program, 7 semester): Specialisation Mecha	nical Engineering, F	ocus Biomechani
Following Curricula			5 5,	
-	General Engineering Science (German p	program, 7 semester): Specialisation Mech	anical Engineering,	Focus Materials
	Engineering Sciences: Compulsory			
	Data Science: Specialisation Materials Scien	nce: Compulsory		
	General Engineering Science (English progr	ram, 7 semester): Specialisation Mechanical En	gineering: Elective C	ompulsory
	Mechanical Engineering: Core Qualification:			

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	
CP	2	
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28	
Lecturer	Prof. Patrick Huber, 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
CP	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

Courses						
Title				Тур	Hrs/wk	СР
Computer Science for Engineers - F	Programming Concepts. I	Data Handling & Communication	(L2689)	Lecture	3	3
Computer Science for Engineers - F				Recitation Section (small)	2	3
Module Responsible	Prof. Sibylle Fröschle					
Admission Requirements	-					
Recommended Previous						
Knowledge						
Educational Objectives	After taking part succ	essfully, students have reache	ed the followi	ng learning results		
Professional Competence						
Knowledge	1					
Skills						
<b>D</b> 10 1						
Personal Competence						
Social Competence Autonomy						
Workload in Hours		ma 110. Chudu Tinaa in Laatuur	. 70			
Credit points		me 110, Study Time in Lecture	2 70			
Course achievement		Form	Description			
course acmevement	No 10%			n semesterbegleitend statt.		
Examination	Written exam					
Examination duration and	120 min					
scale						
Assignment for the	General Engineering	Science (German program,	7 semester	r): Specialisation Mechanica	l Engineering, F	ocus Biomechan
Following Curricula	Compulsory					
	General Engineering	Science (German program, 7 s	emester): Sp	ecialisation Process Engineer	ing: Compulsory	
		Science (German program, 7 s				
	Compulsory	Science (German program, 7 s	emester): Sp	eclalisation Green Technolog	les, Focus Renew	able Energy: Elect
		Science (German program,	7 semester).	Specialisation Mechanical	Engineering Foc	us Energy System
	Compulsory	Science (German program,	/ semester).	specialisation mechanical	Lingineering, Too	us Energy Syster
		Science (German program,	7 semester)	Specialisation Mechanical	Engineering, Foo	us Aircraft Syste
	Engineering: Compuls	sory				
	General Engineering	Science (German program	, 7 semeste	er): Specialisation Mechanic	cal Engineering,	Focus Materials
	Engineering Sciences	: Compulsory				
	General Engineering	Science (German program,	7 semeste	r): Specialisation Mechanica	al Engineering, I	Focus Mechatron
	Compulsory					
		Science (German program, 7 s	semester): Sp	ecialisation Mechanical Engi	neering, Focus Th	eoretical Mechani
	Engineering: Compuls				in a subra . E subra E	
		Science (German program, 7	semester): S	pecialisation Mechanical Eng	ineering, Focus F	roduct Developm
	and Production: Elect	Science (German program, 7 s	omostor): Sn	ecialisation Electrical Engine	ering: Elective Co	mpulsory
		Science (German program, 7 s				
	Compulsory	selence (serman program, 7 s	emester, op	celandation of cell recimolog		
		ng: Core Qualification: Compul	sory			
	Electrical Engineering	: Core Qualification: Compulso	bry			
	Energy and Environm	ental Engineering: Core Qualif	ication: Com	pulsory		
	General Engineering	Science (English program, 7 se	emester): Spe	cialisation Process Engineeri	ng: Elective Com	oulsory
			7 semester)	Specialisation Energy and	Enviromental E	ingineering: Elect
	General Engineering Compulsory	Science (English program,				
	Compulsory	Science (English program, Energy, Water, Climate: Specia	alisation Ener	gy Systems: Elective Compu	lsory	
	Compulsory Green Technologies:			gy Systems: Elective Compu	lsory	
	Compulsory Green Technologies: Logistics and Mobility	Energy, Water, Climate: Specia	ory		lsory	
	Compulsory Green Technologies: Logistics and Mobility Logistics and Mobility	Energy, Water, Climate: Specia : Core Qualification: Compulso	ory		lsory	
	Compulsory Green Technologies: Logistics and Mobility Logistics and Mobility Mechatronics: Core Q	Energy, Water, Climate: Specia : Core Qualification: Compulso : Specialisation Information Te	echnology: Co		lsory	

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

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

## Focus Mechatronics

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

Courses				
Title		Тур	Hrs/wk	СР
Circuit Theory (L0566)		Lecture	3	4
Circuit Theory (L0567)		Recitation Section (small)	2	2
	Prof. Alexander Kölpin			
Admission Requirements				
Kecommended Previous Knowledge	Electrical Engineering I and II, Mathematics I and II			
Kilowieuge				
Educational Objectives	After taking part successfully, students have reached t	he following learning results		
Professional Competence	After taking part successivity, statents have reached t			
	Students are able to explain the basic methods for ca	alculating electrical circuits. They know	w the Fourier ser	ies analysis of linea
, and the dye	networks driven by periodic signals. They know the r			
1	domain, and they are able to explain the frequency be			
1				
Skills	The students are able to calculate currents and volta	ages in linear networks by means of	basic methods,	also when driven b
	periodic signals. They are able to calculate transients in	n electrical circuits in time and frequen	cy domain and a	re able to explain th
	respective transient behaviour. They are able to ana	alyse and to synthesize the frequency	/ behaviour of p	assive two-termina
	circuits.			
Personal Competence				
Social Competence	Students work on exercise tasks in small guided gro	ups. They are encouraged to present	and discuss the	eir results within th
	group.			
Autonomy	The students are able to find out the required method			
	knowledge during the lectures continuously by mea			
	educational objectives. They can link their gained know	viedge to other courses like Electrical E	ingineering I and	Mathematics I.
Workload in Hours	Independent Study Time 110, Study Time in Lecture 70	)		
Credit points				
Course achievement	None			
Examination	Written exam			
Examination duration and	150 min			
scale				
Assignment for the	General Engineering Science (German program, 7	semester): Specialisation Mechanica	al Engineering I	Focus Mechatronics
Following Curricula		semestery. specialisation mechanica	in Engineering, i	
<b>J</b>	General Engineering Science (German program, 7 sem	ester): Specialisation Electrical Engine	ering: Compulsor	y
	Electrical Engineering: Core Qualification: Compulsory			
	Engineering Science: Specialisation Electrical Engineer	ing: Compulsory		
	General Engineering Science (English program, 7	semester): Specialisation Mechanica	l Engineering, I	Focus Mechatronics
	Compulsory			
	Computational Science and Engineering: Specialisation	II. Mathematics & Engineering Science	e: Elective Compu	llsory
	Mechatronics: Core Qualification: Compulsory			
	Technomathematics: Specialisation III. Engineering Sci	ence: 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
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Prof. Alexander Kölpin, Dr. Fabian Lurz
Language	DE
Cycle	WiSe
Content	see interlocking course
Literature	siehe korrespondierende Lehrveranstaltung
	see interlocking course

Courses					
Title		Тур	Hrs/wk	СР	
Simulation and Design of Mechatro	nic Systems (L1822)	Lecture	2	2	
Simulation and Design of Mechatro	nic Systems (L1823)	Recitation Section (large)	1	2	
Simulation and Design of Mechatro	nic Systems (L1824)	Practical Course	1	2	
Module Responsible	NN				
Admission Requirements	None				
<b>Recommended Previous</b>	Fundatmentals of mechanics, control theory and e	electrical engineering			
Knowledge					
Educational Objectives	After taking part successfully, students have reac	hed the following learning results			
Professional Competence					
Knowledge	Students are able to describe methods and calcul	ations for design, modeling, simulation and	optimization of n	nechatronic syster	
Chille	Chudente ave able to apply medane algorithms for	medaling of machatrania systems. They as	a idontific aimeula	to and design sine	
SKIIIS	Students are able to apply modern algorithms for systems and implement those in laboratory condi		n identify, simula	ite and design sim	
	systems and implement those in laboratory condi-	lions.			
Personal Competence					
Social Competence	Students are able to work goal-oriented in small n	nixed groups and present results to target g	roups.		
Autonomy	Students are able to recognize and improve know	ledge deficits independently.			
	With instructor assistance, students are able to evaluate their own knowledge level and define a further course 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	90 min				
scale					
Assignment for the	General Engineering Science (German program,	semester): Specialisation Mechanical Engi	neering, Focus M	lechatronics: Elect	
Following Curricula	Compulsory				
	General Engineering Science (German program	, 7 semester): Specialisation Mechanical	Engineering, Fo	cus Aircraft Syste	
	Engineering: Elective Compulsory				
	Digital Mechanical Engineering: Core Qualification	: Compulsory			
	General Engineering Science (English program, 7	semester): Specialisation Mechanical Engir	neering, Focus Th	neoretical Mechani	
	Engineering: Elective Compulsory				
	General Engineering Science (English program,	7 semester): Specialisation Mechanical	Engineering, Foo	cus Aircraft Syste	
	Engineering: Elective Compulsory				
	General Engineering Science (English program, 7	semester): Specialisation Mechanical Engi	neering, Focus M	lechatronics: Elect	
	Compulsory		5.		
	Mechanical Engineering: Specialisation Theoretica	I Mechanical Engineering: Elective Compute	orv		
	Mechanical Engineering: Specialisation Aircraft Sy		- 3		
	Mechanical Engineering: Specialisation Aircraft Sy				
	Mechanical Engineering: Specialisation Arctart Sy Mechanical Engineering: Specialisation Mechatror				
	Mechanical Engineering: Specialisation Mechatron				
	Mechatronics: Core Qualification: Compulsory	iest Elective compulsory			
	incentationics, core quantication, compuisory				

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

Course L1823: Simulation an	nd Design of Mechatronic Systems
Тур	Recitation Section (large)
Hrs/wk	1
CP	2
Workload in Hours	Independent Study Time 46, Study Time in Lecture 14
Lecturer	NN
Language	DE
Cycle	WiSe
Content	See interlocking course
Literature	See interlocking course
Course L1824: Simulation an	nd Design of Mechatronic Systems
Тур	Practical Course
Hrs/wk	1
CP	2
Workload in Hours	Independent Study Time 46, Study Time in Lecture 14

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

Courses				
Title		Тур	Hrs/wk	СР
Numerical Mathematics I (L0417)		Lecture	2	3
Numerical Mathematics I (L0418)		Recitation Section (small)	2	3
Module Responsible	Prof. Sabine Le Borne			
Admission Requirements	None			
<b>Recommended Previous</b>	<ul> <li>Mathematik I. J. If far Engineering Students</li> </ul>			
Knowledge	<ul> <li>Mathematik I + II for Engineering Students</li> <li>basic MATLAB/Python knowledge</li> </ul>	(german of english) <b>or</b> Analysis & Linear Alg	gebrai + ii tor re	cnnomatnematic
	basic MATEAB/Fython knowledge			
Educational Objectives	After taking part successfully, students have reach	ned the following learning results		
Professional Competence				
Knowledge	Students are able to			
	<ul> <li>name numerical methods for interpolation,</li> </ul>	integration least squares problems eigen	aluo probloms r	onlinger root fin
	problems and to explain their core ideas,	integration, least squares problems, eigen	alde problems, i	ionimear root ini
	<ul> <li>repeat convergence statements for the nun</li> </ul>	nerical methods.		
	<ul> <li>explain aspects for the practical execution of</li> </ul>		utational and stor	rage complexity.
				age complexitor
Skills	Students are able to			
SKIIS				
	<ul> <li>implement, apply and compare numerical n</li> </ul>	nethods using MATLAB/Python,		
	<ul> <li>justify the convergence behaviour of numer</li> </ul>	ical methods with respect to the problem a	nd solution algori	.thm,
	<ul> <li>select and execute a suitable solution approx</li> </ul>	bach for a given problem.		
Personal Competence				
•	Students are able to			
	<ul> <li>work together in heterogeneously compose</li> </ul>	d teams (i.e., teams from different study pr	rograms and bac	kground knowled
	explain theoretical foundations and support	each other with practical aspects regarding	g the implementa	tion of algorithm
Autonomy	Students are capable			
	<ul> <li>to assess whether the supporting theoretical</li> </ul>		individually or in	i a team,
	<ul> <li>to assess their individual progess and, if new</li> </ul>	cessary, to ask questions and seek help.		
Workload in Hours	Independent Study Time 124, Study Time in Lectu	re 56		
Credit points				
Course achievement				
	Written exam			
Examination duration and				
scale	50 minutes			
	General Engineering Science (German program, 7	semester): Specialisation Computer Science	e: Compulsory	
	General Engineering Science (German program)			Focus Material
<b>j</b>	Engineering Sciences: Compulsory	· · · · · · · · · · · · · · · · · · ·	5	
	General Engineering Science (German program, 7	semester): Specialisation Biomedical Engine	eering: Compulso	ory
	General Engineering Science (German program			
	Compulsory			
	General Engineering Science (German program, 7	semester): Specialisation Mechanical Engir	neering, Focus Th	eoretical Mechar
	Engineering: Compulsory			
	General Engineering Science (German program,	7 semester): Specialisation Mechanical	Engineering, Foc	us Aircraft Syst
	Engineering: Elective Compulsory			echatronics: Elec
	Engineering: Elective Compulsory General Engineering Science (German program, 7	semester): Specialisation Mechanical Engi	neering, Focus M	
	General Engineering Science (German program, 7 Compulsory			
	General Engineering Science (German program, 7 Compulsory General Engineering Science (German program,			
	General Engineering Science (German program, 7 Compulsory			
	General Engineering Science (German program, 7 Compulsory General Engineering Science (German program,	7 semester): Specialisation Mechanical I	Engineering, Foc	
	General Engineering Science (German program, 7 Compulsory General Engineering Science (German program, Elective Compulsory Bioprocess Engineering: Specialisation A - General Computer Science: Specialisation Computational N	7 semester): Specialisation Mechanical I Bioprocess Engineering: Elective Compulso lathematics: Elective Compulsory	Engineering, Foc	
	General Engineering Science (German program, 7 Compulsory General Engineering Science (German program, Elective Compulsory Bioprocess Engineering: Specialisation A - General Computer Science: Specialisation Computational N Computer Science: Specialisation II. Mathematics	7 semester): Specialisation Mechanical I Bioprocess Engineering: Elective Compulso lathematics: Elective Compulsory	Engineering, Foc	
	General Engineering Science (German program, 7 Compulsory General Engineering Science (German program, Elective Compulsory Bioprocess Engineering: Specialisation A - General Computer Science: Specialisation Computational N Computer Science: Specialisation II. Mathematics Data Science: Core Qualification: Compulsory	7 semester): Specialisation Mechanical I Bioprocess Engineering: Elective Compulso Mathematics: Elective Compulsory and Engineering Science: Elective Compulso	Engineering, Foc	
	General Engineering Science (German program, 7 Compulsory General Engineering Science (German program, Elective Compulsory Bioprocess Engineering: Specialisation A - General Computer Science: Specialisation Computational N Computer Science: Specialisation II. Mathematics Data Science: Core Qualification: Compulsory Electrical Engineering: Core Qualification: Elective	7 semester): Specialisation Mechanical I Bioprocess Engineering: Elective Compulso Mathematics: Elective Compulsory and Engineering Science: Elective Compulso Compulsory	Engineering, Foc	
	General Engineering Science (German program, 7 Compulsory General Engineering Science (German program, Elective Compulsory Bioprocess Engineering: Specialisation A - General Computer Science: Specialisation Computational N Computer Science: Specialisation II. Mathematics Data Science: Core Qualification: Compulsory Electrical Engineering: Core Qualification: Elective Engineering Science: Core Qualification: Compulso	7 semester): Specialisation Mechanical I Bioprocess Engineering: Elective Compulso Mathematics: Elective Compulsory and Engineering Science: Elective Compulso Compulsory	Engineering, Foc	
	General Engineering Science (German program, 7 Compulsory General Engineering Science (German program, Elective Compulsory Bioprocess Engineering: Specialisation A - General Computer Science: Specialisation Computational N Computer Science: Specialisation II. Mathematics Data Science: Core Qualification: Compulsory Electrical Engineering: Core Qualification: Elective Engineering Science: Core Qualification: Compulso	7 semester): Specialisation Mechanical I Bioprocess Engineering: Elective Compulso Nathematics: Elective Compulsory and Engineering Science: Elective Compulso Compulsory Iry	Engineering, Foc	
	General Engineering Science (German program, 7 Compulsory General Engineering Science (German program, Elective Compulsory Bioprocess Engineering: Specialisation A - General Computer Science: Specialisation Computational N Computer Science: Specialisation II. Mathematics Data Science: Core Qualification: Compulsory Electrical Engineering: Core Qualification: Elective Engineering Science: Core Qualification: Compulso Engineering Science: Core Qualification: Compulso General Engineering Science (English program, 7	7 semester): Specialisation Mechanical I Bioprocess Engineering: Elective Compulso Mathematics: Elective Compulsory and Engineering Science: Elective Compulsor Compulsory my semester): Core Qualification: Compulsory	Engineering, Foc ory ory	
	General Engineering Science (German program, 7 Compulsory General Engineering Science (German program, Elective Compulsory Bioprocess Engineering: Specialisation A - General Computer Science: Specialisation Computational N Computer Science: Specialisation II. Mathematics Data Science: Core Qualification: Compulsory Electrical Engineering: Core Qualification: Elective Engineering Science: Core Qualification: Compulso Engineering Science: Core Qualification: Compulso General Engineering Science (English program, 7 General Engineering Science (English program, 7	7 semester): Specialisation Mechanical I Bioprocess Engineering: Elective Compulso Mathematics: Elective Compulsory and Engineering Science: Elective Compulsor Compulsory my semester): Core Qualification: Compulsory semester): Specialisation Computer Science	Engineering, Foc ory ory : Compulsory	us Energy Syste
	General Engineering Science (German program, 7 Compulsory General Engineering Science (German program, Elective Compulsory Bioprocess Engineering: Specialisation A - General Computer Science: Specialisation Computational M Computer Science: Specialisation II. Mathematics Data Science: Core Qualification: Compulsory Electrical Engineering: Core Qualification: Elective Engineering Science: Core Qualification: Compulso Engineering Science: Core Qualification: Compulso General Engineering Science (English program, 7 General Engineering Science (English program, 7 General Engineering Science (English program)	7 semester): Specialisation Mechanical I Bioprocess Engineering: Elective Compulso Mathematics: Elective Compulsory and Engineering Science: Elective Compulsor Compulsory my semester): Core Qualification: Compulsory semester): Specialisation Computer Science	Engineering, Foc ory ory : Compulsory	us Energy Syste
	General Engineering Science (German program, 7 Compulsory General Engineering Science (German program, Elective Compulsory Bioprocess Engineering: Specialisation A - General Computer Science: Specialisation Computational N Computer Science: Specialisation II. Mathematics Data Science: Core Qualification: Compulsory Electrical Engineering: Core Qualification: Elective Engineering Science: Core Qualification: Compulso Engineering Science: Core Qualification: Compulso General Engineering Science (English program, 7 General Engineering Science (English program, 7 General Engineering Science (English program Compulsory	7 semester): Specialisation Mechanical I Bioprocess Engineering: Elective Compulso Mathematics: Elective Compulsory and Engineering Science: Elective Compulsor Compulsory my semester): Core Qualification: Compulsory semester): Specialisation Computer Science , 7 semester): Specialisation Mechanical	Engineering, Foc ory ory : Compulsory I Engineering, F	us Energy Syste
	General Engineering Science (German program, 7 Compulsory General Engineering Science (German program, Elective Compulsory Bioprocess Engineering: Specialisation A - General Computer Science: Specialisation Computational N Computer Science: Specialisation II. Mathematics Data Science: Core Qualification: Compulsory Electrical Engineering: Core Qualification: Elective Engineering Science: Core Qualification: Compulso Engineering Science: Core Qualification: Compulso General Engineering Science (English program, 7 General Engineering Science (English program, 7	7 semester): Specialisation Mechanical I Bioprocess Engineering: Elective Compulso Mathematics: Elective Compulsory and Engineering Science: Elective Compulsor Compulsory my semester): Core Qualification: Compulsory semester): Specialisation Computer Science , 7 semester): Specialisation Mechanical	Engineering, Foc ory ory : Compulsory I Engineering, F	us Energy Syste
	General Engineering Science (German program, 7 Compulsory General Engineering Science (German program, Elective Compulsory Bioprocess Engineering: Specialisation A - General Computer Science: Specialisation Computational N Computer Science: Specialisation II. Mathematics of Data Science: Core Qualification: Compulsory Electrical Engineering: Core Qualification: Elective Engineering Science: Core Qualification: Compulso Engineering Science: Core Qualification: Compulso General Engineering Science (English program, 7 General Engineering Science (English program, 7 General Engineering Science (English program Compulsory General Engineering Science (English program, 7 Sciences: Compulsory	7 semester): Specialisation Mechanical I Bioprocess Engineering: Elective Compulso Aathematics: Elective Compulsory and Engineering Science: Elective Compulsor Compulsory my semester): Core Qualification: Compulsory semester): Specialisation Computer Science , 7 semester): Specialisation Mechanical semester): Specialisation Mechanical Engine	Engineering, Foc ory : Compulsory I Engineering, F eering, Focus Mat	us Energy Syste Focus Biomechai terials in Enginee
	General Engineering Science (German program, 7 Compulsory General Engineering Science (German program, Elective Compulsory Bioprocess Engineering: Specialisation A - General Computer Science: Specialisation Computational M Computer Science: Specialisation II. Mathematics of Data Science: Core Qualification: Compulsory Electrical Engineering: Core Qualification: Elective Engineering Science: Core Qualification: Compulsory General Engineering Science (English program, 7 General Engineering Science (English program, 7 General Engineering Science (English program, 7 General Engineering Science (English program, 7 Sciences: Compulsory General Engineering Science (English program, 7 Sciences: Compulsory General Engineering Science (English program, 7	7 semester): Specialisation Mechanical I Bioprocess Engineering: Elective Compulso Aathematics: Elective Compulsory and Engineering Science: Elective Compulsor Compulsory my semester): Core Qualification: Compulsory semester): Specialisation Computer Science , 7 semester): Specialisation Mechanical semester): Specialisation Mechanical Engine	Engineering, Foc ory : Compulsory I Engineering, F eering, Focus Mat	us Energy Syste Focus Biomechai terials in Enginee
	General Engineering Science (German program, 7 Compulsory General Engineering Science (German program, Elective Compulsory Bioprocess Engineering: Specialisation A - General Computer Science: Specialisation Computational M Computer Science: Specialisation II. Mathematics of Data Science: Core Qualification: Compulsory Electrical Engineering: Core Qualification: Elective Engineering Science: Core Qualification: Compulsory General Engineering Science (English program, 7 General Engineering Science (English program, 7 General Engineering Science (English program, 7 General Engineering Science (English program, 7 Sciences: Compulsory General Engineering Science (English program, 7 Sciences: Compulsory General Engineering Science (English program, 7 Sciences: Compulsory General Engineering Science (English program, 7 Engineering: Compulsory	7 semester): Specialisation Mechanical I Bioprocess Engineering: Elective Compulso Mathematics: Elective Compulsory and Engineering Science: Elective Compulsory (Compulsory (TY) (TY) (Semester): Core Qualification: Compulsory (Semester): Specialisation Computer Science (, 7 semester): Specialisation Mechanical Engine (Semester): Specialisation Mechanical Engine	Engineering, Foc ory : Compulsory I Engineering, F eering, Focus Mat eeering, Focus Th	us Energy Syste Focus Biomechan terials in Enginee neoretical Mechan
	General Engineering Science (German program, 7 Compulsory General Engineering Science (German program, Elective Compulsory Bioprocess Engineering: Specialisation A - General Computer Science: Specialisation Computational M Computer Science: Specialisation II. Mathematics of Data Science: Core Qualification: Compulsory Electrical Engineering: Core Qualification: Elective Engineering Science: Core Qualification: Compulsory General Engineering Science (English program, 7 General Engineering Science (English program, 7 General Engineering Science (English program, 7 General Engineering Science (English program, 7 Sciences: Compulsory General Engineering Science (English program, 7 Sciences: Compulsory General Engineering Science (English program, 7	7 semester): Specialisation Mechanical I Bioprocess Engineering: Elective Compulso Mathematics: Elective Compulsory and Engineering Science: Elective Compulsory (Compulsory (TY) (TY) (Semester): Core Qualification: Compulsory (Semester): Specialisation Computer Science (, 7 semester): Specialisation Mechanical Engine (Semester): Specialisation Mechanical Engine (Semester): Specialisation Mechanical Engine (Semester): Specialisation Biomedical Engine	Engineering, Foc ory : Compulsory I Engineering, F eering, Focus Mat eering, Focus Th eering: Compulsor	us Energy Syste Focus Biomechai terials in Enginee neoretical Mechai

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

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

Courses				
Title		Тур	Hrs/wk	СР
Electrical Machines and Actuators	L0293)	Lecture	3	4
Electrical Machines and Actuators	L0294)	Recitation Section (large)	2	2
Module Responsible	Prof. Thorsten Kern			
Admission Requirements	None			
<b>Recommended Previous</b>	Basics of mathematics, in particular complex	e numbers, integrals, differentials		
Knowledge	Basics of electrical engineering and mechanical engineering			
Educational Objectives	After taking part successfully, students have			
Professional Competence	Alter taking part successionly, students have	reaction the following learning results		
-	Students can to draw and explain the basic p	principles of electric and magnetic fields.		
5				
		andard types of electric machines and pre-		
	from the power grid to the driven engine.	es they can explain the major parameters of th	e energy efficiency	of the whole syste
	from the power grid to the driven engine.			
Skills	Students are able to calculate two-dimension	anal electric and magnetic fields in particular	ferromagnetic circu	uits with air gap. I
	this they apply the usual methods of the des	ign auf electric machines.		
	They can calulate the operational performa	nce of electric machines from their given cha	racteristic data and	d selected quantiti
		ual equivalent circuits and graphical methods.		
Personal Competence				
Social Competence	none			
Autonomy	Students are able independently to calculate	e electric and magnatic fields for applications.	They are able to ar	nalyse independer
	the operational performance of electric made	chines from the charactersitic data and theyca	an calculate thereo	f selected quantit
	and characteristic curves.			
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	Design of four machines and actuators, revie	ew of design files		
scale				
		am, 7 semester): Specialisation Electrical Engin		
Following Curricula		gram, 7 semester): Specialisation Mechanica	I Engineering, Foc	us Energy System
	Compulsory	ogram, 7 semester): Specialisation Mechani	ical Engineering	Focus Mochatroni
	Compulsory	ogram, 7 semester). Specialisation mechani	icar Engineering, i	focus mechationi
		am, 7 semester): Specialisation Mechanical En	aineerina. Focus Th	neoretical Mechanio
	Engineering: Elective Compulsory		5 5.	
	Digital Mechanical Engineering: Core Qualific	ation: Compulsory		
	Electrical Engineering: Core Qualification: Ele	ective Compulsory		
	Energy and Environmental Engineering: Core	e Qualification: Compulsory		
	General Engineering Science (English progra	m, 7 semester): Specialisation Mechanical Engi	ineering: Elective C	ompulsory
		: Specialisation Energy Technology: Elective Co	mpulsory	
	Logistics and Mobility: Specialisation Engine			
	Logistics and Mobility: Specialisation Traffic I			
		ion Management and Processes: Elective Comp	buisory	
	Mechanical Engineering: Core Qualification: I			
	Mechatronics: Core Qualification: Compulsor Technomathematics: Specialisation III. Engin			
		istics and Mobility: Specialisation Traffic Plannir	and Systems: Fl	ective Compulsory
		sees and mosting. Specialisation frame Flatiliti	-g and Systems. Lie	conversion puisory
	Engineering and Management - Major in Lo	gistics and Mobility: Specialisation Production	Management and	Processes: Electi

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

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

Courses				
Title		Тур	Hrs/wk	СР
Semiconductor Circuit Design (L076	33)	Lecture	3	4
Semiconductor Circuit Design (L086	54)	Recitation Section (small)	1	2
Module Responsible	Prof. Matthias Kuhl			
Admission Requirements	None			
<b>Recommended Previous</b>	Fundamentals of electrical engineering			
Knowledge	Basics of physics, especially semiconductor physics			
	basics of physics, especially semiconductor physics			
Educational Objectives	After taking part successfully, students have reached t	he following learning results		
Professional Competence Knowledge	<ul> <li>Students are able to explain the functionality of</li> <li>Students are able to explain how analog circuits</li> <li>Students are able to explain the functionality of</li> <li>Students know the fundamental digital logic circ</li> <li>Students have knowledge about memory circuits</li> <li>Students know the appropriate fields for the use</li> </ul>	functions and where they are applied. fundamental operational amplifiers and uits and can discuss their advantages a s and can explain their functionality and	I their specificatio and disadvantages	
Skills	<ul> <li>Students can calculate the specifications of different MOS devices and can define the parameters of electronic circuits.</li> <li>Students are able to develop different logic circuits and can design different types of logic circuits.</li> <li>Students can use MOS devices, operational amplifiers and bipolar transistors for specific applications.</li> </ul>			
Personal Competence Social Competence	<ul><li>Students are able work efficiently in heterogene</li><li>Students working together in small groups can s</li></ul>		questions.	
Autonomy	Students are able to assess their level of knowle	dge.		
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56			
Credit points		·		
Course achievement				
Examination				
Examination duration and				
scale				
Assignment for the	General Engineering Science (German program, 7 sem	ester): Specialisation Electrical Enginee	ring: Compulsory	
Following Curricula	General Engineering Science (German program, 7	- · · ·		
	Compulsory			
	Data Science: Core Qualification: Elective Compulsory			
	Electrical Engineering: Core Qualification: Compulsory			
	Engineering Science: Specialisation Electrical Engineer	ng: Compulsory		
	Engineering Science: Specialisation Mechatronics: Com	pulsory		
	General Engineering Science (English program, 7 seme	ster): Specialisation Electrical Engineer	ing: Compulsory	
	General Engineering Science (English program, 7	semester): Specialisation Mechanica	l Engineering, Fo	ocus Mechatron
	Compulsory			
	General Engineering Science (English program, 7 seme	ster): Specialisation Mechatronics: Con	npulsory	
	Computational Science and Engineering: Specialisation		: Elective Compul	sory
	Mechanical Engineering: Specialisation Mechatronics: C	Compulsory		
	Mechatronics: Core Qualification: Compulsory			
	Technomathematics: Specialisation III. Engineering Scie	ence: Elective Compulsory		

urse L0763: Semiconducto	
Тур	Lecture
Hrs/wk	
СР	
	Independent Study Time 78, Study Time in Lecture 42
	Prof. Matthias Kuhl
Language	
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	<ul> <li>U. Tietze und Ch. Schenk, E. Gamm, Halbleiterschaltungstechnik, Springer Verlag, 14. Auflage, 2012, ISBN 3540428496</li> <li>R. J. Baker, CMOS - Circuit Design, Layout and Simulation, J. Wiley &amp; Sons Inc., 3. Auflage, 2011, ISBN: 0471700555</li> <li>H. Göbel, Einführung in die Halbleiter-Schaltungstechnik, Berlin, Heidelberg Springer-Verlag Berlin Heidelberg, 2011, ISBN 9783642208874 ISBN: 9783642208867</li> <li>URL: http://site.ebrary.com/lib/alltitles/docDetail.action?docID=10499499</li> <li>URL: http://dx.doi.org/10.1007/978-3-642-20887-4</li> <li>URL: http://ebooks.ciando.com/book/index.cfm/bok_id/319955</li> <li>URL: http://www.ciando.com/img/bo</li> </ul>

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

Module M0854: Math	ematics IV			
Courses				
Title Differential Equations 2 (Partial Dif		<b>Typ</b> Lecture	Hrs/wk 2 1	<b>CP</b> 1
Differential Equations 2 (Partial Dif Differential Equations 2 (Partial Dif Complex Functions (L1038)		Recitation Section (small) Recitation Section (large) Lecture	1 2	1 1
Complex Functions (L1041) Complex Functions (L1042)		Recitation Section (small) Recitation Section (large)	1 1	1 1
Module Responsible				
Admission Requirements	None Mathematics 1 - III			
Recommended Previous Knowledge	Mathematics I - III			
Educational Objectives	After taking part successfully, students have reached the follow	wing learning results		
Professional Competence Knowledge	<ul> <li>Students can name the basic concepts in Mathematics I</li> <li>Students can discuss logical connections between thes the help of examples.</li> <li>They know proof strategies and can reproduce them.</li> </ul>			
Skills	<ul> <li>Students can model problems in Mathematics IV with the help of the concepts studied in this course. Moreover, they are capable of solving them by applying established methods.</li> <li>Students are able to discover and verify further logical connections between the concepts studied in the course.</li> <li>For a given problem, the students can develop and execute a suitable approach, and are able to critically evaluate the results.</li> </ul>			
Personal Competence Social Competence				
Autonomy	<ul> <li>Students are capable of checking their understanding of complex concepts on their own. They can specify open questions precisely and know where to get help in solving them.</li> <li>Students have developed sufficient persistence to be able to work for longer periods in a goal-oriented manner on hard problems.</li> </ul>			
Workload in Hours	Independent Study Time 68, Study Time in Lecture 112			
Credit points				
Course achievement Examination	None Written exam			
	60 min (Complex Functions) + 60 min (Differential Equations 2	?)		
scale				
-	General Engineering Science (German program, 7 semester): 5 General Engineering Science (German program, 7 semest Compulsory General Engineering Science (German program, 7 semester): 5 General Engineering Science (German program, 7 semester): 5 Engineering: Elective Compulsory	ter): Specialisation Mechanica	al Engineering, I	Focus Mechatronics
	Computer Science: Specialisation Computational Mathematics: Electrical Engineering: Core Qualification: Compulsory General Engineering Science (English program, 7 semester): S General Engineering Science (English program, 7 semest Compulsory	pecialisation Electrical Engineer		
	General Engineering Science (English program, 7 semester): 5 Engineering: Compulsory Computational Science and Engineering: Specialisation II. Math Mechanical Engineering: Specialisation Mechatronics: Compuls Mechanical Engineering: Specialisation Theoretical Mechanical Mechatronics: Core Qualification: Compulsory	nematics & Engineering Science ory	e: Elective Compu	
	Naval Architecture: Core Qualification: Compulsory Theoretical Mechanical Engineering: Technical Complementary	Course Core Studies: Elective	Compulsory	

Course L1043: Differential Ec	quations 2 (Partial Differential Equations)	
Тур	ecture	
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> <li>http://www.math.uni-hamburg.de/teaching/export/tuhh/index.html</li> </ul>	

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

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

Course L1038: Complex Functions				
Тур	Lecture			
Hrs/wk	2			
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			
	<ul> <li>Functions of one complex variable</li> <li>Complex differentiation</li> <li>Conformal mappings</li> <li>Complex integration</li> <li>Cauchy's integral theorem</li> <li>Cauchy's integral formula</li> <li>Taylor and Laurent series expansion</li> <li>Singularities and residuals</li> <li>Integral transformations: Fourier and Laplace transformation</li> </ul>			
Literature	<ul> <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		
CP	1		
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14		
Lecturer	Dozenten des Fachbereiches Mathematik der UHH		
Language	DE		
Cycle	SoSe		
Content	See interlocking course		
Literature	See interlocking course		

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

Courses						
Title				Тур	Hrs/wk	СР
Computer Science for Engineers - F	Programming Concepts, I	Data Handling & Communication	(L2689)	Lecture	3	3
Computer Science for Engineers - F				Recitation Section (small)	2	3
Module Responsible	Prof. Sibylle Fröschle					
Admission Requirements	-					
Recommended Previous						
Knowledge						
Educational Objectives	After taking part succ	essfully, students have reache	ed the followi	ng learning results		
Professional Competence						
Knowledge	1					
Skills						
<b>D</b> 10 1						
Personal Competence						
Social Competence Autonomy						
Workload in Hours		ma 110. Chudu Tinan in Lankur	~ 70			
Credit points		me 110, Study Time in Lectur	e 70			
Course achievement		Form	Description			
course achievement	No 10%			en semesterbegleitend statt.		
Examination	Written exam			-		
Examination duration and	120 min					
scale						
Assignment for the	General Engineering	Science (German program,	7 semester	r): Specialisation Mechanica	I Engineering, F	ocus Biomechan
Following Curricula	Compulsory					
	General Engineering	Science (German program, 7 s	emester): Sp	ecialisation Process Engineer	ing: Compulsory	
	General Engineering Science (German program, 7 semester): Specialisation Biomedical Engineering: Compulsory					
	General Engineering	Science (German program, 7 s	emester): Sp	ecialisation Green Technolog	ies, Focus Renew	able Energy: Elect
	Compulsory					
	General Engineering	Science (German program,	7 semester):	Specialisation Mechanical	Engineering, Foc	us Energy Syster
	Compulsory					
	General Engineering	Science (German program,	7 semester)	: Specialisation Mechanical	Engineering, Foo	us Aircraft Syste
	Engineering: Compuls	sory				
		Science (German program	, 7 semeste	er): Specialisation Mechanic	cal Engineering,	Focus Materials
	Engineering Sciences					
		Science (German program,	7 semeste	r): Specialisation Mechanica	al Engineering,	Focus Mechatron
	Compulsory					
		Science (German program, 7 s	semester): Sp	pecialisation Mechanical Engli	neering, Focus Tr	ieoretical Mechani
	Engineering: Compute		comostor): S	nocialisation Mochanical Eng	incoring Focus F	Product Dovelopm
	and Production: Elect	Science (German program, 7 ive Compulsory	semester). 5	pecialisation mechanical Eng	inteering, rocus r	Toduct Developin
		Science (German program, 7 s	emester): Sp	ecialisation Electrical Engine	erina: Elective Co	mpulsory
		Science (German program, 7 s				
	Compulsory	,			,	
		ng: Core Qualification: Compul	sory			
	Electrical Engineering	: Core Qualification: Compulse	ory			
	Energy and Environm	ental Engineering: Core Qualif	ication: Com	pulsory		
			emester): Spe	cielization Dracass Engineeri	na, Electivo Com	
	General Engineering	Science (English program, 7 se		ecialisation Process Engineeri	ng. Elective Com	pulsory
	General Engineering Compulsory	Science (English program, 7 se	7 semester)	: Specialisation Energy and	Enviromental E	
	General Engineering Compulsory Green Technologies:	Science (English program, 7 se Science (English program,	7 semester)	: Specialisation Energy and	Enviromental E	
	General Engineering Compulsory Green Technologies: Logistics and Mobility	Science (English program, 7 se Science (English program, Energy, Water, Climate: Speci	7 semester): alisation Ener	: Specialisation Energy and rgy Systems: Elective Computer	Enviromental E	
	General Engineering Compulsory Green Technologies: Logistics and Mobility Logistics and Mobility	Science (English program, 7 se Science (English program, Energy, Water, Climate: Speci : Core Qualification: Compulse	7 semester): alisation Ener	: Specialisation Energy and rgy Systems: Elective Comput	Enviromental E	
	General Engineering Compulsory Green Technologies: Logistics and Mobility Logistics and Mobility Mechatronics: Core Q	Science (English program, 7 se Science (English program, Energy, Water, Climate: Specie : Core Qualification: Compulso : Specialisation Information Te	7 semester) alisation Ener ory echnology: Co	: Specialisation Energy and rgy Systems: Elective Comput	Enviromental E	

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

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

## **Focus Product Development and Production**

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

Courses					
<b>Title</b> Advanced Mechanical Design Proje	rt (1.0266)	<b>Typ</b> Project-/problem-based Learning	Hrs/wk 4	<b>CP</b> 6	
Module Responsible		Hojeet /problem based Learning	7	0	
Admission Requirements					
Recommended Previous	None				
Knowledge	Mechanical Engineering: Design				
-	<ul> <li>Advanced Mechanical Engineering Design</li> </ul>				
Educational Objectives	After taking part successfully, students have reached	the following learning results			
Professional Competence					
Knowledge	After passing the module, students are able to:				
	<ul> <li>express the procedure for systematically handl</li> <li>complex design tasks ,</li> </ul>	ing of			
	<ul> <li>describe working principles, their use and com</li> </ul>	pination possibilities			
	<ul> <li>explain guidelines for designing for function an</li> </ul>				
	<ul> <li>explain advanced use-oriented knowledge of m</li> </ul>				
Skills	After passing the module, students are able to:				
	analyze complex tasks and develop principle so	olutions using sketches,			
	<ul> <li>convert principle solutions into a detailed designation</li> </ul>	ın,			
	<ul> <li>use methods to design and solve engineering of</li> </ul>	lesign tasks systematically and solution-ori	ented,		
	<ul> <li>create a technical documentation including all</li> </ul>	necessary technical drawings to understand	the functions	s of the system,	
	<ul> <li>document calculations of selected machine ele</li> </ul>	ments clearly and in detail.			
Personal Competence					
-	After passing the module, students are able to:				
	<ul> <li>present and discuss solutions and technical dra</li> </ul>				
	<ul> <li>reflect the own results in the work groups of th</li> </ul>	e course			
Autonomy	After passing the module, students are able to:				
	independently solve complex design projects, while motivating themselves, acquiring necessary knowledge and sele				
	<ul><li>appropriate methods,</li><li>to independently solve problems.</li></ul>				
	• to independently solve problems.				
Workload in Hours	Independent Study Time 124, Study Time in Lecture 5	56			
Credit points	6				
Course achievement	Compulsory Bonus Form De	scription			
	Yes None Attestation				
Examination					
Examination duration and	180				
scale					
-	General Engineering Science (German program, 7	semester): Specialisation Mechanical Eng	ineering, Foc	us Aircraft Syster	
Following Curricula	Engineering: Compulsory	weater) Constitution Machinel Francis			
	General Engineering Science (German program, 7 se	mester): Specialisation Mechanical Engine	ering, Focus P	roduct Developme	
	and Production: Compulsory	competents Consisting Machanical Fra	incoving For		
	General Engineering Science (English program, 7	semester): specialisation Mechanical Eng	meening, FOC	us Aircraft Syster	
	Engineering: Compulsory	mostor), Specialization Mechanical Engine	ring Focus P	roduct Dovelance	
	General Engineering Science (English program, 7 se and Production: Compulsory	mester/, specialisation Mechanical Enginee	ning, rocus P	iouuci Developme	
	General Engineering Science (English program, 7 ser	nester): Specialisation Mechanical Engineer	ina Focus Th	eoretical Mechanic	
	Engineering: Compulsory	nestery, specialisation mechanical Eligineer	ing, rocus III		
	Mechanical Engineering: Core Qualification: Compulso				

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

Courses					
Title Fundamentals of Machine Tools (L0689) Fundamentals of Machine Tools (L1992) Forming and Cutting Technology (L0613)		<b>Typ</b> Lecture Recitation Section (large) Lecture	<b>Hrs/wk</b> 2 1 2	<b>CP</b> 2 1 2	
Forming and Cutting Technology (L		Recitation Section (large)	1	1	
Module Responsible	Prof. Wolfgang Hintze				
Admission Requirements	None				
Recommended Previous Knowledge	without major course assessment internship recommended Previous knowledge in mathematics, mechanics ar	id electrical engineering			
Educational Objectives	After taking part successfully, students have reach	ed the following learning results			
Professional Competence Knowledge	<ul> <li>Students are able to</li> <li>explain the basics of chip formation and mechanisms and models of machining.</li> <li>explain methods and parameters for design and analysis of metal forming, machining processes and tools.</li> <li>explain technical concepts of machine tool building and give an overview on trends in the machine tool industry.</li> <li>explain types, constructions and functions of CNC-machines and give an overview on multi-machine systems.</li> <li>explain equipment components.</li> </ul>				
Skills	<ul> <li>/s Students are able to</li> <li>select tool geometry, cutting materials, process parameters and appropriate measuring technique in accordance with t</li> </ul>				
	<ul> <li>estimate occurring forces and temperatures during chip formation.</li> <li>ester appropriate machine tools for machining and create NC programs for turning and milling.</li> <li>assess the quality of a machine tools and to detect weak points.</li> </ul>				
Personal Competence Social Competence	Students are able to • develop solutions in a production environme	ent with qualified personnel at technical lev	vel and represent	decisions.	
Autonomy	Students are able to				
	<ul> <li>interpret independently cutting processes.</li> <li>create independently NC programs.</li> <li>select independently machine tools by refer</li> <li>assess own strengths and weaknesses in ge</li> <li>assess their learning progress and define ga</li> <li>assess possible consequences of their action</li> </ul>	neral. .ps to be improved.			
Workload in Hours	Independent Study Time 96, Study Time in Lecture	: 84			
Credit points	6				
Course achievement	None				
Examination	Written exam				
	180 min				
scale					
-	General Engineering Science (German program, 7 and Production: Compulsory General Engineering Science (English program, 7 and Production: Compulsory				

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

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

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

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

	uction Engineering	<u></u>		
Courses				
Гitle		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				
<b>Recommended Previous</b>	no course assessments required			
Knowledge	internship recommended			
Educational Objectives	After taking part successfully, students have r	reached the following learning results		
Professional Competence				
Knowledge	Students are able to			
	name basic criteria for the selection of			
	<ul> <li>name the main groups of Manufacturing</li> </ul>			
	<ul> <li>name the application areas of different</li> </ul>			
		advantages of the different manufacturing proce		
	<ul> <li>describe elements, geometric propertie</li> </ul>	es and kinematic variables and requirements fo	r tools, workpiece	and process.
	<ul> <li>explain the essential models of manufa</li> </ul>	acturing technology.		
Skills	Students are able to			
	<ul> <li>select manufacturing processes in according</li> </ul>	rdance with the requirements		
				a produced
		nple tasks to meet the required tolerances of the	le component to t	se produced.
	<ul> <li>assess components in terms of their pro-</li> </ul>	oduction-oriented construction.		
Personal Competence				
Social Competence	Students are able to			
	<ul> <li>develop solutions in a production envir</li> </ul>	onment with qualified personnel at technical le	vel and represent	decisions.
Autonomv	Students are able to			
2				
	<ul> <li>interpret independently the manufacture</li> </ul>	ring process.		
	<ul> <li>assess own strengths and weaknesses</li> </ul>	in general.		
	<ul> <li>assess their learning progress and defi</li> </ul>	ine gaps to be improved.		
	<ul> <li>assess possible consequences of their</li> </ul>	actions.		
Workload in Hours	Independent Study Time 96, Study Time in Le	cture 84		
Credit points	6			
Course achievement				
	Written exam			
Examination duration and				
	120 mm			
scale	Conoral Engineering Science (Cormer and	m 7 competer), Chapterline Machanistics	incoring Factor	Product Develor
		am, 7 semester): Specialisation Mechanical Eng	jirieering, Focus F	-roduct Developm
Following Curricula	and Production: Compulsory			
		m, 7 semester): Specialisation Mechanical Engi	ineering, Focus Tr	neoretical Mechan
	Engineering: Elective Compulsory			
	Digital Mechanical Engineering: Core Qualifica	ation: Compulsory		
	• · · · · · · · · · · · · · · · · · ·			
	Engineering Science: Specialisation Mechanica	- 7	eering: Compulso	ory
	Engineering Science: Specialisation Mechanica General Engineering Science (English program	n, 7 semester): Specialisation Mechanical Engin		
	General Engineering Science (English program	n, 7 semester): Specialisation Mechanical Engin n, 7 semester): Specialisation Mechanical Engi	neering, Focus Th	neoretical Mechan
	General Engineering Science (English program		neering, Focus Th	neoretical Mechan
	General Engineering Science (English program General Engineering Science (English program Engineering: Elective Compulsory			neoretical Mechan
	General Engineering Science (English program General Engineering Science (English program Engineering: Elective Compulsory	n, 7 semester): Specialisation Mechanical Engi Specialisation Energy Technology: Elective Con		neoretical Mechan
	General Engineering Science (English program General Engineering Science (English program Engineering: Elective Compulsory Green Technologies: Energy, Water, Climate:	n, 7 semester): Specialisation Mechanical Engi Specialisation Energy Technology: Elective Con on Management and Processes: Compulsory		neoretical Mechar
	General Engineering Science (English program General Engineering Science (English program Engineering: Elective Compulsory Green Technologies: Energy, Water, Climate: 1 Logistics and Mobility: Specialisation Production	n, 7 semester): Specialisation Mechanical Engi Specialisation Energy Technology: Elective Con on Management and Processes: Compulsory ring Science: Elective Compulsory		neoretical Mechar
	General Engineering Science (English program General Engineering Science (English program Engineering: Elective Compulsory Green Technologies: Energy, Water, Climate: 1 Logistics and Mobility: Specialisation Production Logistics and Mobility: Specialisation Engineer	n, 7 semester): Specialisation Mechanical Engi Specialisation Energy Technology: Elective Con on Management and Processes: Compulsory ring Science: Elective Compulsory ompulsory		neoretical Mechan

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

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

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

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

ourses				
itle		Тур	Hrs/wk	СР
ompanion Lecture for Materials S	cience Laboratory (L1088)	Lecture	2	2
laterial Science Laboratory (L123	5)	Practical Course	4	4
Module Responsible	Prof. Bodo Fiedler			
Admission Requirements	None			
<b>Recommended Previous</b>	none			
Knowledge				
Educational Objectives	After taking part successfully, students ha	ave reached the following learning results		
Professional Competence				
Knowledge	Students are able to give a summary of	of the technical details of experiments in the	e area of materials so	iences and illust
	respective relationships. They are capab	le of describing and communicating relevant	problems and questio	ns using approp
	technical language. They can explain the	typical process of solving practical problems a	and present related res	ults.
Skille	The students can transfer their fundame	ental knowledge on material sciences to the p	process of solving proc	tical problems
JKIIIS		luring the realization of experiments in the cor		
	identity and overcome typical problems of	any the realization of experiments in the cor	litext of material science	c3.
Personal Competence				
Social Competence	Students are able to cooperate in small g	roups in order to conduct experiments in the o	context of materials sci	ences. They are
	to effectively present and explain their re	esults alone or in groups in front of a qualified a	audience.	
Autonomy	Students are capable of colving problems	in the context of materials sciences, using n	rovided literature. The	v are able to fill.
Autonomy	,	s in the context of materials sciences using p g the literature and other sources provided by		y are able to fill y
Workload in Hours	Independent Study Time 96, Study Time		the supervisor.	
Credit points		III Lecture 84		
Course achievement				
	Subject theoretical and practical work			
	lest reports on the respective tests and o	online learning modules with integrated succes	is control	
scale	Concert Fasting sting Colored (Concert	The second se	-haniaal <b>F</b> aniaansian	France Material
-	General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Materials			
Following Curricula	Engineering Sciences: Compulsory	regreen 7 competer). Creciplication Machania	- Fraincering Frances	Product Develop
	and Production: Elective Compulsory	rogram, 7 semester): Specialisation Mechanica	ai Engineering, rocus i	roduct Develop
		gram, 7 semester): Specialisation Mechanical	Engineering Focus Ma	torials in Engine
	Sciences: Compulsory	gram, 7 semester). Specialisation Mechanical	Engineering, Focus Ma	
	1 3	roduct Development and Production: Compulso		
		aterials in Engineering Sciences: Compulsory	, , , , , , , , , , , , , , , , , , ,	
	Product Development, Materials and Prod			

-	•	
Тур	Lecture	
Hrs/wk	2	
СР		
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28	
Lecturer	Prof. Kaline Pagnan Furlan	
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)	

ourse L1235: Material Science Laboratory		
Тур	Practical Course	
Hrs/wk	4	
CP	4	
Workload in Hours	Independent Study Time 64, Study Time in Lecture 56	
Lecturer	Prof. Kaline Pagnan Furlan, Prof. Stefan Müller, Prof. Patrick Huber, Prof. Bodo Fiedler, Prof. Gerold Schneider, Prof. Jörg Weißmüller	
Language	DE	
Cycle	WiSe	
Content		
Literature	Vorlesungsunterlagen Grundlagen der Werkstoffwissenschaft I & II	

Module M0599: Integ	rated Product De	velopment and	l Lightweigh	t Design		
Courses						
Title				Тур	Hrs/wk	СР
CAE-Team Project (L0271)			Project-/problem-based Learning	2	2	
Development of Lightweight Design Products (L0270) Integrated Product Development I (L0269)			Lecture Lecture	2	2	
	Prof. Dieter Krause			Z		
-						
Admission Requirements	None	out onginooring docis				
Recommended Previous Knowledge	Advanced knowledge ab	out engineering desig	in:			
Kilowieuge	Fundamentals of Mechar	nical Engineering Desi	gn			
	Mechanical Engineering: Design					
	Advanced Mechanical En	gineering Design				
Educational Objectives	After taking part success	fully, students have r	eached the followi	ng learning results		
Professional Competence						
Knowledge	After completing the mo	dule, students are cap	bable of:			
	<ul> <li>explaining the fun</li> </ul>	ctional principle of 3D	O-CAD-Systems, PD	M- and FEM-Systems		
				the product development proces	S	
Skills						
	After completing the mo	dule, students are ab	e to:			
	<ul> <li>evaluate different</li> </ul>	CAD- and PDM-Syst	ems with regards	to the desired requirements su	ch as classifio	ation schemes and
	product structurin	-				
	<ul> <li>design an exemple</li> </ul>	ary product using CAI	D-,PDM- and/or FEN	1-Systems with shared workload		
Personal Competence						
Social Competence	After completing the mo	dule, students are ab	e to:			
	• To develop a project plan and allocate work appropriate work packages in the framework of group discussions					
	<ul> <li>Present project results as a team for instance in a presentation</li> </ul>					
A	Chudanta and annahla af					
Autonomy	Students are capable of:					
	<ul> <li>independently ada</li> </ul>	apt to a CAE-Tool and	complete a given	practical task with it		
Workload in Hours	Independent Study Time	06 Study Time in Le	cturo 94			
Credit points	6	50, Study Time In Le				
Course achievement		orm	Description			
course achievement		ubject theoretical	andCAE-Teampro	ojekt inkl. Vortrag und Ausarbeitu	ing	
	р	ractical work				
Examination	Written exam					
Examination duration and	90					
scale						
Assignment for the	General Engineering Sc	ience (German prog	ram, 7 semester)	Specialisation Mechanical Eng	ineering, Foc	us Aircraft Systems
Following Curricula	Engineering: Compulsory	/				
			m, 7 semester): S	pecialisation Mechanical Enginee	ering, Focus Pi	oduct Development
	and Production: Compuls	-				
	Engineering Science: Spe		5 5	1 2		
			am, / semester):	Specialisation Mechanical Eng	ineering, Foci	is Aircraft Systems
	Engineering: Compulsory		m 7 comostor): Si	pecialisation Mechanical Enginee	ring Focus P	aduct Dovelopment
	and Production: Compuls		n, / semester). S	secondation mechanical enginee		sauce Development
			. 7 semester): Spe	cialisation Mechanical Engineeri	na: Elective Co	ompulsory
				d Production: Compulsory		
	Mechanical Engineering:	•				
				elementary Course Core Studies:	Elective Comp	oulsory

Course L0271: CAE-Team Pro	ject
Тур	Project-/problem-based Learning
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Prof. Dieter Krause
Language	DE
Cycle	SoSe
Content	<ul> <li>Practical Introduction in the used software systems (Creo, Windchill, Hyperworks)</li> <li>Team formation, allocation of tasks and generation of a project plan</li> <li>Collective creation of one product out of CAD models supported by FEM calculations and PDM system</li> <li>Manufacturing of selected parts using 3D printer</li> <li>Presentation of results</li> </ul> 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 Pr	ourse L0269: Integrated Product Development I		
Тур	Lecture		
Hrs/wk	2		
CP	2		
Workload in Hours	dependent Study Time 32, Study Time in Lecture 28		
Lecturer	of. Dieter Krause		
Language	DE		
Cycle	SoSe		
Content	<ul> <li>Introduction to Integrated Product Development</li> <li>3D CAD -Systems and CAD interfaces</li> <li>Administration of part lists / PDM systems</li> <li>PDM in different industries</li> <li>Selection of CAD-/PDM Systems</li> <li>Simulation</li> <li>Construction methods</li> <li>Design for X</li> </ul>		
Literature	<ul> <li>Ehrlenspiel, K.: Integrierte Produktentwicklung, München, Carl Hanser Verlag</li> <li>Lee, K.: Principles of CAD / CAM / CAE Systems, Addison Wesles</li> <li>Schichtel, M.: Produktdatenmodellierung in der Praxis, München, Carl Hanser Verlag</li> <li>Anderl, R.: CAD Schnittstellen, München, Carl Hanser Verlag</li> <li>Spur, G., Krause, F.: Das virtuelle Produkt, München, Carl Hanser Verlag</li> </ul>		

Module M0865: Funda	mentals of Production and	Quality Management		
Courses				
Title		Тур	Hrs/wk	СР
Production Process Organization (L	0925)	Lecture	2	3
Quality Management (L0926)		Lecture	2	3
Module Responsible	Prof. Hermann Lödding			
Admission Requirements	None			
<b>Recommended Previous</b>	None			
Knowledge				
Educational Objectives	After taking part successfully, students	have reached the following learning results		
Professional Competence				
Knowledge	Students are able to explain the conten	ts of the lecture of the module.		
Skills	Students are able to apply the methods	and models in the module to industrial problem	s.	
Personal Competence				
Social Competence	-			
Autonomy	-			
Workload in Hours	Independent Study Time 124, Study Tin	ne in Lecture 56		
Credit points	6			
Course achievement	None			
Examination	Written exam			
Examination duration and	180 Minuten			
scale				
Assignment for the	General Engineering Science (German	program, 7 semester): Specialisation Mecha	nical Engineering, Foc	us Aircraft Systems
Following Curricula	Engineering: Compulsory			
	General Engineering Science (German	program, 7 semester): Specialisation Mechanica	I Engineering, Focus P	Product Development
	and Production: Compulsory			
	Engineering Science: Core Qualification			
		rogram, 7 semester): Specialisation Mechanical I		ompulsory
		rogram, 7 semester): Core Qualification: Compul	-	
		oduction Management and Processes: Compulso	ry	
	Logistics and Mobility: Specialisation En			
	Mechanical Engineering: Core Qualificat			
	Engineering and Management - Major in	Logistics and Mobility: Specialisation Production	n Management and Pro	cesses: Compulsory

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

Course L0926: Quality Manag	jement		
Тур	Lecture		
Hrs/wk	2		
CP	3		
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28		
Lecturer	Prof. Hermann Lödding		
Language	EN		
Cycle	SoSe		
Content	<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>		

Courses						
Title				Tur	Hrs/wk	<b>CD</b>
Computer Science for Engineers - F	Programming Concepts, (	Data Handling & Communication	(L2689)	<b>Typ</b> Lecture	Hrs/wk 3	<b>СР</b> 3
Computer Science for Engineers - P				Recitation Section (small)	2	3
Module Responsible	Prof. Sibylle Fröschle					
Admission Requirements						
Recommended Previous						
Knowledge						
Educational Objectives	After taking part succ	essfully, students have reache	ed the followi	ng learning results		
Professional Competence						
Knowledge	1					
Skills						
Demonstration of the second						
Personal Competence						
Social Competence Autonomy						
Workload in Hours		me 110, Study Time in Lectur	0.70			
Credit points		The 110, Study Time in Lectur	e 70			
Course achievement		Form	Description			
course achievement	No 10 %	Attestation		en semesterbegleitend statt.		
Examination	Written exam					
Examination duration and	120 min					
scale						
Assignment for the	General Engineering	Science (German program,	7 semeste	r): Specialisation Mechanica	I Engineering, F	ocus Biomechani
Following Curricula	Compulsory					
	General Engineering	Science (German program, 7 s	emester): Sp	ecialisation Process Engineer	ing: Compulsory	
	General Engineering	Science (German program, 7 s	emester): Sp	ecialisation Biomedical Engin	eerina: Compulso	prv
		Science (German program, 7 s				
	Compulsory	Science (German program, 7 a	semester). Sp	ecialisation oreen recimolog	ies, rocus nenew	able Energy. Elect
		Science (German program,	7 comostor)	Specialisation Mechanical	Engineering Foc	us Energy System
	Compulsory	Science (German program,	/ semester).		Lingineering, Too	us Lifergy Syster
		Science (German program,	7 semester)	: Specialisation Mechanical	Engineering, Foo	us Aircraft Syste
	Engineering: Compuls					-
	General Engineering	Science (German program	, 7 semeste	er): Specialisation Mechanic	al Engineering,	Focus Materials
	Engineering Sciences	: Compulsory				
	General Engineering	Science (German program,	7 semeste	r): Specialisation Mechanica	al Engineering, I	ocus Mechatroni
	Compulsory					
	General Engineering	Science (German program, 7 s	semester): Sp	pecialisation Mechanical Engi	neering, Focus Th	eoretical Mechani
	Engineering: Compuls	sory				
	General Engineering	Science (German program, 7	semester): S	pecialisation Mechanical Eng	ineering, Focus F	roduct Developm
	and Production: Elect					
		Science (German program, 7 s				
		Science (German program, 7 s	semester): Sp	ecialisation Green Technolog	ies, Focus Renew	able Energy: Elect
	Compulsory					
	Bioprocess Engineerin	ng: Core Qualification: Compu				
	Electrical Excitor environments	Come Que lification Comenda				
		: Core Qualification: Compulse	•	pulcon		
	Energy and Environm	ental Engineering: Core Quali	fication: Com		ng: Elective Com	
	Energy and Environm General Engineering	ental Engineering: Core Quali Science (English program, 7 se	fication: Com emester): Spe	ecialisation Process Engineeri		
	Energy and Environm General Engineering General Engineering	ental Engineering: Core Quali	fication: Com emester): Spe	ecialisation Process Engineeri		
	Energy and Environm General Engineering General Engineering Compulsory	ental Engineering: Core Quali Science (English program, 7 sc Science (English program,	fication: Com emester): Spe 7 semester)	ecialisation Process Engineeri : Specialisation Energy and	Enviromental E	
	Energy and Environm General Engineering General Engineering Compulsory Green Technologies:	ental Engineering: Core Quali Science (English program, 7 se	fication: Com emester): Spe 7 semester) alisation Ener	ecialisation Process Engineeri : Specialisation Energy and	Enviromental E	
	Energy and Environm General Engineering General Engineering Compulsory Green Technologies: Logistics and Mobility	ental Engineering: Core Quali Science (English program, 7 sc Science (English program, Energy, Water, Climate: Speci	emester): Spe 7 semester) alisation Ener pry	ecialisation Process Engineeri : Specialisation Energy and rgy Systems: Elective Compu	Enviromental E	
	Energy and Environm General Engineering General Engineering Compulsory Green Technologies: Logistics and Mobility Logistics and Mobility	ental Engineering: Core Quali Science (English program, 7 sc Science (English program, Energy, Water, Climate: Speci : Core Qualification: Compulso	emester): Spe 7 semester) alisation Ener pry	ecialisation Process Engineeri : Specialisation Energy and rgy Systems: Elective Compu	Enviromental E	
	Energy and Environm General Engineering Compulsory Green Technologies: Logistics and Mobility Logistics and Mobility Mechatronics: Core Q	ental Engineering: Core Qualit Science (English program, 7 sc Science (English program, Energy, Water, Climate: Speci :: Core Qualification: Compulso :: Specialisation Information Te	fication: Com emester): Spe 7 semester) alisation Ener ory echnology: Co	ecialisation Process Engineeri : Specialisation Energy and rgy Systems: Elective Compu	Enviromental E	

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

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

## **Focus Theoretical Mechanical Engineering**

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

Courses				
Title		Тур	Hrs/wk 2	<b>СР</b> 3
Numerical Mathematics I (L0417) Numerical Mathematics I (L0418)		Lecture Recitation Section (small)	2	3
Module Responsible	Brof Sabina La Barna	Rectation Section (Small)	L	5
Admission Requirements	None			
Recommended Previous	Mathematik I + II for Engineering Students (	german or english) <b>or</b> Analysis & Linear Alg	jebra I + II for Te	chnomathematicia
Knowledge	basic MATLAB/Python knowledge			
	After taking part successfully, students have reach	ed the following learning results		
Professional Competence				
Knowledge	Students are able to			
	name numerical methods for interpolation,	integration, least squares problems, eigenv	alue problems, r	onlinear root findi
	problems and to explain their core ideas,			
	<ul> <li>repeat convergence statements for the num</li> </ul>	erical methods,		
	<ul> <li>explain aspects for the practical execution of</li> </ul>		Itational and sto	rage complexitx.
	· · · · · · · · · · · · · · · · · · ·			
Skille	Students are able to			
SKIIIS	Students are able to			
	<ul> <li>implement, apply and compare numerical m</li> </ul>	ethods using MATLAB/Python,		
	<ul> <li>justify the convergence behaviour of numer</li> </ul>	ical methods with respect to the problem ar	nd solution algori	ithm,
	<ul> <li>select and execute a suitable solution approx</li> </ul>		-	
		5		
Personal Competence				
Social Competence	Students are able to			
	<ul> <li>work together in heterogeneously compose explain theoretical foundations and support</li> </ul>			
Autonomy	Students are capable			
	<ul> <li>to assess whether the supporting theoretical</li> </ul>	l and practical excercises are better solved	individually or in	atoam
	<ul> <li>to assess whether the supporting theoretical</li> <li>to assess their individual progess and, if neoretical</li> </ul>			ra teann,
	• to assess their individual progess and, if her	essaly, to ask questions and seek help.		
Workload in Hours	Independent Study Time 124, Study Time in Lectur	re 56		
Credit points	6			
Course achievement	None			
Examination	Written exam			
Eveningtion dynation and				
Examination duration and				
scale				
	General Engineering Science (German program, 7	semester): Specialisation Computer Science	e: Compulsory	
Assignment for the	General Engineering Science (German program, 7 General Engineering Science (German program			Focus Materials
Assignment for the				Focus Materials
Assignment for the	General Engineering Science (German program	n, 7 semester): Specialisation Mechanic	al Engineering,	
Assignment for the	General Engineering Science (German program Engineering Sciences: Compulsory	n, 7 semester): Specialisation Mechanic semester): Specialisation Biomedical Engine	al Engineering, eering: Compulso	Dry
Assignment for the	General Engineering Science (German program Engineering Sciences: Compulsory General Engineering Science (German program, 7	n, 7 semester): Specialisation Mechanic semester): Specialisation Biomedical Engine	al Engineering, eering: Compulso	Dry
Assignment for the	General Engineering Science (German program Engineering Sciences: Compulsory General Engineering Science (German program, 7 General Engineering Science (German program	n, 7 semester): Specialisation Mechanic semester): Specialisation Biomedical Engine , 7 semester): Specialisation Mechanical	al Engineering, eering: Compulso Engineering, F	ory Tocus Biomechani
Assignment for the	General Engineering Science (German program Engineering Sciences: Compulsory General Engineering Science (German program, 7 General Engineering Science (German program Compulsory	n, 7 semester): Specialisation Mechanic semester): Specialisation Biomedical Engine , 7 semester): Specialisation Mechanical	al Engineering, eering: Compulso Engineering, F	ory Tocus Biomechani
Assignment for the	General Engineering Science (German program Engineering Sciences: Compulsory General Engineering Science (German program, 7 General Engineering Science (German program Compulsory General Engineering Science (German program, 7	n, 7 semester): Specialisation Mechanic semester): Specialisation Biomedical Engine , 7 semester): Specialisation Mechanical semester): Specialisation Mechanical Engin	al Engineering, eering: Compulso Engineering, F eering, Focus Th	ory Focus Biomechani Neoretical Mechani
Assignment for the	General Engineering Science (German program Engineering Sciences: Compulsory General Engineering Science (German program, 7 General Engineering Science (German program Compulsory General Engineering Science (German program, 7 Engineering: Compulsory	n, 7 semester): Specialisation Mechanic semester): Specialisation Biomedical Engine , 7 semester): Specialisation Mechanical semester): Specialisation Mechanical Engin	al Engineering, eering: Compulso Engineering, F eering, Focus Th	ory Focus Biomechani Neoretical Mechani
Assignment for the	General Engineering Science (German program Engineering Sciences: Compulsory General Engineering Science (German program, 7 General Engineering Science (German program Compulsory General Engineering Science (German program, 7 Engineering: Compulsory General Engineering Science (German program,	n, 7 semester): Specialisation Mechanic semester): Specialisation Biomedical Engine , 7 semester): Specialisation Mechanical semester): Specialisation Mechanical Engin 7 semester): Specialisation Mechanical E	al Engineering, eering: Compulso Engineering, F eering, Focus Th Engineering, Foc	ory iocus Biomechani neoretical Mechani us Aircraft System
Assignment for the	General Engineering Science (German program Engineering Sciences: Compulsory General Engineering Science (German program, 7 General Engineering Science (German program Compulsory General Engineering Science (German program, 7 Engineering: Compulsory General Engineering Science (German program, Engineering: Elective Compulsory	n, 7 semester): Specialisation Mechanic semester): Specialisation Biomedical Engine , 7 semester): Specialisation Mechanical semester): Specialisation Mechanical Engin 7 semester): Specialisation Mechanical E	al Engineering, eering: Compulso Engineering, F eering, Focus Th Engineering, Foc	ory iocus Biomechani neoretical Mechani us Aircraft System
Assignment for the	General Engineering Science (German program Engineering Sciences: Compulsory General Engineering Science (German program, 7 General Engineering Science (German program Compulsory General Engineering Science (German program, 7 Engineering: Compulsory General Engineering Science (German program, Engineering: Elective Compulsory General Engineering Science (German program, 7 Compulsory	n, 7 semester): Specialisation Mechanic semester): Specialisation Biomedical Engine , 7 semester): Specialisation Mechanical semester): Specialisation Mechanical Engin 7 semester): Specialisation Mechanical Engin semester): Specialisation Mechanical Engin	al Engineering, eering: Compulso Engineering, F eering, Focus Th Engineering, Foc neering, Focus M	ory Focus Biomechani Recoretical Mechani Rus Aircraft Syste echatronics: Elect
Assignment for the	General Engineering Science (German program Engineering Sciences: Compulsory General Engineering Science (German program, 7 General Engineering Science (German program Compulsory General Engineering Science (German program, 7 Engineering: Compulsory General Engineering Science (German program, Engineering: Elective Compulsory General Engineering Science (German program, 7 Compulsory General Engineering Science (German program, 7 Compulsory General Engineering Science (German program, 7	n, 7 semester): Specialisation Mechanic semester): Specialisation Biomedical Engine , 7 semester): Specialisation Mechanical semester): Specialisation Mechanical Engin 7 semester): Specialisation Mechanical Engin semester): Specialisation Mechanical Engin	al Engineering, eering: Compulso Engineering, F eering, Focus Th Engineering, Foc neering, Focus M	ory Focus Biomechani Reoretical Mechani Rus Aircraft System echatronics: Electi
Assignment for the	General Engineering Science (German program Engineering Sciences: Compulsory General Engineering Science (German program, 7 General Engineering Science (German program Compulsory General Engineering Science (German program, 7 Engineering: Compulsory General Engineering Science (German program, Engineering: Elective Compulsory General Engineering Science (German program, 7 Compulsory General Engineering Science (German program, 7 Compulsory General Engineering Science (German program, 7 Engineering Science (German program, 7 Elective Compulsory	n, 7 semester): Specialisation Mechanic semester): Specialisation Biomedical Engine , 7 semester): Specialisation Mechanical semester): Specialisation Mechanical Engin 7 semester): Specialisation Mechanical Engin 7 semester): Specialisation Mechanical Engin 7 semester): Specialisation Mechanical Engin	al Engineering, eering: Compulso Engineering, F eering, Focus Th Engineering, Foc neering, Focus M Engineering, Foc	ory Focus Biomechani Reoretical Mechani Rus Aircraft System echatronics: Electi
Assignment for the	General Engineering Science (German program Engineering Sciences: Compulsory General Engineering Science (German program, 7 General Engineering Science (German program Compulsory General Engineering Science (German program, 7 Engineering: Compulsory General Engineering Science (German program, Engineering: Elective Compulsory General Engineering Science (German program, 7 Compulsory General Engineering Science (German program, 7 Compulsory General Engineering Science (German program, Elective Compulsory Bioprocess Engineering: Specialisation A - General	<ul> <li>n, 7 semester): Specialisation Mechanic</li> <li>semester): Specialisation Biomedical Engine</li> <li>, 7 semester): Specialisation Mechanical</li> <li>semester): Specialisation Mechanical Engin</li> <li>7 semester): Specialisation Mechanical I</li> <li>semester): Specialisation Mechanical Engin</li> <li>7 semester): Specialisation Mechanical Engin</li> </ul>	al Engineering, eering: Compulso Engineering, F eering, Focus Th Engineering, Foc neering, Focus M Engineering, Foc	ory Focus Biomechani Reoretical Mechani Rus Aircraft System echatronics: Electi
Assignment for the	General Engineering Science (German program Engineering Sciences: Compulsory General Engineering Science (German program, 7 General Engineering Science (German program Compulsory General Engineering Science (German program, 7 Engineering: Compulsory General Engineering Science (German program, Engineering: Elective Compulsory General Engineering Science (German program, 7 Compulsory General Engineering Science (German program, 7 Compulsory General Engineering Science (German program, 7 Elective Compulsory Bioprocess Engineering: Specialisation A - General Computer Science: Specialisation Computational M	<ul> <li>n, 7 semester): Specialisation Mechanic</li> <li>semester): Specialisation Biomedical Engine</li> <li>, 7 semester): Specialisation Mechanical</li> <li>semester): Specialisation Mechanical Engin</li> <li>7 semester): Specialisation Mechanical Engin</li> </ul>	al Engineering, eering: Compulso Engineering, F eering, Focus Th Engineering, Focus neering, Focus M Engineering, Focus ry	ory Focus Biomechani Reoretical Mechani Rus Aircraft System echatronics: Electi
Assignment for the	General Engineering Science (German program Engineering Sciences: Compulsory General Engineering Science (German program, 7 General Engineering Science (German program Compulsory General Engineering Science (German program, 7 Engineering: Compulsory General Engineering Science (German program, Engineering: Elective Compulsory General Engineering Science (German program, 7 Compulsory General Engineering Science (German program, 7 Compulsory General Engineering Science (German program, 7 Elective Compulsory Bioprocess Engineering: Specialisation A - General Computer Science: Specialisation Computational M Computer Science: Specialisation II. Mathematics a	<ul> <li>n, 7 semester): Specialisation Mechanic</li> <li>semester): Specialisation Biomedical Engine</li> <li>, 7 semester): Specialisation Mechanical</li> <li>semester): Specialisation Mechanical Engin</li> <li>7 semester): Specialisation Mechanical Engin</li> </ul>	al Engineering, eering: Compulso Engineering, F eering, Focus Th Engineering, Focus neering, Focus M Engineering, Focus ry	ory Focus Biomechani Reoretical Mechani Rus Aircraft System echatronics: Electi
Assignment for the	General Engineering Science (German program Engineering Sciences: Compulsory General Engineering Science (German program, 7 General Engineering Science (German program, Compulsory General Engineering Science (German program, 7 Engineering: Compulsory General Engineering Science (German program, Engineering: Elective Compulsory General Engineering Science (German program, 7 Compulsory General Engineering Science (German program, 7 Compulsory General Engineering Science (German program, Elective Compulsory Bioprocess Engineering: Specialisation A - General Computer Science: Specialisation Computational M Computer Science: Specialisation II. Mathematics a Data Science: Core Qualification: Compulsory	n, 7 semester): Specialisation Mechanic semester): Specialisation Biomedical Engine , 7 semester): Specialisation Mechanical semester): Specialisation Mechanical Engin 7 semester): Specialisation Mechanical Engin 7 semester): Specialisation Mechanical Engin 7 semester): Specialisation Mechanical Engin 8 semester): Specialisation Mechanical Engin 9 semester): Specialisation Mechanical Engin 8 semester): Specialisation Mechanical Engin 9 semester): Specialisation Mechanical Engin	al Engineering, eering: Compulso Engineering, F eering, Focus Th Engineering, Focus neering, Focus M Engineering, Focus ry	ory Focus Biomechani Reoretical Mechani Rus Aircraft System echatronics: Electi
Assignment for the	General Engineering Science (German program Engineering Sciences: Compulsory General Engineering Science (German program, 7 General Engineering Science (German program Compulsory General Engineering Science (German program, 7 Engineering: Compulsory General Engineering Science (German program, Engineering: Elective Compulsory General Engineering Science (German program, 7 Compulsory General Engineering Science (German program, 7 Compulsory General Engineering Science (German program, 7 Compulsory Bioprocess Engineering: Specialisation A - General Computer Science: Specialisation Computational M Computer Science: Specialisation II. Mathematics a Data Science: Core Qualification: Compulsory Electrical Engineering: Core Qualification: Elective	n, 7 semester): Specialisation Mechanic semester): Specialisation Biomedical Engine , 7 semester): Specialisation Mechanical semester): Specialisation Mechanical Engin 7 semester): Specialisation Mechanical Engin 7 semester): Specialisation Mechanical Engin 7 semester): Specialisation Mechanical Engin 7 semester): Specialisation Mechanical Engin 8 Bioprocess Engineering: Elective Compulso 10 lathematics: Elective Compulsory 10 and Engineering Science: Elective Compulso 10 compulsory	al Engineering, eering: Compulso Engineering, F eering, Focus Th Engineering, Focus neering, Focus M Engineering, Focus ry	ory Focus Biomechani Reoretical Mechani Rus Aircraft System echatronics: Electi
Assignment for the	General Engineering Science (German program Engineering Sciences: Compulsory General Engineering Science (German program, 7 General Engineering Science (German program, Compulsory General Engineering Science (German program, 7 Engineering: Compulsory General Engineering Science (German program, Engineering: Elective Compulsory General Engineering Science (German program, Engineering: Elective Compulsory General Engineering Science (German program, 7 Compulsory General Engineering Science (German program, Elective Compulsory Bioprocess Engineering: Specialisation A - General Computer Science: Specialisation Computational M Computer Science: Specialisation II. Mathematics a Data Science: Core Qualification: Compulsory Electrical Engineering: Core Qualification: Elective Engineering Science: Core Qualification: Compulsor	n, 7 semester): Specialisation Mechanic semester): Specialisation Biomedical Engine , 7 semester): Specialisation Mechanical semester): Specialisation Mechanical Engin 7 semester): Specialisation Mechanical Engin 7 semester): Specialisation Mechanical Engin 7 semester): Specialisation Mechanical Engin 7 semester): Specialisation Mechanical Engin 8 Bioprocess Engineering: Elective Compulso 1 athematics: Elective Compulsory 1 and Engineering Science: Elective Compulso Compulsory ry	al Engineering, eering: Compulso Engineering, F eering, Focus Th Engineering, Focus neering, Focus M Engineering, Focus ry	ory Focus Biomechani Reoretical Mechani Rus Aircraft System echatronics: Electi
Assignment for the	General Engineering Science (German program Engineering Sciences: Compulsory General Engineering Science (German program, 7 General Engineering Science (German program, Compulsory General Engineering Science (German program, 7 Engineering: Compulsory General Engineering Science (German program, Engineering: Elective Compulsory General Engineering Science (German program, 7 Compulsory General Engineering Science (German program, 7 Compulsory General Engineering Science (German program, 7 Compulsory Bioprocess Engineering: Specialisation A - General Computer Science: Specialisation Computational M Computer Science: Specialisation II. Mathematics a Data Science: Core Qualification: Elective Engineering Science: Core Qualification: Compulsory Electrical Engineering: Core Qualification: Compulsor	n, 7 semester): Specialisation Mechanic semester): Specialisation Biomedical Engine , 7 semester): Specialisation Mechanical semester): Specialisation Mechanical Engin 7 semester): Specialisation Mechanical Engin 7 semester): Specialisation Mechanical Engin 7 semester): Specialisation Mechanical Engin 7 semester): Specialisation Mechanical Engin 8 Bioprocess Engineering: Elective Compulso 10 athematics: Elective Compulsory 10 and Engineering Science: Elective Compulso Compulsory ry ry	al Engineering, eering: Compulso Engineering, F eering, Focus Th Engineering, Focus neering, Focus M Engineering, Focus ry	ory Focus Biomechani Recoretical Mechani Rus Aircraft Syste echatronics: Elect
Assignment for the	General Engineering Science (German program Engineering Sciences: Compulsory General Engineering Science (German program, 7 General Engineering Science (German program, Compulsory General Engineering Science (German program, 7 Engineering: Compulsory General Engineering Science (German program, Engineering: Elective Compulsory General Engineering Science (German program, 7 Compulsory General Engineering Science (German program, 7 Compulsory General Engineering Science (German program, 7 Compulsory Bioprocess Engineering: Specialisation A - General Computer Science: Specialisation Computational M Computer Science: Specialisation II. Mathematics a Data Science: Core Qualification: Elective Engineering Science: Core Qualification: Compulsory Electrical Engineering: Core Qualification: Compulso Engineering Science: Core Qualification: Compulso Engineering Science: Core Qualification: Compulso	n, 7 semester): Specialisation Mechanic semester): Specialisation Biomedical Engine , 7 semester): Specialisation Mechanical semester): Specialisation Mechanical Engin 7 semester): Specialisation Mechanical Engin 7 semester): Specialisation Mechanical Engin 7 semester): Specialisation Mechanical Engin 7 semester): Specialisation Mechanical Engin 8 Bioprocess Engineering: Elective Compulso 10 athematics: Elective Compulsory 10 and Engineering Science: Elective Compulso Compulsory ry ry emester): Core Qualification: Compulsory	al Engineering, eering: Compulso Engineering, Fo eering, Focus Th Engineering, Focus meering, Focus M Engineering, Focus ry	ory Focus Biomechani Recoretical Mechani Rus Aircraft Syste echatronics: Elect
Assignment for the	General Engineering Science (German program Engineering Sciences: Compulsory General Engineering Science (German program, 7 General Engineering Science (German program, Compulsory General Engineering Science (German program, 7 Engineering: Compulsory General Engineering Science (German program, Engineering: Elective Compulsory General Engineering Science (German program, 7 Compulsory General Engineering Science (German program, 7 Compulsory General Engineering Science (German program, 7 Compulsory Bioprocess Engineering: Specialisation A - General Computer Science: Specialisation Computational M Computer Science: Specialisation II. Mathematics a Data Science: Core Qualification: Elective Engineering Science: Core Qualification: Compulsory Electrical Engineering: Core Qualification: Compulso Engineering Science: Core Qualification: Compulso General Engineering Science (English program, 7 SGeneral SCIENCE)	n, 7 semester): Specialisation Mechanic semester): Specialisation Biomedical Engine , 7 semester): Specialisation Mechanical semester): Specialisation Mechanical Engin 7 semester): Specialisation Mechanical Engin 7 semester): Specialisation Mechanical Engin 7 semester): Specialisation Mechanical Engin 7 semester): Specialisation Mechanical Engin 8 Bioprocess Engineering: Elective Compulso 10 athematics: Elective Compulsory 10 and Engineering Science: Elective Compulso 20 compulsory 17 ry 17 emester): Core Qualification: Compulsory 17 emester): Specialisation Computer Science	al Engineering, eering: Compulso Engineering, Focus Th Engineering, Focus M Engineering, Focus M Engineering, Focus ry ry :: Compulsory	ory Focus Biomechani Rus Aircraft Syste echatronics: Elect us Energy Syster
Assignment for the	General Engineering Science (German program Engineering Sciences: Compulsory General Engineering Science (German program, 7 General Engineering Science (German program, Compulsory General Engineering Science (German program, 7 Engineering: Compulsory General Engineering Science (German program, Engineering: Elective Compulsory General Engineering Science (German program, 7 Compulsory General Engineering Science (German program, 7 Compulsory General Engineering Science (German program, 7 Compulsory Bioprocess Engineering: Specialisation A - General Computer Science: Specialisation Computational M Computer Science: Specialisation II. Mathematics a Data Science: Core Qualification: Elective Engineering Science: Core Qualification: Compulsory Electrical Engineering: Core Qualification: Compulso Engineering Science: Core Qualification: Compulso Engineering Science: Core Qualification: Compulso	n, 7 semester): Specialisation Mechanic semester): Specialisation Biomedical Engine , 7 semester): Specialisation Mechanical semester): Specialisation Mechanical Engin 7 semester): Specialisation Mechanical Engin 7 semester): Specialisation Mechanical Engin 7 semester): Specialisation Mechanical Engin 7 semester): Specialisation Mechanical Engin 8 Bioprocess Engineering: Elective Compulso 10 athematics: Elective Compulsory 10 and Engineering Science: Elective Compulso 20 compulsory 17 ry 17 emester): Core Qualification: Compulsory 17 emester): Specialisation Computer Science	al Engineering, eering: Compulso Engineering, Focus Th Engineering, Focus M Engineering, Focus M Engineering, Focus ry ry :: Compulsory	ory Focus Biomechani Rus Aircraft Syste echatronics: Elect us Energy Syster

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

Course L0418: Numerical Mathematics I		
Тур	Recitation Section (small)	
Hrs/wk	2	
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
Heat Transfer (L0458)		Lecture	3	4
Heat Transfer (L0459)		Recitation Section (large)	2	2
Module Responsible	Dr. Andreas Moschallski			
Admission Requirements	None			
Recommended Previous	Technical Thermodynamics I, II and Fluid Dynamics			
Knowledge	After taking part successfully, students have reached	the following learning results		
Professional Competence	After taking part successfully, students have reached	the following learning results		
	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 criti	cal way.		
Skills	The students are able to			
	- understand the physics of Heat Transfer,			
	- calculate and evaluate complex Heat Transfer proc	esses,		
	- solve excersises self-consistent and in small groups	i.		
Personal Competence				
Social Competence	The students are able to discuss in small groups and	develop an approach.		
Autonomy	The students are able to develop a complex problem	self-consistent and analyse the results i	n a critical way. A	A qualified exchan
	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	5 5 7 7 5 7	semester): Specialisation Mechanical I	Engineering, Foc	us Energy System
Following Curricula	Compulsory			
	General Engineering Science (German program, 7 se			
	General Engineering Science (German program, 7 se	emester): Specialisation Mechanical Engir	eering, Focus Th	eoretical Mechani
	Engineering: Compulsory			
	Energy Systems: Technical Complementary Course C			
	General Engineering Science (English program, 7	semester): Specialisation Mechanical I	Engineering, Foc	us Energy System
	Compulsory			
	General Engineering Science (English program, 7 ser		ering: Compulso	ry
	Mechanical Engineering: Specialisation Energy Syste	ms: Compulsory		
	Mechanical Engineering: Specialisation Theoretical M	echanical Engineering: Elective Compuls	orv	

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

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

Courses				
ītle		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				
	no course assessments required			
	no course assessments required			
Knowledge	internship recommended			
	After taking part successfully, students ha	ave reached the following learning results		
Professional Competence				
Knowledge	Students are able to			
	a name basis suitavis for the coloria	n of manufacturing processos		
	name basic criteria for the selection			
	<ul> <li>name the main groups of Manufact</li> </ul>			
	<ul> <li>name the application areas of difference</li> </ul>			
	<ul> <li>name boundaries, advantages and</li> </ul>	l disadvantages of the different manufacturing proce	ess.	
	<ul> <li>describe elements, geometric prope</li> </ul>	perties and kinematic variables and requirements for	tools, workpiece	and process.
	<ul> <li>explain the essential models of man</li> </ul>	nufacturing technology.		
Skills	Students are able to			
	<ul> <li>select manufacturing processes in a</li> </ul>	accordance with the requirements.		
	<ul> <li>design manufacturing processes for</li> </ul>	or simple tasks to meet the required tolerances of th	e component to b	pe produced.
	<ul> <li>assess components in terms of their</li> </ul>	ir production-oriented construction.		
Personal Competence				
Social Competence	Students are able to			
	<ul> <li>develop solutions in a production er</li> </ul>	environment with qualified personnel at technical lev	el and represent	decisions.
Autonomy	Students are able to			
	<ul> <li>interpret independently the manufactoria</li> </ul>			
	<ul> <li>assess own strengths and weaknes</li> </ul>	sses in general.		
	<ul> <li>assess their learning progress and</li> </ul>	l define gaps to be improved.		
	<ul> <li>assess possible consequences of th</li> </ul>	neir actions.		
Workload in Hours	Independent Study Time 96, Study Time in	in Lecture 84		
Credit points				
Course achievement	None			
Examination	Written exam			
Examination duration and	120 min			
scale				
Assignment for the	General Engineering Science (German pro	rogram, 7 semester): Specialisation Mechanical Eng	ineering, Focus F	Product Developm
Following Curricula	and Production: Compulsory			
-		ogram, 7 semester): Specialisation Mechanical Engi	neerina. Focus Tł	neoretical Mechar
	Engineering: Elective Compulsory	· · · · · · · · · · · · · · · · · · ·	5,	
	Digital Mechanical Engineering: Core Qual	lification: Compulson		
	Engineering Science: Specialisation Mecha		ooring, Commuter	
		gram, 7 semester): Specialisation Mechanical Engine		
		ogram, 7 semester): Specialisation Mechanical Engi	neering, Focus Th	eoretical Mechar
	Engineering: Elective Compulsory			
	Green Technologies: Energy, Water, Clima	ate: Specialisation Energy Technology: Elective Com	ipulsory	
	Logistics and Mobility: Specialisation Prod	duction Management and Processes: Compulsory		
		incering Colones, Elective Compulson		
	Logistics and Mobility: Specialisation Engin	meening science: Elective Compulsory		
	Logistics and Mobility: Specialisation Engli Mechanical Engineering: Core Qualification			
		on: Compulsory		

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

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

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

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

Courses				
Title		Тур	Hrs/wk	СР
Electrical Machines and Actuators	(L0293)	Lecture	3	4
Electrical Machines and Actuators	L0294)	Recitation Section (large)	2	2
Module Responsible	Prof. Thorsten Kern			
Admission Requirements	None			
<b>Recommended Previous</b>	Basics of mathematics, in particular complex	e numbers, integrals, differentials		
Knowledge	Basics of electrical engineering and mechanical engineering			
Educational Objectives	After taking part successfully, students have	reached the following learning results		
Professional Competence		· · · · · · · · · · · · · · · · · · ·		
-	Students can to draw and explain the basic p	rinciples of electric and magnetic fields.		
	-			
		andard types of electric machines and pres		
	from the power grid to the driven engine.	s they can explain the major parameters of the	e energy eniciency	of the whole syste
	nom the power gift to the driven engine.			
Skills	Students are able to calculate two-dimensio	nal electric and magnetic fields in particular f	erromagnetic circu	uits with air gap. I
	this they apply the usual methods of the desi	gn auf electric machines.		
	They can calulate the operational performar	nce of electric machines from their given char	acteristic data and	d selected quantiti
		al equivalent circuits and graphical methods.		
Personal Competence				
Social Competence	none			
Autonomy	Students are able independently to calculate	electric and magnatic fields for applications. T	hey are able to ar	nalyse independer
	the operational performance of electric mac	hines from the charactersitic data and theyca	n calculate thereo	f selected quantit
	and characteristic curves.			
	Independent Study Time 110, Study Time in	Lecture 70		
Credit points				
Course achievement				
Examination				
	Design of four machines and actuators, revie	w of design files		
scale				
		m, 7 semester): Specialisation Electrical Engine		
Following Curricula	Compulsory	gram, 7 semester): Specialisation Mechanical	Engineering, Foc	us Energy System
		ogram, 7 semester): Specialisation Mechanic	al Engineering. I	Focus Mechatroni
	Compulsory	J,	,	
		am, 7 semester): Specialisation Mechanical Eng	ineering, Focus Th	eoretical Mechani
	Engineering: Elective Compulsory			
	Digital Mechanical Engineering: Core Qualific	ation: Compulsory		
	Electrical Engineering: Core Qualification: Ele	ctive Compulsory		
	Energy and Environmental Engineering: Core			
	5 5 7 5 7 5	n, 7 semester): Specialisation Mechanical Engir	5	ompulsory
		Specialisation Energy Technology: Elective Cor	npulsory	
	Logistics and Mobility: Specialisation Enginee			
	Logistics and Mobility: Specialisation Traffic P		ulsory	
	Mechanical Engineering: Core Qualification: E	on Management and Processes: Elective Comp	u1301 y	
	Mechatronics: Core Qualification: Compulsory			
	Technomathematics: Specialisation III. Engine			
		stics and Mobility: Specialisation Traffic Plannin	g and Systems: Ele	ective Compulsorv
	Lingineering and Management - Major in Lo	gistics and Mobility: Specialisation Production	Management and	Processes: Electi

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

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

Courses				
Title		Тур	Hrs/wk	СР
Modeling, Simulation and Optimiza	tion (L2446)	Integrated Lecture	4	6
Module Responsible	Prof. Benedikt Kriegesmann			
Admission Requirements	None			
<b>Recommended Previous</b>	Sound knowledge of engineering mathematics, engineering mechanics and fluid mechanics			
Knowledge				
Educational Objectives	After taking part successfully, students have re	eached the following learning results		
Professional Competence				
Knowledge	Students will have an overview of various tec	hnical problems and the differential equation	ons, which describe	them. Students v
	gave an overview of different solution approac	hes and for which kind of problems they can	be used for.	
Skille	Students are able to solve different technical p	roblems with the introduced discretization m	acthods	
JAIIIS	Students are able to solve different technical p	Toblems with the introduced discretization in	lethous.	
Personal Competence				
Social Competence	The students are able to discuss problems and	jointly develop solution strategies.		
Autonomy	The students are able to develop solution strat	egies for complex problems self-consistent a	and critically analyse	results
Autonomy		egies for complex problems sen consistent o	and endeany unaryse	results.
Workload in Hours	Independent Study Time 124, Study Time in Le	ecture 56		
Credit points	6			
Course achievement	None			
Examination	Oral exam			
Examination duration and	30 min			
scale				
Assignment for the	General Engineering Science (German program	n, 7 semester): Specialisation Mechanical En	gineering, Focus Th	eoretical Mechani
Following Curricula	Engineering: Compulsory			
	Engineering Science: Core Qualification: Comp	ulsory		
	General Engineering Science (English program		•	
	General Engineering Science (English program	, 7 semester): Specialisation Mechanical En	gineering, Focus Th	eoretical Mechani
	Engineering: Elective Compulsory			
	Mechanical Engineering: Specialisation Theore	tical Mechanical Engineering: Elective Comp	ulsory	
	Mechanical Engineering: Specialisation Theore	tical Mechanical Engineering: Compulsory		
	Technomathematics: Specialisation III. Enginee	ring Science: Elective Compulsory		

Course L2446: Modeling, Simulation and Optimization		
Тур	Integrated Lecture	
Hrs/wk	4	
CP	6	
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56	
Lecturer	Prof. Benedikt Kriegesmann, Prof. 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		lrs/wk	СР
Differential Equations 2 (Partial Dif	ferential Equations) (L1043)	Lecture	2	-,	1
Differential Equations 2 (Partial Dif		Recitation Sect			1
Differential Equations 2 (Partial Dif	-	Recitation Sect			1
Complex Functions (L1038)		Lecture	2		1
Complex Functions (L1041)		Recitation Sect	tion (small) 1		1
Complex Functions (L1042)		Recitation Sect	tion (large) 1		1
Module Responsible	Prof. Anusch Taraz				
Admission Requirements	None				
Recommended Previous					
Knowledge	Matternates 2 * III				
Educational Objectives	After taking part successfully, students h	ave reached the following learning res	ults		
Professional Competence					
Knowledge					
Knowledge	Students can name the basic conc	epts in Mathematics IV. They are able	to explain them usin	ig appropria	te examples.
	Students can discuss logical conn	ections between these concepts. The	y are capable of illu	strating the	ese connections w
	the help of examples.				
	<ul> <li>They know proof strategies and ca</li> </ul>	n reproduce them.			
Skills					
		Mathematics IV with the help of the c	concepts studied in t	this course.	Moreover, they a
	capable of solving them by applying	ig established methods.			
	Students are able to discover and	verify further logical connections betw	een the concepts stu	udied in the	course.
	<ul> <li>For a given problem, the student</li> </ul>	s can develop and execute a suitable	e approach, and are	e able to cr	itically evaluate t
	results.				
Personal Competence					
Social Competence					
Social Competence		r in teams. They are capable to use ma	athematics as a com	mon langua	ige.
	In doing so, they can communicat	e new concepts according to the need	Is of their cooperatin	ng partners.	Moreover, they c
	design examples to check and dea	epen the understanding of their peers.			
Autonomv					
Autonomy		their understanding of complex conce	epts on their own. Th	hey can spe	ecify open questic
	precisely and know where to get h	elp in solving them.			
	Students have developed sufficie	nt persistence to be able to work for	longer periods in a	goal-orient	ed manner on ha
	problems.				
Workload in Hours	Independent Study Time 68, Study Time	in Lecture 112			
Workload in Hours Credit points		in Lecture 112			
	6	in Lecture 112			
Credit points	6 None	in Lecture 112			
Credit points Course achievement Examination	6 None				
Credit points Course achievement Examination	6 None Written exam 60 min (Complex Functions) + 60 min (D				
Credit points Course achievement Examination Examination duration and scale	6 None Written exam 60 min (Complex Functions) + 60 min (D	ifferential Equations 2)	ctrical Engineering: (	Compulsory	
Credit points Course achievement Examination Examination duration and scale Assignment for the	6 None Written exam 60 min (Complex Functions) + 60 min (D	ifferential Equations 2) ogram, 7 semester): Specialisation Ele			
Credit points Course achievement Examination Examination duration and scale Assignment for the	6 None Written exam 60 min (Complex Functions) + 60 min (D General Engineering Science (German pr	ifferential Equations 2) ogram, 7 semester): Specialisation Ele			
Credit points Course achievement Examination Examination duration and scale Assignment for the	6 None Written exam 60 min (Complex Functions) + 60 min (D General Engineering Science (German Compulsory	ifferential Equations 2) ogram, 7 semester): Specialisation Ele program, 7 semester): Specialisati	on Mechanical Eng	ineering, F	
Credit points Course achievement Examination Examination duration and scale Assignment for the	6 None Written exam 60 min (Complex Functions) + 60 min (D General Engineering Science (German pr General Engineering Science (German Compulsory General Engineering Science (German pr	ifferential Equations 2) ogram, 7 semester): Specialisation Ele program, 7 semester): Specialisati ogram, 7 semester): Specialisation Nav	on Mechanical Eng	ineering, F npulsory	ocus Mechatroni
Credit points Course achievement Examination Examination duration and scale Assignment for the	6 None Written exam 60 min (Complex Functions) + 60 min (D General Engineering Science (German pr General Engineering Science (German pr General Engineering Science (German pr General Engineering Science (German pr	ifferential Equations 2) ogram, 7 semester): Specialisation Ele program, 7 semester): Specialisati ogram, 7 semester): Specialisation Nav	on Mechanical Eng	ineering, F npulsory	ocus Mechatroni
Credit points Course achievement Examination Examination duration and scale Assignment for the	6 None Written exam 60 min (Complex Functions) + 60 min (D General Engineering Science (German pr General Engineering Science (German pr General Engineering Science (German pr General Engineering Science (German pr General Engineering Science (German pr Engineering: Elective Compulsory	ifferential Equations 2) ogram, 7 semester): Specialisation Ele program, 7 semester): Specialisati ogram, 7 semester): Specialisation Na ogram, 7 semester): Specialisation Me	on Mechanical Eng val Architecture: Con echanical Engineering	ineering, F npulsory	ocus Mechatroni
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Credit points Course achievement Examination Examination duration and scale Assignment for the	6 None Written exam 60 min (Complex Functions) + 60 min (D General Engineering Science (German pr General Engineering Science (German pr General Engineering Science (German pr General Engineering Science (German pr Engineering: Elective Compulsory Computer Science: Specialisation Compu Electrical Engineering: Core Qualification	ifferential Equations 2) ogram, 7 semester): Specialisation Ele program, 7 semester): Specialisati ogram, 7 semester): Specialisation Na ogram, 7 semester): Specialisation Me tational Mathematics: Elective Compul : Compulsory	on Mechanical Eng val Architecture: Con echanical Engineering Isory	npulsory g, Focus The	ocus Mechatroni
Credit points Course achievement Examination Examination duration and scale Assignment for the	6 None Written exam 60 min (Complex Functions) + 60 min (D General Engineering Science (German pr General Engineering Science (German pr General Engineering Science (German pr General Engineering Science (German pr Engineering: Elective Compulsory Computer Science: Specialisation Compu Electrical Engineering: Core Qualification General Engineering: Science (English pro	ifferential Equations 2) ogram, 7 semester): Specialisation Ele program, 7 semester): Specialisati ogram, 7 semester): Specialisation Nav ogram, 7 semester): Specialisation Me tational Mathematics: Elective Compul : Compulsory gram, 7 semester): Specialisation Elec	on Mechanical Eng val Architecture: Con echanical Engineering Isory trical Engineering: C	ineering, F npulsory g, Focus The compulsory	iocus Mechatroni eoretical Mechani
Credit points Course achievement Examination Examination duration and scale Assignment for the	6 None Written exam 60 min (Complex Functions) + 60 min (D General Engineering Science (German pr General Engineering Science (German pr General Engineering Science (German pr General Engineering Science (German pr Engineering: Elective Compulsory Computer Science: Specialisation Compu Electrical Engineering: Core Qualification General Engineering Science (English pro General Engineering Science (English pro	ifferential Equations 2) ogram, 7 semester): Specialisation Ele program, 7 semester): Specialisati ogram, 7 semester): Specialisation Nav ogram, 7 semester): Specialisation Me tational Mathematics: Elective Compul : Compulsory gram, 7 semester): Specialisation Elec	on Mechanical Eng val Architecture: Con echanical Engineering Isory trical Engineering: C	ineering, F npulsory g, Focus The compulsory	iocus Mechatroni eoretical Mechani
Credit points Course achievement Examination Examination duration and scale Assignment for the	6 None Written exam 60 min (Complex Functions) + 60 min (D General Engineering Science (German pr General Engineering Science (German pr General Engineering Science (German pr General Engineering Science (German pr Engineering: Elective Compulsory Computer Science: Specialisation Compu Electrical Engineering: Core Qualification General Engineering Science (English pro General Engineering Science (English pro General Engineering Science (English Compulsory	ifferential Equations 2) ogram, 7 semester): Specialisation Ele program, 7 semester): Specialisation Nav ogram, 7 semester): Specialisation Me tational Mathematics: Elective Compul : Compulsory gram, 7 semester): Specialisation Elec program, 7 semester): Specialisation	on Mechanical Eng val Architecture: Con echanical Engineering Isory ctrical Engineering: C on Mechanical Eng	ineering, F npulsory g, Focus The compulsory ineering, F	iocus Mechatroni eoretical Mechani iocus Mechatroni
Credit points Course achievement Examination Examination duration and scale Assignment for the	6 None Written exam 60 min (Complex Functions) + 60 min (D General Engineering Science (German pr General Engineering Science (German pr General Engineering Science (German pr General Engineering Science (German pr Engineering: Elective Compulsory Computer Science: Specialisation Compu Electrical Engineering: Core Qualification General Engineering Science (English pr General Engineering Science (English pr General Engineering Science (English pr General Engineering Science (English pr	ifferential Equations 2) ogram, 7 semester): Specialisation Ele program, 7 semester): Specialisation Nav ogram, 7 semester): Specialisation Me tational Mathematics: Elective Compul : Compulsory gram, 7 semester): Specialisation Elec program, 7 semester): Specialisation	on Mechanical Eng val Architecture: Con echanical Engineering Isory ctrical Engineering: C on Mechanical Eng	ineering, F npulsory g, Focus The compulsory ineering, F	iocus Mechatroni eoretical Mechani iocus Mechatroni
Credit points Course achievement Examination Examination duration and scale Assignment for the	6 None Written exam 60 min (Complex Functions) + 60 min (D General Engineering Science (German pr General Engineering Science (German pr General Engineering Science (German pr General Engineering Science (German pr Engineering: Elective Compulsory Computer Science: Specialisation Compu Electrical Engineering: Core Qualification General Engineering Science (English pr General Engineering Science (English pr General Engineering Science (English pr General Engineering Science (English pr General Engineering Science (English pr Engineering: Compulsory	ifferential Equations 2) ogram, 7 semester): Specialisation Ele program, 7 semester): Specialisation Nav ogram, 7 semester): Specialisation Me tational Mathematics: Elective Compul : Compulsory ogram, 7 semester): Specialisation Elec program, 7 semester): Specialisation Me	ion Mechanical Eng val Architecture: Con echanical Engineering Isory ctrical Engineering: C on Mechanical Eng echanical Engineering	ineering, F npulsory g, Focus The compulsory ineering, F g, Focus The	ocus Mechatroni eoretical Mechani ocus Mechatroni eoretical Mechani
Credit points Course achievement Examination Examination duration and scale Assignment for the	6 None Written exam 60 min (Complex Functions) + 60 min (D General Engineering Science (German pr General Engineering Science (German pr General Engineering Science (German pr General Engineering Science (German pr Engineering: Elective Compulsory Computer Science: Specialisation Compu Electrical Engineering: Core Qualification General Engineering Science (English pr General Engineering Science (English pr General Engineering Science (English pr General Engineering Science (English pr	ifferential Equations 2) ogram, 7 semester): Specialisation Ele program, 7 semester): Specialisation Nav ogram, 7 semester): Specialisation Me tational Mathematics: Elective Compul : Compulsory ogram, 7 semester): Specialisation Elec program, 7 semester): Specialisation Me	ion Mechanical Eng val Architecture: Con echanical Engineering Isory ctrical Engineering: C on Mechanical Eng echanical Engineering	ineering, F npulsory g, Focus The compulsory ineering, F g, Focus The	ocus Mechatroni eoretical Mechani ocus Mechatroni eoretical Mechani
Credit points Course achievement Examination Examination duration and scale Assignment for the	6 None Written exam 60 min (Complex Functions) + 60 min (D General Engineering Science (German pr General Engineering Science (German pr General Engineering Science (German pr General Engineering Science (German pr Engineering: Elective Compulsory Computer Science: Specialisation Compu Electrical Engineering: Core Qualification General Engineering Science (English pr General Engineering Science (English pr General Engineering Science (English pr General Engineering Science (English pr General Engineering Science (English pr Engineering: Compulsory	ifferential Equations 2) ogram, 7 semester): Specialisation Ele program, 7 semester): Specialisation Nav ogram, 7 semester): Specialisation Me tational Mathematics: Elective Compul : Compulsory ogram, 7 semester): Specialisation Elec program, 7 semester): Specialisation Me Specialisation II. Mathematics & Engin	ion Mechanical Eng val Architecture: Con echanical Engineering Isory ctrical Engineering: C on Mechanical Eng echanical Engineering	ineering, F npulsory g, Focus The compulsory ineering, F g, Focus The	ocus Mechatroni eoretical Mechani ocus Mechatroni eoretical Mechani
Credit points Course achievement Examination Examination duration and scale Assignment for the	6 None Written exam 60 min (Complex Functions) + 60 min (D General Engineering Science (German pr General Engineering Science (German pr General Engineering Science (German pr General Engineering Science (German pr Engineering: Elective Compulsory Computer Science: Specialisation Compu Electrical Engineering: Core Qualification General Engineering Science (English pr General Engineering Science (English pr General Engineering Science (English pr General Engineering Science (English pr General Engineering Science (English pr Engineering: Compulsory Computational Science and Engineering:	ifferential Equations 2) ogram, 7 semester): Specialisation Ele program, 7 semester): Specialisation Nav ogram, 7 semester): Specialisation Me tational Mathematics: Elective Compul : Compulsory ogram, 7 semester): Specialisation Elec program, 7 semester): Specialisation Elec program, 7 semester): Specialisation Me Specialisation II. Mathematics & Engin lechatronics: Compulsory	ion Mechanical Eng val Architecture: Con echanical Engineering Isory ctrical Engineering: C on Mechanical Eng echanical Engineering echanical Engineering	ineering, F npulsory g, Focus The compulsory ineering, F g, Focus The	ocus Mechatroni eoretical Mechani ocus Mechatroni eoretical Mechani
Credit points Course achievement Examination Examination duration and scale Assignment for the	6 None Written exam 60 min (Complex Functions) + 60 min (D General Engineering Science (German pr General Engineering Science (German pr General Engineering Science (German pr General Engineering Science (German pr General Engineering Science (German pr Engineering: Elective Compulsory Computer Science: Specialisation Compu Electrical Engineering: Core Qualification General Engineering Science (English pr General Engineering Science (English pr General Engineering Science (English pr General Engineering Science (English pr Engineering: Compulsory Computational Science and Engineering: Mechanical Engineering: Specialisation N	ifferential Equations 2) ogram, 7 semester): Specialisation Ele program, 7 semester): Specialisation Nav ogram, 7 semester): Specialisation Me tational Mathematics: Elective Compul : Compulsory ogram, 7 semester): Specialisation Elec program, 7 semester): Specialisation Elec program, 7 semester): Specialisation Me Specialisation II. Mathematics & Engin lechatronics: Compulsory heoretical Mechanical Engineering: Ele	ion Mechanical Eng val Architecture: Con echanical Engineering Isory ctrical Engineering: C on Mechanical Eng echanical Engineering echanical Engineering	ineering, F npulsory g, Focus The compulsory ineering, F g, Focus The	ocus Mechatroni eoretical Mechani ocus Mechatroni eoretical Mechani
Credit points Course achievement Examination Examination duration and scale Assignment for the	6 None Written exam 60 min (Complex Functions) + 60 min (D General Engineering Science (German pr General Engineering Science (German pr General Engineering Science (German pr General Engineering Science (German pr General Engineering Science (German pr Engineering: Elective Compulsory Computer Science: Specialisation Compu Electrical Engineering: Core Qualification General Engineering Science (English pr General Engineering Science (English pr General Engineering Science (English pr General Engineering Science (English pr Engineering: Compulsory Computational Science and Engineering: Mechanical Engineering: Specialisation M Mechanical Engineering: Specialisation T	ifferential Equations 2) ogram, 7 semester): Specialisation Ele program, 7 semester): Specialisation Nav ogram, 7 semester): Specialisation Me tational Mathematics: Elective Compul : Compulsory ogram, 7 semester): Specialisation Elec program, 7 semester): Specialisation Elec program, 7 semester): Specialisation Me Specialisation II. Mathematics & Engin lechatronics: Compulsory heoretical Mechanical Engineering: Ele Isory	ion Mechanical Eng val Architecture: Con echanical Engineering Isory ctrical Engineering: C on Mechanical Eng echanical Engineering echanical Engineering	ineering, F npulsory g, Focus The compulsory ineering, F g, Focus The	ocus Mechatroni eoretical Mechani ocus Mechatroni eoretical Mechani

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

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

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

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

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

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

Courses						
Title				Tur	Hrs/wk	<b>CD</b>
Computer Science for Engineers - F	Programming Concepts, (	Data Handling & Communication	(L2689)	<b>Typ</b> Lecture	Hrs/wk 3	<b>СР</b> 3
Computer Science for Engineers - P				Recitation Section (small)	2	3
Module Responsible	Prof. Sibylle Fröschle					
Admission Requirements						
Recommended Previous						
Knowledge						
Educational Objectives	After taking part succ	essfully, students have reache	ed the followi	ng learning results		
Professional Competence						
Knowledge	1					
Skills						
Demonstration of the second						
Personal Competence						
Social Competence Autonomy						
Workload in Hours		me 110, Study Time in Lectur	0.70			
Credit points		The 110, Study Time in Lectur	e 70			
Course achievement		Form	Description			
course achievement	No 10 %	Attestation		en semesterbegleitend statt.		
Examination	Written exam					
Examination duration and	120 min					
scale						
Assignment for the	General Engineering	Science (German program,	7 semeste	r): Specialisation Mechanica	I Engineering, F	ocus Biomechani
Following Curricula	Compulsory					
	General Engineering	Science (German program, 7 s	emester): Sp	ecialisation Process Engineer	ing: Compulsory	
	General Engineering	Science (German program, 7 s	emester): Sp	ecialisation Biomedical Engin	eerina: Compulso	prv
		Science (German program, 7 s				
	Compulsory	Science (German program, 7 a	semester). Sp	ecialisation oreen recimolog	ies, rocus nenew	able Energy. Elect
		Science (German program,	7 comostor)	Specialisation Mechanical	Engineering Foc	us Energy System
	Compulsory	Science (German program,	/ semester).		Lingineering, Too	us Lifergy Syster
		Science (German program,	7 semester)	: Specialisation Mechanical	Engineering, Foo	us Aircraft Syste
	Engineering: Compuls					-
	General Engineering	Science (German program	, 7 semeste	er): Specialisation Mechanic	al Engineering,	Focus Materials
	Engineering Sciences	: Compulsory				
	General Engineering	Science (German program,	7 semeste	r): Specialisation Mechanica	al Engineering, I	ocus Mechatroni
	Compulsory					
	General Engineering	Science (German program, 7 s	semester): Sp	pecialisation Mechanical Engi	neering, Focus Th	eoretical Mechani
	Engineering: Compuls	sory				
	General Engineering	Science (German program, 7	semester): S	pecialisation Mechanical Eng	ineering, Focus F	roduct Developm
	and Production: Elect					
		Science (German program, 7 s				
		Science (German program, 7 s	semester): Sp	ecialisation Green Technolog	ies, Focus Renew	able Energy: Elect
	Compulsory					
	Bioprocess Engineerin	ng: Core Qualification: Compu				
	Electrical Excitor environments	Come Que lification Comenda				
		: Core Qualification: Compulse	•	pulcon		
	Energy and Environm	ental Engineering: Core Quali	fication: Com		ng: Elective Com	
	Energy and Environm General Engineering	ental Engineering: Core Quali Science (English program, 7 se	fication: Com emester): Spe	ecialisation Process Engineeri		
	Energy and Environm General Engineering General Engineering	ental Engineering: Core Quali	fication: Com emester): Spe	ecialisation Process Engineeri		
	Energy and Environm General Engineering General Engineering Compulsory	ental Engineering: Core Quali Science (English program, 7 sc Science (English program,	fication: Com emester): Spe 7 semester)	ecialisation Process Engineeri : Specialisation Energy and	Enviromental E	
	Energy and Environm General Engineering General Engineering Compulsory Green Technologies:	ental Engineering: Core Quali Science (English program, 7 se	fication: Com emester): Spe 7 semester) alisation Ener	ecialisation Process Engineeri : Specialisation Energy and	Enviromental E	
	Energy and Environm General Engineering General Engineering Compulsory Green Technologies: Logistics and Mobility	ental Engineering: Core Quali Science (English program, 7 sc Science (English program, Energy, Water, Climate: Speci	emester): Spe 7 semester) alisation Ener pry	ecialisation Process Engineeri : Specialisation Energy and rgy Systems: Elective Compu	Enviromental E	
	Energy and Environm General Engineering General Engineering Compulsory Green Technologies: Logistics and Mobility Logistics and Mobility	ental Engineering: Core Quali Science (English program, 7 sc Science (English program, Energy, Water, Climate: Speci : Core Qualification: Compulso	emester): Spe 7 semester) alisation Ener pry	ecialisation Process Engineeri : Specialisation Energy and rgy Systems: Elective Compu	Enviromental E	
	Energy and Environm General Engineering Compulsory Green Technologies: Logistics and Mobility Logistics and Mobility Mechatronics: Core Q	ental Engineering: Core Qualit Science (English program, 7 sc Science (English program, Energy, Water, Climate: Speci :: Core Qualification: Compulso :: Specialisation Information Te	fication: Com emester): Spe 7 semester) alisation Ener ory echnology: Co	ecialisation Process Engineeri : Specialisation Energy and rgy Systems: Elective Compu	Enviromental E	

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

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

## **Specialization Biomedical Engineering**

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

Courses						
Title		Тур	Hrs/wk	СР		
Fundamentals of Materials Science	e I (L1085)	Lecture	2	2		
Fundamentals of Materials Science	e II (Advanced Ceramic Materials, Polymers and Composites) (L0506)	Lecture	2	2		
Physical and Chemical Basics of M	aterials Science (L1095)	Lecture	2	2		
Module Responsible	Prof. Jörg Weißmüller					
Admission Requirements	None					
<b>Recommended Previous</b>	Highschool-level physics, chemistry und mathematics					
Knowledge						
Educational Objectives	After taking part successfully, students have reached the follow	ving learning results				
Professional Competence						
Knowledge	The students have acquired a fundamental knowledge on it	metals, ceramics and	polymers and can desc	ribe this knowled		
	comprehensively. Fundamental knowledge here means specific	cally the issues of atom	nic structure, microstructu	ure, phase diagran		
	phase transformations, corrosion and mechanical properties. T	he students know abou	ut the key aspects of char	acterization metho		
	for materials and can identify relevant approaches for cha	aracterizing specific p	roperties. They are able	e to trace materia		
	phenomena back to the underlying physical and chemical laws	of nature.				
Skills	The students are able to trace materials phenomena back t	to the underlying phy	sical and chemical laws	of nature. Materi		
	phenomena here refers to mechanical properties such as strength, ductility, and stiffness, chemical properties such as corrosic					
	resistance, and to phase transformations such as solidification	on, precipitation, or m	elting. 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 duration and	Written exam					
scale						
	General Engineering Science (German program, 7 semester): S	pecialisation Mechanic	al Engineering: Compulse	orv		
	General Engineering Science (German program, 7 semester): S					
	General Engineering Science (German program, 7 semester): S					
	Data Science: Specialisation Materials Science: Compulsory					
	Digital Mechanical Engineering: Core Qualification: Compulsory	,				
	Energy and Environmental Engineering: Core Qualification: Cor					
	Green Technologies: Energy, Water, Climate: Specialisation Energy	ergy Technology: Elect	ive Compulsory			
	Logistics and Mobility: Specialisation Engineering Science: Elec	tive Compulsory				
	Logistics and Mobility: Specialisation Production Management a	and Processes: Elective	e Compulsory			
	Mechanical Engineering: Core Qualification: Compulsory					
	Mechatronics: Core Qualification: Compulsory					
	Naval Architecture: Core Qualification: Compulsory					
	Technomathematics: Specialisation III. Engineering Science: Ele	ective Compulsory				
	Engineering and Management - Major in Logistics and Mobili	ty: Specialisation Prod	luction Management and	Processes: Elect		

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

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

Course L1095: Physical and O	Chemical Basics of Materials Science		
Тур	Lecture		
Hrs/wk	2		
CP	2		
Workload in Hours	dependent Study Time 32, Study Time in Lecture 28		
Lecturer	Gregor Vonbun-Feldbauer, 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	<ul> <li>Für den Elektromagnetismus:</li> <li>Bergmann-Schäfer: "Lehrbuch der Experimentalphysik", Band 2: "Elektromagnetismus", de Gruyter</li> <li>Für die Atomphysik:</li> <li>Haken, Wolf: "Atom- und Quantenphysik", Springer</li> <li>Für die Materialphysik und Elastizität:</li> <li>Hornbogen, Warlimont: "Metallkunde", Springer</li> </ul>		

Courses					
Title			Тур	Hrs/wl	k CP
Embodiment Design and 3D-CAD (I	_0268)		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	(L0267)		Project-/problem-based	Learning 2	1
Module Responsible	Prof. Dieter Krause				
Admission Requirements	None				
<b>Recommended Previous</b>	<ul> <li>Eundamental</li> </ul>	s of Mechanical Engineering	a Design		
Knowledge	Mechanics	s of Meenanical Engineering	besign		
		s of Materials Science			
	Production Er				
		5 5			
Educational Objectives	After taking part suc	ccessfully, students have re	ached the following learning results		
Professional Competence					
Knowledge	After passing the mo	odule, students are able to:			
	<ul> <li>explain desig</li> </ul>	n guidelines for machinery	parts e.g. considering load situation, m	aterials and manuf	acturing requirements
	describe basi				
	explain basics	s methods of engineering d	esigning.		
CI ///					
SKIIIS	After passing the mo	odule, students are able to:			
	<ul> <li>independently</li> </ul>	y create sketches, technica	l drawings and documentations e.g. usi	ng 3D CAD,	
	<ul> <li>design compo</li> </ul>	onents based on design gui	delines autonomously,		
	<ul> <li>dimension (ca</li> </ul>	alculate) used components,			
	<ul> <li>use methods</li> </ul>	to design and solve engine	ering design tasks systamtically and so	lution-oriented,	
	<ul> <li>apply creativity</li> </ul>	ty techniques in teams.			
Personal Competence					
	After passing the module, students are able to:				
,	develop and evaluate solutions in groups including making and documenting decisions,				
		use of scientific methods,			
	<ul> <li>present and discuss solutions and technical drawings within groups,</li> <li>reflect the own results in the work groups of the course.</li> </ul>				
	<ul> <li>reflect the ow</li> </ul>	in results in the work group	is of the course.		
Autonomy	Students are able				
	<ul> <li>to estimate t</li> </ul>	heir level of knowledge usi	ng activating methods within the lectur	es (e.a. with clicke	rc)
	<ul> <li>to estimate their level of knowledge using activating methods within the lectures (e.g. with clickers),</li> <li>To solve engineering design tasks systematically.</li> </ul>				
	t to solve engi	neering design data system	hateany.		
Workload in Hours	Independent Study	Time 40, Study Time in Lec	ture 140		
Credit points					
Course achievement		Form Written elaboration	Description	k	
	Yes None Yes None	Written elaboration	Teamprojekt Konstruktionsmethod Konstruktionsprojekt 1	N	
	Yes None	Written elaboration	Konstruktionsprojekt 2		
	Yes None	Written elaboration	3D-CAD-Praktikum		
Examination					
Examination duration and					
scale					
	General Engineering	J Science (German program	n, 7 semester): Specialisation Mechanica	al Engineering: Con	npulsory
Following Curricula			n, 7 semester): Specialisation Biomedica		
<b>2</b>			, 7 semester): Specialisation Biomedica		
		ngineering: Core Qualificat		-	
	-	mental Engineering: Core Q			
	Engineering Science	: Core Qualification: Comp	ulsory		
	General Engineering Science (English program, 7 semester): Specialisation Biomedical Engineering: Compulsory Green Technologies: Energy, Water, Climate: Specialisation Energy Technology: Elective Compulsory				pulsory
	Mechanical Engineering: Core Qualification: Compulsory				
	Mechatronics: Core	Qualification: Compulsory			
	Noval Architecture	Core Qualification: Compute			

Course L0268: Embodiment D	Design and 3D-CAD
Тур	Lecture
Hrs/wk	2
CP	1
Workload in Hours	Independent Study Time 2, Study Time in Lecture 28
Lecturer	Prof. Dieter Krause
Language	DE
Cycle	WiSe
Content	<ul> <li>Basics of 3D CAD technology</li> <li>Practical course to apply a 3D CAD system         <ul> <li>Introduction to the system</li> <li>Sketching and creation of components</li> <li>Creation of assemblies</li> <li>Deriving technical drawings</li> </ul> </li> </ul>
Literature	<ul> <li>CAx für Ingenieure eine praxisbezogene Einführung; Vajna, S., Weber, C., Bley, H., Zeman, K.; Springer-Verlag, aktuelle Auflage.</li> <li>Handbuch Konstruktion; Rieg, F., Steinhilper, R.; Hanser; aktuelle Auflage.</li> <li>Dubbel, Taschenbuch für den Maschinenbau; Grote, KH., Feldhusen, J.(Hrsg.); Springer-Verlag, aktuelle Auflage.</li> <li>Technisches Zeichnen: Grundlagen, Normen, Beispiele, Darstellende Geometrie, Hoischen, H; Hesser, W; Cornelsen, aktuelle Auflage.</li> <li>Maschinenelemente, Band I-III; Niemann, G., Springer-Verlag, aktuelle Auflage.</li> <li>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			
CP	2		
Workload in Hours	Independent Study Time 18, Study Time in Lecture 42		
Lecturer	Prof. Thorsten Schüppstuhl		
Language	DE		
Cycle	WiSe		
Content	<ul> <li>Create a technical documentation of an existing mechanical model</li> <li>Consolidation of the following aspects of technical drawings:         <ul> <li>Presentation of technical objects and standardized parts (bearings, seals, shaft-hub joints, detachable connections, springs, axes and shafts)</li> <li>Sectional views</li> <li>Dimensioning</li> <li>Tolerances and surface specifications</li> <li>Creating a tally sheet</li> </ul> </li> </ul>		
Literature	<ol> <li>Hoischen, H.; Hesser, W.: Technisches Zeichnen. Grundlagen, Normen, Beispiele, darstellende Geometrie, 33. Auflage. Berlin 2011.</li> <li>Labisch, S.; Weber, C.: Technisches Zeichnen. Selbstständig lernen und effektiv üben, 4. Auflage. Wiesbaden 2008.</li> <li>Fischer, U.: Tabellenbuch Metall, 43. Auflage. Haan-Gruiten 2005.</li> </ol>		

Course L0592: Mechanical D	esign Project II
Тур	Project-/problem-based Learning
Hrs/wk	3
CP	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.

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

Module M0680: Fluid	Dynamics				
-					
Courses					
Title			/p	Hrs/wk	СР
Fluid Mechanics (L0454)			cture	3	4
Fluid Mechanics (L0455)		Re	ecitation Section (large)	2	Z
	-				
Admission Requirements	None				
	Sound knowledge of engineering mathe	ematics, engineering mecha	nics and thermodynamics		
Knowledge					
	After taking part successfully, students	have reached the following	learning results		
Professional Competence					
Knowledge	Students will have the required sound knowledge to explain the general principles of fluid engineering and physics of fluids Students can scientifically outline the rationale of flow physics using mathematical models and are familiar with methods for the performance analysis and the prediciton of fluid engineering devices.				
Skills	Students are able to apply fluid-engineering principles and flow-physics models for the analysis of technical systems. The lecture enables the student to carry out all necessary theoretical calculations for the fluid dynamic design of engineering devices on scientific level.				
Personal Competence					
Social Competence	The students are able to discuss proble	ms and jointly develop solut	ion 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 Tin	me 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 p	program, 7 semester): Speci	alisation Mechanical Engi	neering: Compuls	ory
Following Curricula	General Engineering Science (German p	program, 7 semester): Speci	alisation Biomedical Engir	neering: Compulso	ory
	General Engineering Science (German p	program, 7 semester): Speci	alisation Naval Architectu	re: Compulsory	
	Mechanical Engineering: Core Qualificat	tion: Compulsory			
	Naval Architecture: Core Qualification: 0	Compulsory			
	Technomathematics: Specialisation III. I	Engineering Science: Electiv	e Compulsory		

Course L0454: Fluid Mechan	ics
Тур	Lecture
Hrs/wk	3
CP	4
Workload in Hours	Independent Study Time 78, Study Time in Lecture 42
Lecturer	Prof. Thomas Rung
Language	DE/EN
Cycle	SoSe
Content	<ul> <li>continuum physics definition of fluids, difference to solids/structures and material properties of fluids</li> <li>dimensional analysis and similitude</li> <li>fluid forces and fluid statics</li> <li>transport and conservation of mass, momentum &amp; energy</li> <li>fluid kinematics</li> <li>technically relevant flow models for incompressible fluids         <ul> <li>control volume &amp; stream tube analysis</li> <li>vortical flow models</li> <li>potential flows</li> <li>boundary layer flows</li> <li>different types of conservation equations and their realm (Navier-Stokes/Euler/Bernoulli equations)</li> <li>analytical solutions for Navier-Stokes systems</li> </ul> </li> <li>Analysis of internal flows (channels, pipes, open channels) and external flows, fundamentals of wing aerodynamics</li> <li>turbulent flows</li> <li>fundamentals of gas dynamics (1D compressible flows)</li> </ul>
Literature	

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

Courses					
Title		Түр	Hrs/wk	СР	
Mechanics IV (Oscillations, Analytical Mechanics, Numerical Mechanics) (L1137)		Lecture	3	3	
Mechanics IV (Oscillations, Analytical Mechanics, Numerical Mechanics) (L1138)		Recitation Section (small)	2	2	
Mechanics IV (Oscillations, Analytic	al Mechanics, Numerical Mechanics) (L1139)	Recitation Section (large)	1	1	
Module Responsible	Prof. Robert Seifried				
Admission Requirements	None				
<b>Recommended Previous</b>	Mathematics I-III and Mechanics I-III				
Knowledge					
Educational Objectives	After taking part successfully, students have reached the following learning results				
Professional Competence					
Knowledge	The students can				
	<ul> <li>describe the axiomatic procedure used in mechanical contexts;</li> </ul>				
	<ul> <li>explain important steps in model design;</li> </ul>				
	<ul> <li>present technical knowledge.</li> </ul>				
Skills	The students can				
	explain the important elements of mathem	atical / mechanical analysis and model fo	rmation, and app	ly it to the context	
	their own problems;				
	apply basic methods to engineering probler				
	<ul> <li>estimate the reach and boundaries of the m</li> </ul>	ethods and extend them to be applicable	to wider problem	sets.	
Personal Competence	<b>_</b>				
Social Competence	The students can work in groups and support each	other to overcome difficulties.			
Autonomy	Students are capable of determining their own stre	engths and weaknesses and to organize th	eir time and lear	ning based on those	
Workload in Hours	Independent Study Time 96, Study Time in Lecture 84				
Credit points	6				
Course achievement	None				
Examination	Written exam				
Examination duration and	120 min				
scale					
Assignment for the	General Engineering Science (German program, 7	semester): Specialisation Mechanical Engi	neering: Compuls	sory	
Following Curricula	General Engineering Science (German program, 7	semester): Specialisation Biomedical Engi	neering: Compuls	ory	
-	General Engineering Science (German program, 7 semester): Specialisation Naval Architecture: Compulsory				
	Energy Systems: Technical Complementary Course	e Core Studies: Elective Compulsory			
	Mechanical Engineering: Core Qualification: Comp	ulsory			
	Mechatronics: Core Qualification: Compulsory				
	Naval Architecture: Core Qualification: Compulsory	1			
	Technomathematics: Specialisation III. Engineering	Science: Elective Compulsory			

Course L1137: Mechanics IV	(Oscillations, Analytical Mechanics, Numerical Mechanics)
Тур	Lecture
Hrs/wk	3
СР	3
Workload in Hours	Independent Study Time 48, Study Time in Lecture 42
Lecturer	Prof. Robert Seifried
Language	DE
Cycle	SoSe
Content	
	<ul> <li>Elements of vibration theory</li> <li>Vibration of Multi-degree of freedom systems</li> <li>Analytical Mechanics</li> <li>Multibody Systems</li> <li>Numerical methods for time integration</li> <li>Introduction to Matlab</li> </ul>
Literature	K. Magnus, H.H. Müller-Slany: Grundlagen der Technischen Mechanik. 7. Auflage, Teubner (2009). D. Gross, W. Hauger, J. Schröder, W. Wall: Technische Mechanik 1-4. 11. Auflage, Springer (2011). W. Schiehlen, P. Eberhard: Technische Dynamik, Springer (2012).

Course L1138: Mechanics IV	(Oscillations, Analytical Mechanics, Numerical Mechanics)					
Тур	Recitation Section (small)					
Hrs/wk	2					
СР						
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28					
Lecturer	Prof. Robert Seifried					
Language	DE					
Cycle	SoSe					
Content	See interlocking course					
Literature	See interlocking course					
Course L1139: Mechanics IV	(Oscillations, Analytical Mechanics, Numerical Mechanics)					
Тур	Recitation Section (large)					
Hrs/wk	1					
CP	1					
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14					
Lecturer	Prof. Robert Seifried					
Language	DE					

Cycle

Content

SoSe

Literature See interlocking course

See interlocking course

Courses					
Title		Тур	Hrs/wk	СР	
Introduction to Anatomy (L0384)		Lecture	2	3	
Module Responsible	Prof. Udo Schumacher				
Admission Requirements	None				
<b>Recommended Previous</b>	None				
Knowledge					
Educational Objectives	After taking part successfully, students h	ave reached the following learning results			
Professional Competence					
Knowledge	The students can describe basal structur	es and functions of internal organs and the m	usculoskeletal system.		
	The students can describe the basic mac	roscopy and microscopy of those systems.			
Skille	The students can recognize the relations	hip between given anatomical facts and the c	lovelenment of come cor	nman disaasasi t	
SKIIIS	-	and their functions in the context of widesprea		ninon uiseases, u	
	can explain the relevance of structures a	ind their functions in the context of widesprea	u uiseuses.		
Personal Competence					
Social Competence	The students can participate in current d	iscussions in biomedical research and medicin	ne on a professional leve	Ι.	
Autonomy	Autonomy. The students are able to access anotomical braulades by the machine can participate in access that is				
Autonomy	my The students are able to access anatomical knowledge by themselves, can participate in conversations on the the relevant knowledge themselves.				
	the relevant knowledge 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	90 minutes				
scale					
Assignment for the	General Engineering Science (German pr	ogram, 7 semester): Specialisation Biomedica	al Engineering: Compulso	ry	
Following Curricula	General Engineering Science (German	program, 7 semester): Specialisation Me	chanical Engineering, F	ocus Biomechan	
	Compulsory				
	Data Science: Specialisation Medicine: Co	ompulsory			
	Electrical Engineering: Specialisation Medical Technology: Elective Compulsory				
	Engineering Science: Specialisation Biomedical Engineering: Compulsory				
	General Engineering Science (English program, 7 semester): Specialisation Biomedical Engineering: Compulsory				
	Mechanical Engineering: Specialisation B				
		ledical Technology and Control Theory: Electiv			
		lanagement and Business Administration: Elec			
		rtificial Organs and Regenerative Medicine: El			
	Biomedical Engineering: Specialisation Ir Technomathematics: Specialisation III. En	nplants and Endoprostheses: Elective Compul	sory		

se L0384: Introduction t	
	Lecture
Hrs/wk	
СР	
	Independent 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: 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

Courses						
Title		Typ	Hrs/wk	СР		
ntroduction to Radiology and Radi	ation Therapy (L0383)	<b>Typ</b> Lecture	2	3		
Module Responsible	Prof. Ulrich Carl					
Admission Requirements	None					
<b>Recommended Previous</b>	None					
Knowledge						
	After taking part successfully, students have	reached the following learning results				
Professional Competence Knowledge	Therany					
Knowledge	The students can distinguish different types of	of currently used equipment with respect	to its use in radiation the	erapy.		
	The students can explain treatment plans used in radiation therapy in interdisciplinary contexts (e.g. surgery, internal medicine The students can describe the patients' passage from their initial admittance through to follow-up care. Diagnostics					
	The students can illustrate the technical bas	e concepts of projection radiography, ir	cluding angiography an	d mammography, a		
	well as sectional imaging techniques (CT, MR		iciaaling anglography an	aa		
	The students can explain the diagnostic as w	vall as thorapoutic use of imaging techni	ques as well as the tech	nical basis for thos		
	techniques.	ter as therapeutic use of imaging techni	ques, as well as the tech			
	The students can choose the right treatment	method depending on the patient's clinic	al history and heeds.			
	The student can explain the influence of tech	nical errors on the imaging techniques.				
	The student can draw the right conclusions b	ased on the images' diagnostic findings o	or the error protocol.			
Skille	Therapy					
Skiiis	The students can distinguish curative and pal	liative 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 principle (effects vs adverse effects)					
	The students can distinguish different kinds of radiation, can choose the best one depending on the situation (location of the					
	tumor) and choose the energy needed in that situation (irradiation planning).					
	The student can assess what an individual	psychosocial service should look like (	e.g. follow-up treatment	, sports, social he		
	groups, self-help groups, social services, psyc	ho-oncology).				
	Diagnostics					
	The students can suggest solutions for repair	s of imaging instrumentation after baving	a dono orror analycoc			
	The students can suggest solutions for repair	s of imaging instrumentation after having	g done error analyses.			
	The students can classify results of imaging	techniques according to different grou	ps of diseases based or	n their knowledge		
	anatomy, pathology and pathophysiology.					
Personal Competence						
Social Competence	The students can assess the special social sit			-		
	The students are aware of the special, oft measures and can meet them appropriately.	en fear-dominated behavior of sick pe	ople caused by diagnos	stic and therapeut		
	measures and can meet them appropriately.					
Autonomy	The students can apply their new knowledge					
	The students can introduce younger students	to the clinical daily routine.				
	The students are able to access anatomical		te competently in conve	rsations on the top		
	and acquire the relevant knowledge themselv	/es.				
Workload in Hours	Independent Study Time 62, Study Time in Le	ecture 28				
Credit points	3					
Course achievement	None					
Examination						
Examination duration and scale	90 minutes					
	General Engineering Science (German progra	m, 7 semester): Specialisation Biomedica	al Engineering: Compulso	ory		
Following Curricula	General Engineering Science (German pro					
	Compulsory					
	Data Science: Specialisation Medicine: Compo	•				
	Electrical Engineering: Specialisation Medical Engineering Science: Specialisation Biomedic					
	General Engineering Science (English program		I Engineering: Compulso	ry		
	Mechanical Engineering: Specialisation Biome					
	Biomedical Engineering: Specialisation Medic					
	Biomedical Engineering: Specialisation Manage					
	Biomedical Engineering: Specialisation Artific Biomedical Engineering: Specialisation Impla					
			· · J			

Technomathematics: Specialisation III. Engineering Science: Elective Compulsory

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

Courses				
Title		Тур	Hrs/wk	СР
Numerical Mathematics I (L0417)		Lecture	2	3
Numerical Mathematics I (L0418)		Recitation Section (small)	2	3
Module Responsible	Prof. Sabine Le Borne			
Admission Requirements	None			
<b>Recommended Previous</b>	<ul> <li>Mathematik I + II for Engineering Students (germa</li> </ul>	an or english) <b>or</b> Analysis & Linear Alo	aebra I + II for Te	chnomathematic
Knowledge	basic MATLAB/Python knowledge			
-	After taking part successfully, students have reached the	e following learning results		
Professional Competence				
Knowleage	Students are able to			
	<ul> <li>name numerical methods for interpolation, integr</li> </ul>	ation, least squares problems, eigenv	value problems, r	onlinear root fin
	problems and to explain their core ideas,			
	<ul> <li>repeat convergence statements for the numerical</li> </ul>	methods,		
	<ul> <li>explain aspects for the practical execution of num</li> </ul>	erical methods with respect to compo	utational and stor	rage complexitx.
Skills	Students are able to			
	<ul> <li>implement, apply and compare numerical method</li> </ul>	s using MATLAB/Python,		
	<ul> <li>justify the convergence behaviour of numerical m</li> </ul>		nd solution algori	thm,
	<ul> <li>select and execute a suitable solution approach for</li> </ul>			
Personal Competence	<b>-</b>			
Social Competence	Students are able to			
	<ul> <li>work together in heterogeneously composed tear</li> </ul>	ns (i.e., teams from different study pr	ograms and bacl	kground knowled
	explain theoretical foundations and support each	other with practical aspects regarding	the implementa	tion of algorithm
	<b>-</b>			
Autonomy	Students are capable			
	<ul> <li>to assess whether the supporting theoretical and</li> </ul>	practical excercises are better solved	individually or in	a team,
	<ul> <li>to assess their individual progess and, if necessar</li> </ul>	y, to ask questions and seek help.		
	Independent Study Time 124, Study Time in Lecture 56			
Credit points				
Course achievement				
Examination				
Examination duration and	90 minutes			
scale				
	General Engineering Science (German program, 7 seme			Farmer Material
Following Curricula	General Engineering Science (German program, 7	semester): Specialisation Mechanic	ai Engineering,	Focus Material
	Engineering Sciences: Compulsory	tor), Specialization Riemodical Engin	ooring, Compuls	
	General Engineering Science (German program, 7 seme General Engineering Science (German program, 7 s			
	Compulsory	emester). Specialisation mechanica	r Engineering, r	ocus biomecnu
	General Engineering Science (German program, 7 seme	ster): Specialisation Mechanical Engir	neering. Focus Th	eoretical Mecha
	Engineering: Compulsory	,		
	General Engineering Science (German program, 7 se	mester): Specialisation Mechanical	Engineering, Foc	us Aircraft Syst
	Engineering: Elective Compulsory			
	General Engineering Science (German program, 7 seme	ster): Specialisation Mechanical Engi	neering, Focus M	echatronics: Elec
	Compulsory	5	-	
			Engineering, Foc	
	General Engineering Science (German program, 7 se	mester): Specialisation Mechanical I		us Energy Syste
	General Engineering Science (German program, 7 se Elective Compulsory	mester): Specialisation Mechanical I		us Energy Syste
		·	iry	us Energy Syste
	Elective Compulsory	ocess Engineering: Elective Compulso	pry	us Energy Syste
	Elective Compulsory Bioprocess Engineering: Specialisation A - General Biopr	ocess Engineering: Elective Compulso natics: Elective Compulsory		us Energy Syste
	Elective Compulsory Bioprocess Engineering: Specialisation A - General Biopr Computer Science: Specialisation Computational Mather	ocess Engineering: Elective Compulso natics: Elective Compulsory		us Energy Syste
	Elective Compulsory Bioprocess Engineering: Specialisation A - General Biopr Computer Science: Specialisation Computational Mather Computer Science: Specialisation II. Mathematics and Er Data Science: Core Qualification: Compulsory Electrical Engineering: Core Qualification: Elective Comp	ocess Engineering: Elective Compulso natics: Elective Compulsory gineering Science: Elective Compulso		us Energy Syste
	Elective Compulsory Bioprocess Engineering: Specialisation A - General Biopr Computer Science: Specialisation Computational Mather Computer Science: Specialisation II. Mathematics and Er Data Science: Core Qualification: Compulsory Electrical Engineering: Core Qualification: Elective Comp Engineering Science: Core Qualification: Compulsory	ocess Engineering: Elective Compulso natics: Elective Compulsory gineering Science: Elective Compulso		us Energy Syste
	Elective Compulsory Bioprocess Engineering: Specialisation A - General Biopr Computer Science: Specialisation Computational Mather Computer Science: Specialisation II. Mathematics and Er Data Science: Core Qualification: Compulsory Electrical Engineering: Core Qualification: Elective Comp Engineering Science: Core Qualification: Compulsory Engineering Science: Core Qualification: Compulsory	occess Engineering: Elective Compulso natics: Elective Compulsory gineering Science: Elective Compulso ulsory		us Energy Syste
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	Elective Compulsory Bioprocess Engineering: Specialisation A - General Biopr Computer Science: Specialisation Computational Mather Computer Science: Specialisation II. Mathematics and Er Data Science: Core Qualification: Compulsory Electrical Engineering: Core Qualification: Elective Comp Engineering Science: Core Qualification: Compulsory Engineering Science: Core Qualification: Compulsory General Engineering Science (English program, 7 semes General Engineering Science (English program, 7 semes	occess Engineering: Elective Compulso natics: Elective Compulsory gineering Science: Elective Compulso ulsory er): Core Qualification: Compulsory er): Specialisation Computer Science	ry : Compulsory	
	Elective Compulsory Bioprocess Engineering: Specialisation A - General Biopr Computer Science: Specialisation Computational Mather Computer Science: Specialisation II. Mathematics and Er Data Science: Core Qualification: Compulsory Electrical Engineering: Core Qualification: Elective Comp Engineering Science: Core Qualification: Compulsory Engineering Science: Core Qualification: Compulsory General Engineering Science (English program, 7 semess General Engineering Science (English program, 7 semess General Engineering Science (English program, 7 semess	occess Engineering: Elective Compulso natics: Elective Compulsory gineering Science: Elective Compulso ulsory er): Core Qualification: Compulsory er): Specialisation Computer Science	ry : Compulsory	
	Elective Compulsory Bioprocess Engineering: Specialisation A - General Biopr Computer Science: Specialisation Computational Mather Computer Science: Specialisation II. Mathematics and Er Data Science: Core Qualification: Compulsory Electrical Engineering: Core Qualification: Elective Comp Engineering Science: Core Qualification: Compulsory Engineering Science: Core Qualification: Compulsory General Engineering Science (English program, 7 semess General Engineering Science (English program, 7 se General Engineering Science (English program, 7 se General Engineering Science (English program, 7 se Compulsory	occess Engineering: Elective Compulso natics: Elective Compulsory gineering Science: Elective Compulso ulsory eer): Core Qualification: Compulsory eer): Specialisation Computer Science emester): Specialisation Mechanical	: Compulsory Engineering, F	ocus Biomechai
	Elective Compulsory Bioprocess Engineering: Specialisation A - General Biopr Computer Science: Specialisation Computational Mather Computer Science: Specialisation II. Mathematics and Er Data Science: Core Qualification: Compulsory Electrical Engineering: Core Qualification: Elective Comp Engineering Science: Core Qualification: Compulsory Engineering Science: Core Qualification: Compulsory General Engineering Science (English program, 7 semess General Engineering Science (English program, 7 semess General Engineering Science (English program, 7 se Compulsory General Engineering Science (English program, 7 semess Compulsory General Engineering Science (English program, 7 semess	occess Engineering: Elective Compulso natics: Elective Compulsory gineering Science: Elective Compulso ulsory eer): Core Qualification: Compulsory eer): Specialisation Computer Science emester): Specialisation Mechanical	: Compulsory Engineering, F	ocus Biomechai
	Elective Compulsory Bioprocess Engineering: Specialisation A - General Biopr Computer Science: Specialisation Computational Mather Computer Science: Specialisation II. Mathematics and Er Data Science: Core Qualification: Compulsory Electrical Engineering: Core Qualification: Elective Comp Engineering Science: Core Qualification: Compulsory Engineering Science: Core Qualification: Compulsory General Engineering Science (English program, 7 semess General Engineering Science (English program, 7 semess General Engineering Science (English program, 7 semess General Engineering Science (English program, 7 semess Compulsory General Engineering Science (English program, 7 semess Sciences: Compulsory	occess Engineering: Elective Compulso natics: Elective Compulsory gineering Science: Elective Compulso ulsory eer): Core Qualification: Compulsory eer): Specialisation Computer Science emester): Specialisation Mechanical ter): Specialisation Mechanical Engine	: Compulsory Engineering, F eering, Focus Mat	ocus Biomechai
	Elective Compulsory Bioprocess Engineering: Specialisation A - General Biopr Computer Science: Specialisation Computational Mather Computer Science: Specialisation II. Mathematics and Er Data Science: Core Qualification: Compulsory Electrical Engineering: Core Qualification: Elective Comp Engineering Science: Core Qualification: Compulsory Engineering Science: Core Qualification: Compulsory General Engineering Science (English program, 7 semess General Engineering Science (English program, 7 semess General Engineering Science (English program, 7 semess General Engineering Science (English program, 7 semess Sciences: Compulsory General Engineering Science (English program, 7 semess Sciences: Compulsory General Engineering Science (English program, 7 semess Sciences: Compulsory General Engineering Science (English program, 7 semess Sciences: Compulsory	occess Engineering: Elective Compulso natics: Elective Compulsory gineering Science: Elective Compulso ulsory eer): Core Qualification: Compulsory eer): Specialisation Computer Science emester): Specialisation Mechanical ter): Specialisation Mechanical Engine	: Compulsory Engineering, F eering, Focus Mat	ocus Biomechai
	Elective Compulsory Bioprocess Engineering: Specialisation A - General Biopr Computer Science: Specialisation Computational Mather Computer Science: Specialisation II. Mathematics and Er Data Science: Core Qualification: Compulsory Electrical Engineering: Core Qualification: Elective Comp Engineering Science: Core Qualification: Compulsory Engineering Science: Core Qualification: Compulsory General Engineering Science (English program, 7 semess General Engineering Science (English program, 7 semess General Engineering Science (English program, 7 semess General Engineering Science (English program, 7 semess Sciences: Compulsory General Engineering Science (English program, 7 semess Sciences: Compulsory General Engineering Science (English program, 7 semess Sciences: Compulsory General Engineering Science (English program, 7 semess Sciences: Compulsory	occess Engineering: Elective Compulso natics: Elective Compulsory gineering Science: Elective Compulso ulsory eer): Core Qualification: Compulsory eer): Specialisation Computer Science emester): Specialisation Mechanical ere): Specialisation Mechanical Engine eter): Specialisation Mechanical Engine	: Compulsory ⊢ Engineering, F eering, Focus Mat eering, Focus Th	ocus Biomechai erials in Enginee eoretical Mechai
	Elective Compulsory Bioprocess Engineering: Specialisation A - General Biopr Computer Science: Specialisation Computational Mather Computer Science: Specialisation II. Mathematics and Er Data Science: Core Qualification: Compulsory Electrical Engineering: Core Qualification: Elective Comp Engineering Science: Core Qualification: Compulsory Engineering Science: Core Qualification: Compulsory General Engineering Science (English program, 7 semess General Engineering Science (English program, 7 semess General Engineering Science (English program, 7 semess General Engineering Science (English program, 7 semess Sciences: Compulsory General Engineering Science (English program, 7 semess Sciences: Compulsory General Engineering Science (English program, 7 semess Sciences: Compulsory General Engineering Science (English program, 7 semess Sciences: Compulsory	access Engineering: Elective Compulso natics: Elective Compulsory gineering Science: Elective Compulso ulsory eer): Core Qualification: Compulsory eer): Specialisation Computer Science emester): Specialisation Mechanical Engine eter): Specialisation Mechanical Engine eter): Specialisation Biomedical Engine	: Compulsory Engineering, F eering, Focus Mat eering, Focus Th eering: Compulso	ocus Biomechai erials in Enginee eoretical Mechai

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

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

Courses					
Title		Тур	Hrs/wk	СР	
Heat Transfer (L0458)		Lecture	3	4	
Heat Transfer (L0459)		Recitation Section (large)	2	2	
Module Responsible	Dr. Andreas Moschallski				
Admission Requirements	None				
Recommended Previous	Technical Thermodynamics I, II and Fluid Dynamics				
Knowledge					
Professional Competence	After taking part successfully, students have reached the	ollowing learning results			
•	The students are able to				
	- describe the different physical mechanism of Heat Trans	fer,			
	- explain the technical terms,				
	- to analyse comlex heat transfer processes in a critical w				
	- to analyse comiex neat 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,				
	- calculate and evaluate complex near transler processes,				
	- solve excersises self-consistent and in small groups.				
Personal Competence					
-	The students are able to discuss in small groups and deve	lop an approach.			
4	The shuddow on the bad and a second or making a 16				
Autonomy	The students are able to develop a complex problem self- with other students is given.	consistent and analyse the results i	n a critical way. A	a quaimed exchar	
	with other stadents 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	General Engineering Science (German program, 7 sem	ostor): Spocialisation Mochanical	Enginooring Eoc	us Eporav System	
Following Curricula	Compulsory	ester). Specialisation Mechanical	Engineering, Foc	us Ellergy System	
	General Engineering Science (German program, 7 semester): Specialisation Biomedical Engineering: Compulsory				
	General Engineering Science (German program, 7 semest		÷ ,	-	
	Engineering: Compulsory		5.		
	Energy Systems: Technical Complementary Course Core S	tudies: Elective Compulsory			
	General Engineering Science (English program, 7 sem		Engineering, Foc	us Energy Syste	
	Compulsory		5 5,	5, , , , ,	
	General Engineering Science (English program, 7 semeste	r): Specialisation Biomedical Engine	ering: Compulso	ry	
	Mechanical Engineering: Specialisation Energy Systems: 0		•		
	Mechanical Engineering: Specialisation Theoretical Mecha		00/		

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

Course L0459: Heat Transfer	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			

-					
Courses					
Title			Тур	Hrs/wk	СР
Practical Course: Measurement and Control Systems (L1119)			Practical Course	2	2
Measurement Technology for Mechanical Engineering (L1116)			Lecture	2	3
Measurement Technology for Mech		118)	Recitation Section (large)	1	1
Module Responsible					
Admission Requirements	None				
	Basic knowledge of p	physics, chemistry and electric	al engineering		
Knowledge					
Educational Objectives	After taking part suc	cessfully, students have reach	ed the following learning results		
Professional Competence					
Knowledge	Students are able to	o name the most important fu	ndmentals of the Measurement Techno	logy (Quantities an	d Units, Uncertair
	Calibration, Static a	nd Dynamic Properties of Sens	ors and Systems).		
	-				
	-		methods for different kinds of quantitie	s to be maesured	(Electrical Quantit
	Temperature, mecha	anical quantities, Flow, Time, I	-requency).		
	They can describe in	nportant methods of chemical	Analysis (Gas Sensors, Spectroscopy, Ga	as Chromatography	)
Skills	Students can select	suitable measuring methods to	given problems and can use refering m	neasurement device	s in practice.
			· · · · · · · · · · · · · · · · · · ·		
	The students are ab	le to orally explain issues in th	ne subject area of measurement techno	logy and solution a	pproaches as wel
	place the issues into	the right context and applicat	ion area.		
Personal Competence					
	Students can arrive	at work recults in groups and s	locument them in a common report		
Social Competence	Students can arrive	at work results in groups and c	locument them in a common report.		
Autonomy	Students are able to	familiarize themselves with ne	ew measurement technologies.		
Workload in Hours	Independent Study T	Fime 110, Study Time in Lectur	re 70		
Credit points					
Course achievement		Form	Description		
	Yes None	Subject theoretical and	ł		
		practical work			
Examination	Subject theoretical a	and practical work			
Examination duration and					
scale	200 millaces				
	General Engineering	Science (German program 7	semester): Specialisation Mechanical En	aineerina: Compuls	00/
			semester): Specialisation Biomedical En		
r onowing curricula			semester): Specialisation Energy and En		-
		ngineering: Core Qualification:		in official Enginee	ang. compusory
		mental Engineering: Core Quali			
		: Specialisation Mechatronics:			
		: Specialisation Mechanical En			
	Engineering Science: Specialisation Biomedical Engineering: Elective Compulsory General Engineering Science (English program, 7 semester): Specialisation Energy and Enviromental Engineering: Compulsory				
				-	
	General Engineering Science (English program, 7 semester): Specialisation Mechanical Engineering: 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 Mechatronics: Compulsory				
			emester): Specialisation Mechanical Eng		
			emester): Specialisation Biomedical Eng	-	ompuisory
	-		anagement and Processes: Elective Com	ipuisory	
	Mechanical Engineer	ring: Core Qualification: Compu	lisory		
	Marshartna i C	Overlification C			
		Qualification: Compulsory			
			and Mobility: Specialisation Productio	n Management and	d Processes: Elect

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

Course L1116: Measurement	Technology for Mechanical Engineering				
Тур	Lecture				
Hrs/wk	2				
СР	3				
	Independent Study Time 62, Study Time in Lecture 28				
	Prof. Thorsten Kern, Dennis Kähler				
Language					
Cycle	WiSe 1 Fundamentals				
Content	1.1 Quantities and Units				
	1.2 Uncertainty				
	1.3 Calibration				
	1.4 Static and Dynamic Properties of Sensors and Systems				
	2 Measurement of Electrical Quantities				
	2.1 Current and Voltage				
	2.2 Impedance				
	2.3 Amplification				
	Oscilloscope				
	2.5 Analog-to-Digital Conversion				
	2.6 Data Transmission				
	3 Measurement of Nonelectric Quantities				
	3.1 Temperature				
	3.2 Length, Displacement, Angle				
	3.3 Strain, Force, Pressure				
	3.4 Flow				
	3.5 Time, Frequency				
Literature	Lerch, R.: "Elektrische Messtechnik; Analoge, digitale und computergestützte Verfahren", Springer, 2006, ISBN: 978-3-540-34055- 3.				
	Profos, P. Pfeifer, T.: "Handbuch der industriellen Messtechnik", Oldenbourg, 2002, ISBN: 978-3486217940.				

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

Courses				
Title		Тур	Hrs/wk	СР
Introduction to Biochemistry and Mo	blecular Biology (L0386)	Lecture	2	3
Module Responsible	Prof. Hans-Jürgen Kreienkamp			
Admission Requirements	None			
<b>Recommended Previous</b>	None			
Knowledge				
Educational Objectives	After taking part successfully, studen	ts have reached the following learning results		
Professional Competence				
Knowledge	The students can			
	<ul> <li>describe basic biomolecules;</li> </ul>			
	<ul> <li>explain how genetic informatic</li> </ul>	on is coded in the DNA;		
	explain the connection between	n DNA and proteins;		
<i>CL 11</i>				
SKIIIS	The students can			
	<ul> <li>recognize the importance of m</li> </ul>	olecular parameters for the course of a disease;		
	<ul> <li>describe selected molecular-di</li> </ul>	agnostic procedures;		
	<ul> <li>explain the relevance of these</li> </ul>	procedures for some diseases		
Personal Competence				
	The students can participate in discu	ssions in research and medicine on a technical leve	el.	
···· , ··· ,				
Autonomy	The students can develop understand	ding of topics from the course, using technical liter	ature, by themselves.	
Workload in Hours	Independent Study Time 62, Study Ti	me in Lecture 28		
Credit points	3			
Course achievement	None			
Examination	Written exam			
Examination duration and	60 minutes			
scale				
Assignment for the	General Engineering Science (Germa	n program, 7 semester): Specialisation Biomedical	Engineering: Compulsor	У
Following Curricula	General Engineering Science (Gerr	nan program, 7 semester): Specialisation Mecl	hanical Engineering, Fo	cus Biomechani
	Compulsory			
	Data Science: Specialisation Medicine	e: Compulsory		
	Electrical Engineering: Specialisation	Medical Technology: Elective Compulsory		
	Engineering Science: Specialisation B	liomedical Engineering: Compulsory		
	General Engineering Science (English	program, 7 semester): Specialisation Biomedical	Engineering: Compulsory	1
	General Engineering Science (Engl	ish program, 7 semester): Specialisation Mech	hanical Engineering, Fo	cus Biomechani
	Compulsory			
	Mechanical Engineering: Specialisation	on Biomechanics: Compulsory		
	Biomedical Engineering: Specialisation	n Management and Business Administration: Elect	tive Compulsory	
	Biomedical Engineering: Specialisation	on Artificial Organs and Regenerative Medicine: Ele	ective Compulsory	
	Biomedical Engineering: Specialisation	on Medical Technology and Control Theory: Elective	e Compulsory	
	Biomedical Engineering: Specialisation	on Implants and Endoprostheses: Elective Compuls	ory	

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

Courses					
Title		Тур	Hrs/wk	СР	
Implants and Fracture Healing (L03	76)	Lecture	2	3	
Module Responsible	Prof. Michael Morlock				
Admission Requirements	None				
<b>Recommended Previous</b>	It is recommended to participate in "Intro	oduction into Anatomie" before attending "Imp	lants and Fracture Heal	ing".	
Knowledge					
Educational Objectives	After taking part successfully, students h	ave reached the following learning results			
Professional Competence					
Knowledge	The students can describe the different v	vays how bones heal, and the requirements fo	r their existence.		
	The students can name different treatme	ents for the spine and hollow bones under give	n fracture morphologies	i.	
Skills	The students can determine the forces a	cting within the human body under quasi-stati	c situations under speci	fic assumptions.	
- 10 ·					
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 Mec	hanical Engineering, F	ocus Biomechani	
Following Curricula					
	5 5	ogram, 7 semester): Specialisation Biomedica	l Engineering: Compulso	ory	
	Engineering Science: Specialisation Biomedical Engineering: Compulsory				
		ogram, 7 semester): Specialisation Biomedical		-	
		program, 7 semester): Specialisation Mec	hanical Engineering, F	ocus Biomechani	
	Compulsory				
	Mechanical Engineering: Specialisation B				
		nplants and Endoprostheses: Elective Compuls			
		rtificial Organs and Regenerative Medicine: Ele			
		anagement and Business Administration: Elec			
	Biomedical Engineering: Specialisation M	edical Technology and Control Theory: Electiv	e Compulsory		
	Orientation Studies: Core Qualification: E	lective Compulsory			

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

Courses					
Title			Тур	Hrs/wk	СР
Introduction into Medical Technolog	gy and Systems (L034	12)	Lecture	2	3
Introduction into Medical Technolog	gy and Systems (L034	13)	Project Seminar	2	2
Introduction into Medical Technolog	gy and Systems (L187	76)	Recitation Section (large)	1	1
Module Responsible	Prof. Alexander Sci	hlaefer			
Admission Requirements	None				
<b>Recommended Previous</b>	principles of math	(algebra, analysis/calculus)			
Knowledge	principles of stoch	astics			
	principles of progra	amming, R/Matlab			
Educational Objectives	After taking part si	uccessfully students have reach	ned the following learning results		
Professional Competence	finter taking part of				
Knowledge	The students can	explain principles of medical	technology, including imaging systems,	computer aided s	urgery and medi
hitemedge			rview of regulatory affairs and standards		
		···· · · · · · · · · · · · · · · · · ·			- 5) -
Skills	The students are a	ble to evaluate systems and me	edical devices in the context of clinical ap	plications.	
Personal Competence					
	The students descr	ribe a problem in medical techn	ology as a project, and define tasks that	are solved in a joint	effort.
Autonomy	The students can	reflect their knowledge and doo	ument the results of their work. They ca	an present the resu	ılts in an appropria
	manner.				
Workload in Hours	Independent Study	/ Time 110, Study Time in Lectu	re 70		
Credit points	6				
Course achievement	Compulsory Bonus	Form	Description		
	Yes 10 %	Written elaboration			
	Yes 10 %	Presentation			
Examination	Written exam				
Examination duration and	90 minutes				
scale					
Assignment for the	General Engineerin	ng Science (German program, 7	semester): Specialisation Biomedical Eng	gineering: Compuls	ory
Following Curricula	Computer Science:	: Specialisation Computer and S	oftware Engineering: Elective Compulsor	у	
	Computer Science:	: Specialisation II. Mathematics	and Engineering Science: Elective Compu	llsory	
	Data Science: Core	e Qualification: Elective Compuls	sory		
	Electrical Engineer	ing: Core Qualification: Elective	Compulsory		
	Engineering Science	ce: Specialisation Biomedical En	gineering: Compulsory		
	General Engineering Science (English program, 7 semester): Specialisation Biomedical Engineering: Compulsory				
	Computational Science and Engineering: Specialisation II. Mathematics & Engineering Science: Elective Compulsory				
	Biomedical Engineering: Specialisation Artificial Organs and Regenerative Medicine: Elective Compulsory				
	Biomedical Engine	iomedical Engineering: Specialisation Implants and Endoprostheses: Elective Compulsory			
	Biomedical Engine	ering: Specialisation Medical Te	chnology and Control Theory: Elective Co	mpulsory	
	Biomedical Engine	ering: Specialisation Manageme	nt and Business Administration: Elective	Compulsory	

Course L0342: Introduction in	nto 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		
CP	2		
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28		
Lecturer	exander Schlaefer		
Language	DE		
Cycle	SoSe		
Content	See interlocking course		
Literature	See interlocking course		

Course L1876: Introduction i	nto Medical Technology and Systems			
Тур	Recitation Section (large)			
Hrs/wk	1			
CP	1			
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14			
Lecturer	Prof. Alexander Schlaefer			
Language	DE			
Cycle	SoSe			
Content	imaging systems			
	- computer aided surgery			
	- medical sensor systems			
	- medical information systems			
	egulatory affairs			
	tandard 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.			

Courses					
Title		Тур	Hrs/wk	СР	
ntroduction to Physiology (L0385)		Lecture	2	3	
Module Responsible	Dr. Roger Zimmermann				
Admission Requirements	None				
<b>Recommended Previous</b>	None				
Knowledge					
Educational Objectives	After taking part successfully, students ha	we reached the following learning results			
<b>Professional Competence</b>					
Knowledge	The students can				
	<ul> <li>describe the basics of the energy m</li> </ul>	atabolism.			
		selected fields of muscle, heart/circulation, n	euro- and sensory physic	ology	
Skills		basic bodily functions (sensory, transmission	and processing of inform	mation, developm	
	of forces and vital functions) and relate th	em to similar technical systems.			
Personal Competence					
Social Competence	The students can conduct discussions in r				
	The students can find solutions to problen	ns in the field of physiology, both analytical a	and metrological.		
Autonomy	The students can derive answers to que	stions arising in the course and other phys	iological areas, using te	chnical literature	
	themselves.				
	Independent Study Time 62, Study Time in	n Lecture 28			
Credit points					
Course achievement					
	Written exam				
Examination duration and	60 minutes				
scale					
Assignment for the		gram, 7 semester): Specialisation Biomedica		-	
Following Curricula		program, 7 semester): Specialisation Me	chanical Engineering, F	-ocus Biomechan	
	Compulsory Data Science: Specialisation Medicine: Co				
	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 Biomechanic				
	Compulsory		enamear Engineering, i	Seas Biomeentan	
		gram, 7 semester): Specialisation Biomedica	l Engineering: Compulso	ry	
	General Engineering Science (English prog	gram, 7 semester): Specialisation Biomedica	I Engineering: Elective C	ompulsory	
	Mechanical Engineering: Specialisation Bio	omechanics: Compulsory			
	Biomedical Engineering: Specialisation Me	dical Technology and Control Theory: Electiv	ve Compulsory		
	Biomedical Engineering: Specialisation Ma	nagement and Business Administration: Ele	ctive Compulsory		
	Biomedical Engineering: Specialisation Art	ificial Organs and Regenerative Medicine: E	lective Compulsory		
	Biomedical Engineering: Specialisation Im	plants and Endoprostheses: Elective Compu	lsory		
	Technomathematics: Specialisation III. En	aineering Science: Elective Compulsory			

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	

Courses				
Гitle		Тур	Hrs/wk	СР
Experimental Methods in Biomecha	nics (L0377)	Lecture	2	3
Module Responsible	Prof. Michael Morlock			
Admission Requirements	None			
<b>Recommended Previous</b>	It is recommended to participate in "Imp	lantate und Frakturheilung" before attending	"Experimentelle Methode	en".
Knowledge				
Educational Objectives	After taking part successfully, students h	nave reached the following learning results		
Professional Competence				
Knowledge	The students can describe the different v	ways how bones heal, and the requirements f	or their existence.	
	The students can name different treatme	ents for the spine and hollow bones under giv	en fracture morphologies	5.
	The students can describe different mea	surement techniques for forces and moveme	nts and choose the adec	nuate technique fo
	given task.	surement techniques for forces and moveme		
	-			
Skills	The students can describe the basic han	dling of several experimental techniques used	d in biomechanics.	
Personal 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	General Engineering Science (German	n program, 7 semester): Specialisation Me	chanical Engineering, F	ocus Biomechani
Following Curricula	Compulsory			
	General Engineering Science (German pr	rogram, 7 semester): Specialisation Biomedic	al Engineering: Compulso	ory
	Engineering Science: Specialisation Biom	nedical Engineering: Elective Compulsory		
	General Engineering Science (English	program, 7 semester): Specialisation Me	chanical Engineering, F	ocus Biomechani
	Compulsory			
	General Engineering Science (English pro	ogram, 7 semester): Specialisation Biomedica	l Engineering: Compulso	ry
	General Engineering Science (English pro	ogram, 7 semester): Specialisation Biomedica	l Engineering: Elective C	ompulsory
	Mechanical Engineering: Specialisation B	Biomechanics: Compulsory		

Course L0377: Experimental Methods in Biomechanics	
Тур	Lecture
Hrs/wk	2
СР	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Prof. Michael Morlock
Language	DE
Cycle	SoSe
Content	
Literature	Wird in der Veranstaltung bekannt gegeben

Courses						
Courses				_		
<b>Title</b> Computer Science for Engineers - F	Programming Conconts	Data Handling & Communicatio	n (12690)	<b>Typ</b> Lecture	Hrs/wk 3	<b>СР</b> 3
Computer Science for Engineers - F				Recitation Section (small)	2	3
Module Responsible		5				
Admission Requirements	None					
Recommended Previous						
Knowledge						
Educational Objectives	After taking part succ	essfully, students have reac	hed the follow	ving learning results		
Professional Competence						
Knowledge						
Skills						
Barran I Carrantena						
Personal Competence						
Social Competence Autonomy						
Workload in Hours	Independent Study T	me 110, Study Time in Lectu	Ire 70			
Credit points		ine 110, Study fille in Lecti	ure 70			
Course achievement	Compulsory Bonus	Form	Description			
course demeterment	No 10 %	Attestation	Testate find	en semesterbegleitend statt.		
Examination	Written exam					
Examination duration and	120 min					
scale						
Assignment for the	General Engineering	Science (German program	n, 7 semeste	er): Specialisation Mechanica	l Engineering, F	ocus Biomechani
Following Curricula	Compulsory					
				pecialisation Process Engineer		
				pecialisation Biomedical Engin		
		Science (German program, 7	/ semester): S	pecialisation Green Technologi	ies, Focus Renew	able Energy: Elect
	Compulsory					
		Science (German program	, 7 semester	): Specialisation Mechanical I	Engineering, Foc	us Energy Syster
	Compulsory	Ceienee (Cermon pressen	7 comostor	). Creciclication Machanical	Fraincaring Foo	we Aircraft Cueta
	Engineering: Compute		i, / semester	): Specialisation Mechanical	Engineering, Foc	us Aircrait Syste
			m 7 semes	ter): Specialisation Mechanic	al Engineering	Focus Materials
	Engineering Sciences		in, 7 series	ter). Specialisation incentance	ur Engineering,	i ocus matemais
			n, 7 semest	er): Specialisation Mechanica	I Engineering, I	ocus Mechatroni
	Compulsory	. , , ,			5 5.	
	General Engineering	Science (German program, 7	7 semester): S	pecialisation Mechanical Engir	neering, Focus Th	eoretical Mechani
	Engineering: Compuls	sory				
	General Engineering	Science (German program,	7 semester):	Specialisation Mechanical Eng	ineering, Focus P	roduct Developme
	and Production: Elect	ive Compulsory				
				pecialisation Electrical Enginee		
		Science (German program, 7	semester): S	pecialisation Green Technologi	ies, Focus Renew	able Energy: Elect
	Compulsory					
		ng: Core Qualification: Comp				
		g: Core Qualification: Compute Intal Engineering: Core Qua		anulcony		
				ecialisation Process Engineeri	na: Elective Com	oulsory
				): Specialisation Energy and		
	Compulsory	, J		,		5 5. 2.500
		Energy, Water, Climate: Spe	cialisation Ene	ergy Systems: Elective Compul	sory	
	Logistics and Mobility	: Core Qualification: Compul	sory			
	Logistics and Mobility	: Specialisation Information	Technology: C	Compulsory		
	Mechatronics: Core Q	ualification: Compulsory				
		Core Qualification: Compuls		Specialisation Information Tec		

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

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

### **Specialization Naval Architecture**

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

Module M1118: Hydro	ostatics and Body Plan			
Courses				
Title		Тур	Hrs/wk	СР
Hydrostatics (L1260)		Lecture	2	3
Hydrostatics (L1261)		Recitation Section (large)	2	1
Body Plan (L1452)		Project Seminar	2	2
Module Responsible	Prof. Stefan Krüger			
Admission Requirements	None			
<b>Recommended Previous</b>	Good knowledge in Mathemathics I-III and Mech	anics I-III.		
Knowledge	It is recommended that the students are familia	r with typical design relevant drawings, e.g. B	ody Plan, GA- Pla	an, Tank Plan etc.
<b>Educational Objectives</b>	After taking part successfully, students have re-	ached the following learning results		
Professional Competence				
Knowledge	The lecture enables the student to carry out al	I necessary theoretical calculations for ship d	esign on a scient	ific level. The lectur
	is basic requirement for all following lectures in	the subjects shipo design and safety of ships.		
CL 11				
SKIIIS	The student is able to carry out hydrostatic ca		ent stability. He i	s able to design hul
	forms that are safe against capsizing or sinking			
Personal Competence				
Social Competence	The student gets access to hydrostatical proble	ms.		
Autonomy				
	Independent Study Time 96, Study Time in Lect	ure 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): Specialisation Naval Architectur	re: Compulsory	
Following Curricula	Naval Architecture: Core Qualification: Compuls	ory		

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

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

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

#### 6. Stability in Waves

- Roll Motions at Large Amplitudes
- Pure Loss of Stability on the Wave Crest
- Principle of Parametric Excitation
- Principle of Direct Wave Moments
- Grim's Equivalent Wave Concept
- 6 Longitudinal Strength
- Longitudinal Mass Distribution, Shear Forces, Bending Moments
- Longitudinal Strength in Stability Booklet
- 7. Deadweight Survey and Inclining Experiment
- Deplacement Computations from Draft mark Readings
- Weights to go on /come from board
- Inclining Experiment with Heeling Moments from Weights and Heeling Tanks
- Residual Sounding Volumes
- Determination of COG from Metacentric height and from Cross Curves
- Roll Decay Test
- 8. Launching and Docking
  - Launching Plan, Arrangement of Launching Blocks
  - Rigid Body Launching: Tilting, Dumping, Equation of Techel
  - Computation of Launching Event
  - Bottom Pressure and Longitudinal Strength
  - Linear- Elastic Effects
  - Transversal Stability on Slipway and in Dock

#### 9. Grounding

- Loss of Buoynacy when Grounded
- Pointwise Grounding
- Ship Grounds on Keel
- 10. Introduction into Damage Stability Problems
- Added Mass Method
- Loss of Buoyant Volume Method
- Simple Equilibrium Computations
- Intermediate Stages of Flooding (Addes Mass Method), Cross- and Downflooding
- Water Ingress Through Openings
- 11. Special Problems (optional and agreed upon)
- e.g. Heavy Lift Operations
- e.g. Jacking of Jackup Vessels

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

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

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

Courses				
Title		Тур	Hrs/wk	СР
Fundamentals of Materials Science	I (L1085)	Lecture	2	2
	II (Advanced Ceramic Materials, Polymers and Composites) (L0506)	Lecture	2	2
Physical and Chemical Basics of Ma	terials Science (L1095)	Lecture	2	2
Module Responsible	Prof. Jörg Weißmüller			
Admission Requirements	None			
<b>Recommended Previous</b>	Highschool-level physics, chemistry und mathematics			
Knowledge				
Educational Objectives	After taking part successfully, students have reached the follow	ving learning results		
Professional Competence		<u> </u>		
	The students have acquired a fundamental knowledge on r	metals, ceramics and	d polymers and can descr	ribe this knowled
	comprehensively. Fundamental knowledge here means specific			
	phase transformations, corrosion and mechanical properties. T			
	for materials and can identify relevant approaches for cha			
	phenomena back to the underlying physical and chemical laws			
Skills	The students are able to trace materials phenomena back t	to the underlying ph	ysical and chemical laws	of nature. Mater
	phenomena here refers to mechanical properties such as stre	ngth, ductility, and s	tiffness, chemical propertie	es such as corros
	resistance, and to phase transformations such as solidificatio	n, precipitation, or r	nelting. The students can	explain the relat
	between processing conditions and the materials microstruct	ure, and they can ac	count for the impact of m	icrostructure on
	material's behavior.			
Personal Competence				
Social Competence	-			
Autonomy	-			
Workload in Hours	Independent Study Time 96, Study Time in Lecture 84			
Credit points				
Course achievement				
	Written exam			
Examination duration and	180 min			
scale				
Assignment for the	General Engineering Science (German program, 7 semester): S	pecialisation Mechan	ical Engineering: Compulso	ory
Following Curricula	General Engineering Science (German program, 7 semester): S	pecialisation Biomedi	cal Engineering: Compulso	ry
	General Engineering Science (German program, 7 semester): S	pecialisation Naval A	rchitecture: Compulsory	
	Data Science: Specialisation Materials Science: Compulsory			
	Digital Mechanical Engineering: Core Qualification: Compulsory			
	Energy and Environmental Engineering: Core Qualification: Con	npulsory		
	Green Technologies: Energy, Water, Climate: Specialisation Ene	ergy Technology: Elec	tive Compulsory	
	Logistics and Mobility: Specialisation Engineering Science: Elect	tive Compulsory		
	Logistics and Mobility: Specialisation Production Management a		e Compulsory	
	Mechanical Engineering: Core Qualification: Compulsory			
	Mechatronics: Core Qualification: Compulsory			
	Naval Architecture: Core Qualification: Compulsory			
	Technomathematics: Specialisation III. Engineering Science: Ele	ective Compulsory		
	Engineering and Management - Major in Logistics and Mobili	ty: Specialisation Pro	duction Management and	Processes: Elect

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

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

Course L1095: Physical and C	Chemical Basics of Materials Science
Тур	Lecture
Hrs/wk	2
СР	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Gregor Vonbun-Feldbauer, Prof. Stefan Müller
Language	DE
Cycle	WiSe
Content	<ul> <li>Motivation: "Atoms in Mechanical Engineering?"</li> <li>Basics: Force and Energy</li> <li>The electromagnetic Interaction <ul> <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> </li> </ul>
Literature	<ul> <li>Für den Elektromagnetismus:</li> <li>Bergmann-Schäfer: "Lehrbuch der Experimentalphysik", Band 2: "Elektromagnetismus", de Gruyter</li> <li>Für die Atomphysik:</li> <li>Haken, Wolf: "Atom- und Quantenphysik", Springer</li> <li>Für die Materialphysik und Elastizität:</li> <li>Hornbogen, Warlimont: "Metallkunde", Springer</li> </ul>

Courses				
Title		Тур	Hrs/wk	СР
	al Mechanics, Numerical Mechanics) (L1137)	Lecture	3	3
-	al Mechanics, Numerical Mechanics) (L1138)	Recitation Section (small)	2	2
-	al Mechanics, Numerical Mechanics) (L1139)	Recitation Section (large)	1	1
Module Responsible	Prof. Robert Seifried			
Admission Requirements	None			
Recommended Previous	Mathematics I-III and Mechanics I-III			
Knowledge				
	After taking part successfully, students have reach	ed the following learning results		
Professional Competence				
-	The students can			
nnomedge				
	<ul> <li>describe the axiomatic procedure used in m</li> </ul>	echanical contexts;		
	<ul> <li>explain important steps in model design;</li> </ul>			
	<ul> <li>present technical knowledge.</li> </ul>			
Chille	The students can			
SKIIIS	The students can			
	explain the important elements of mathematical elements of mathematical elements of mathematical elements of the second elements elements of the second elements	atical / mechanical analysis and model for	mation, and app	ly it to the context
	their own problems;			
	<ul> <li>apply basic methods to engineering problem</li> </ul>	is;		
	<ul> <li>estimate the reach and boundaries of the m</li> </ul>	ethods and extend them to be applicable	to wider problem	sets.
Personal Competence				
Social Competence	The students can work in groups and support each	other to overcome difficulties.		
Autonomy	Students are capable of determining their own stre	ngths and weaknesses and to organize th	eir time and lear	ning based on those
Workload in Hours	Independent Study Time 96, Study Time in Lecture	84		
Credit points	6			
Course achievement	None			
Examination	Written exam			
Examination duration and	120 min			
scale				
Assignment for the	General Engineering Science (German program, 7	semester): Specialisation Mechanical Engi	neering: Compuls	sory
Following Curricula	General Engineering Science (German program, 7	semester): Specialisation Biomedical Engi	neering: Compuls	sory
-	General Engineering Science (German program, 7			
	Energy Systems: Technical Complementary Course		. ,	
	Mechanical Engineering: Core Qualification: Compu			
	Mechatronics: Core Qualification: Compulsory	-		
	Naval Architecture: Core Qualification: Compulsory			
	Technomathematics: Specialisation III. Engineering			

Course L1137: Mechanics IV	(Oscillations, Analytical Mechanics, Numerical Mechanics)
Тур	Lecture
Hrs/wk	3
CP	3
Workload in Hours	Independent Study Time 48, Study Time in Lecture 42
Lecturer	Prof. Robert Seifried
Language	DE
Cycle	SoSe
Content	<ul> <li>Elements of vibration theory</li> <li>Vibration of Multi-degree of freedom systems</li> <li>Analytical Mechanics</li> <li>Multibody Systems</li> <li>Numerical methods for time integration</li> <li>Introduction to Matlab</li> </ul>
Literature	K. Magnus, H.H. Müller-Slany: Grundlagen der Technischen Mechanik. 7. Auflage, Teubner (2009). D. Gross, W. Hauger, J. Schröder, W. Wall: Technische Mechanik 1-4. 11. Auflage, Springer (2011). W. Schiehlen, P. Eberhard: Technische Dynamik, Springer (2012).

Course L1138: Mechanics IV	(Oscillations, Analytical Mechanics, Numerical Mechanics)
Тур	Recitation Section (small)
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Prof. Robert Seifried
Language	DE
Cycle	SoSe
Content	See interlocking course
Literature	See interlocking course
Course L1139: Mechanics IV	(Oscillations, Analytical Mechanics, Numerical Mechanics)
Тур	Recitation Section (large)
Hrs/wk	1
СР	1
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14
Lecturer	Prof. Robert Seifried
Language	DE

Cycle

Content

SoSe

Literature See interlocking course

See interlocking course

Module M0854: Math	ematics IV			
Courses				
Title Differential Equations 2 (Partial Diff Differential Equations 2 (Partial Diff Differential Equations 2 (Partial Diff	erential Equations) (L1044)	<b>Typ</b> Lecture Recitation Section (small) Recitation Section (large)	Hrs/wk 2 1	<b>CP</b> 1 1
Complex Functions (L1038) Complex Functions (L1041) Complex Functions (L1042)		Lecture Recitation Section (small) Recitation Section (large)	2 1 1	1 1
Module Responsible	Prof. Anusch Taraz	Reclation Section (large)	T	L
Admission Requirements	None			
Recommended Previous Knowledge	Mathematics 1 - III			
Educational Objectives	After taking part successfully, students have reached the fo	ollowing learning results		
Professional Competence Knowledge	<ul> <li>Students can name the basic concepts in Mathemati</li> <li>Students can discuss logical connections between t the help of examples.</li> <li>They know proof strategies and can reproduce them</li> </ul>	hese concepts. They are capable		
Skills	<ul> <li>Students can model problems in Mathematics IV w capable of solving them by applying established met</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>	hods. al connections between the conce	pts studied in the	e course.
Personal Competence Social Competence	<ul> <li>Students are able to work together in teams. They a</li> <li>In doing so, they can communicate new concepts at design examples to check and deepen the understand</li> </ul>	ccording to the needs of their coop		
Autonomy	<ul> <li>Students are capable of checking their understanding precisely and know where to get help in solving ther</li> <li>Students have developed sufficient persistence to problems.</li> </ul>	n.		
Workload in Hours	Independent Study Time 68, Study Time in Lecture 112			
Credit points	6			
Course achievement	None			
	Written exam	ns 2)		
Examination duration and scale	60 min (Complex Functions) + 60 min (Differential Equation	13 2]		
Assignment for the Following Curricula	General Engineering Science (German program, 7 semeste General Engineering Science (German program, 7 sem Compulsory General Engineering Science (German program, 7 semeste General Engineering Science (German program, 7 semeste Engineering: Elective Compulsory Computer Science: Specialisation Computational Mathemal	nester): Specialisation Mechanica r): Specialisation Naval Architectur r): Specialisation Mechanical Engir	e: Compulsory	Focus Mechatronio
	Electrical Engineering: Core Qualification: Compulsory General Engineering Science (English program, 7 semester General Engineering Science (English program, 7 sem Compulsory General Engineering Science (English program, 7 semeste Engineering: Compulsory Computational Science and Engineering: Specialisation II. M Mechanical Engineering: Specialisation Mechatronics: Comp	nester): Specialisation Mechanica r): Specialisation Mechanical Engir Mathematics & Engineering Science pulsory	I Engineering, neering, Focus Th Elective Compu	Focus Mechatronio
	Mechanical Engineering: Specialisation Theoretical Mechan Mechatronics: Core Qualification: Compulsory Naval Architecture: Core Qualification: Compulsory Theoretical Mechanical Engineering: Technical Complemen			

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

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

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

Course L1038: Complex Functions	
Тур	Lecture
Hrs/wk	2
CP	1
Workload in Hours	Independent Study Time 2, Study Time in Lecture 28
Lecturer	Dozenten des Fachbereiches Mathematik der UHH
Language	DE
Cycle	SoSe
Content	Main features of complex analysis
Literature	<ul> <li>Functions of one complex variable</li> <li>Complex differentiation</li> <li>Conformal mappings</li> <li>Complex integration</li> <li>Cauchy's integral theorem</li> <li>Cauchy's integral formula</li> <li>Taylor and Laurent series expansion</li> <li>Singularities and residuals</li> <li>Integral transformations: Fourier and Laplace transformation</li> </ul>
	<ul> <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	
CP	1	
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14	
Lecturer	Dozenten des Fachbereiches Mathematik der UHH	
Language	DE	
Cycle	SoSe	
Content	See interlocking course	
Literature	See interlocking course	

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

Module M0680: Fluid	Dynamics				
Courses					
Title			Тур	Hrs/wk	СР
Fluid Mechanics (L0454)			Lecture	3	4
Fluid Mechanics (L0455)	l .		Recitation Section (large)	2	2
Module Responsible	Prof. Thomas Rung				
Admission Requirements	None				
<b>Recommended Previous</b>	Sound knowledge of engineering mathe	ematics, engineering mecl	nanics and thermodynamics		
Knowledge					
Educational Objectives	After taking part successfully, students	have reached the following	ng learning results		
Professional Competence					
Knowledge	Students will have the required sound knowledge to explain the general principles of fluid engineering and physics of fluids. Students can scientifically outline the rationale of flow physics using mathematical models and are familiar with methods for the performance analysis and the prediciton of fluid engineering devices.				
Skills	Students are able to apply fluid-engineering principles and flow-physics models for the analysis of technical systems. The lecture enables the student to carry out all necessary theoretical calculations for the fluid dynamic design of engineering devices on a scientific level.				
Personal Competence Social Competence	The students are able to discuss proble	ems and jointly develop so	lution 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 Tir	me in Lecture 70			
Credit points	6				
Course achievement	None				
Examination	Written exam				
Examination duration and	180 min				
scale					
Assignment for the	General Engineering Science (German	program, 7 semester): Spe	ecialisation Mechanical Engi	neering: Compuls	ory
-	General Engineering Science (German		-		-
<b>-</b>	General Engineering Science (German		-	<b>e</b> ,	-
	Mechanical Engineering: Core Qualificat			)	
	Naval Architecture: Core Qualification: (				
	Technomathematics: Specialisation III.		tive Compulsory		

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

Course L0455: Fluid Mechani	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	

Courses				
Title		Тур	Hrs/wk	СР
Ship Dynamics (L0352)		Lecture	2	3
Ship Dynamics (L1620)		Recitation Section (small)	1	1
	in Naval Architecure and Ocean Engineering (L0364)	Lecture	2	3
	Prof. Moustafa Abdel-Maksoud			
Admission Requirements	None			
Recommended Previous Knowledge	<ul><li>Technical mechanics</li><li>Linear algebra, analysis, complex numbers</li><li>Fluid mechanics</li></ul>			
Educational Objectives	After taking part successfully, students have reached t	ne following learning results		
Professional Competence				
Knowledge	<ul> <li>The students are able to give an overview over varior procedure of the manoeuvres.</li> </ul>	us manoeuvres. They can name applic	ation goals and t	hey can describe t
	- The students are able to give an overview over varius	rudder types. They can name criteria	in the rudder des	ign.
	- The students can name computation methods which a	are used to determine forces and motio	ons in waves.	
Skills	<ul> <li>The students can come up with the equations of motion</li> <li>The students are able to determine hydrodynamic control</li> </ul>			e and linearise the
	- The students can explain how a rudder works and the	y can explain the physical effects whic	h can occur.	
	- The students can mathematically describe waves.			
	- The students can explain the mathematically descript	ion of harmoncial motions in waves an	d they can deter	mine them.
Personal Competence				
Social Competence	- The students can arrive at work results in groups and	document them.		
	- The students can discuss in groups and explain their	point of view.		
Autonomy	- The students can assess their own strengthes and we	aknesses and the define further work s	teps on this basi	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	General Engineering Science (German program, 7 sem	ester): Specialisation Naval Architectur	e: Compulsorv	
Following Curricula	General Engineering Science (English program, 7 seme			
2	Naval Architecture: Core Qualification: Compulsory		. ,	

Course L0352: Ship Dynamic	S
Тур	Lecture
Hrs/wk	2
CP	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
	Equations of motion
	Hydrodynamic forces and moments
	Linear equations and their solutions
	Full-scale trials for evaluating the maneuvering performance
	Regulations for maneuverability
	Rudder
	Seakeeping
	Representation of harmonic processes
	Motions of a rigid ship in regular waves
	Flow forces on ship cross sections
	Strip method
	Consequences induced by ship motion in regular waves
	Behavior of ships in a stationary sea state
	Long-term distribution of seaway influences
Literature	
	<ul> <li>Abdel-Maksoud, M., Schiffsdynamik, Vorlesungsskript, Institut f ür Fluiddynamik und Schiffstheorie, Technische Universit ät</li> </ul>
	Hamburg-Harburg, 2014
	<ul> <li>Abdel-Maksoud, M., Ship Dynamics, Lecture notes, Institute for Fluid Dynamic and Ship Theory, Hamburg University of Technology, 2014</li> </ul>
	• Bertram, V., Practical Ship Design Hydrodynamics, Butterworth-Heinemann, Linacre House - Jordan Hill, Oxford, United
	Kingdom, 2000
	<ul> <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> </ul>
	<ul> <li>Brix, J. (ed.), Mandeuvring Technical Manual, Seenaleh-Venag, Hamburg, 1993</li> <li>Claus, G., Lehmann, E., Östergaard, C). Offshore Structures, I+II, Springer-Verlag. Berlin Heidelberg, Deutschland, 1992</li> </ul>
	<ul> <li>Faltinsen, O. M., Sea Loads on Ships and Offshore Structures, Cambridge University Press, United Kingdom, 1990</li> </ul>
	<ul> <li>Handbuch der Werften, Deutschland, 1986</li> </ul>
	<ul> <li>Jensen, J. J., Load and Global Response of Ships, Elsevier Science, Oxford, United Kingdom, 2001</li> </ul>
	<ul> <li>Lewis, Edward V. (ed.), Principles of Naval Architecture - Motion in Waves and Controllability, Society of Naval Architects and</li> </ul>
	Marine Engineers, Jersey City, NJ, 1989
	<ul> <li>Lewandowski, E. M., The Dynamics of Marine Craft: Maneuvering and Seakeeping, World Scientific, USA, 2004</li> </ul>
	Lloyd, A., Ship Behaviour in Rough Weather, Gosport, Chichester, Sussex, United Kingdom, 1998
	<u> </u>

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

Tvn	Lecture
Hrs/wk	
	3
-	- 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	<ul> <li>V. Müller, Statistik und Stochastik in der Schiffs- und Meerestechnik, Vorlesungsskript, Institut für Fluiddynamik und Schiffstheorie, Technische Universität Hamburg-Harburg, 2014</li> <li>W. Blendermann "Grundlagen der Wahrscheinlichkeitsrechnung", Vorlesungsskript, Arbeitsbereich Fluiddynamik und Schiffstheorie, Technische Universität Hamburg-Harburg, 2001</li> <li>H. W. Coleman, W. G. Steele, Experimentation and Uncertainty Analysis for Engineers, 3 <sup>rd</sup> Edition, John Wiley &amp; Sons, Inc., Net York, NY, 2009</li> <li>ITTC Recommended Procedures and Guidelines, In: Quality Systems Manual, International Towing Tank Conference (ITTC), 2011</li> <li>F.M. Dekking, C. Kraaikamp, H.P. Lopuhaä, L.E. Meester, A Modern Introduction To Probability and Statistics, Springer, 2005</li> <li>Springer Handbook of Engineering Statistics, H. Pham (Hrsg.), Springer, 2006</li> <li>A. Klenke, Wahrscheinlichkeitstheorie, Springer, 2013</li> </ul>

Courses				
Title		Тур	Hrs/wk	СР
Ship Structural Design (L0412)		Lecture	2	3
Ship Structural Design (L0415)		Recitation Section (small)	2	3
Welding Technology (L1123)		Lecture	3	3
Module Responsible	Prof. Sören Ehlers			
Admission Requirements	None			
<b>Recommended Previous</b>	s Mechanics I - III			
Knowledge	• Fundamentals of Materials Science I - III			
	Welding Technology I			
	Fundamentals of Mechanical Design I - III			
Educational Objectives	After taking part successfully, students h	ave reached the following learning results		
Professional Competence				
Knowledge	e Students can reproduce design and sizin	g as well as fabrication of the different areas of shi	p structures and o	f different ship typ
	(incl. detail design); they can describe ca	lculation models for complex structures.		
Personal Competence	2			
		uctural design and discuss their decisions construct	ively in a group.	
	e Students are capable to present their stru	uctural design and discuss their decisions construct idently different structural areas of the ship hull a		types and to defi
Social Competence	e Students are capable to present their stru			types and to defi
Social Competence	e Students are capable to present their structure v Students are capable to design independent			types and to def
Social Competence Autonomy	<ul> <li>Students are capable to present their strive</li> <li>Students are capable to design indeper appropriate fabrication methods.</li> </ul>	dently different structural areas of the ship hull a		types and to def
Social Competence Autonomy Workload in Hours	<ul> <li>Students are capable to present their striver</li> <li>Students are capable to design independent appropriate fabrication methods.</li> <li>Independent Study Time 172, Study Time</li> </ul>	dently different structural areas of the ship hull a		types and to defi
Social Competence Autonomy Workload in Hours Credit points	<ul> <li>Students are capable to present their structure</li> <li>Students are capable to design independent appropriate fabrication methods.</li> <li>Independent Study Time 172, Study Time</li> <li>9</li> </ul>	dently different structural areas of the ship hull a		types and to defi
Social Competence Autonomy Workload in Hours Credit points Course achievement	<ul> <li>Students are capable to present their structure</li> <li>Students are capable to design independent appropriate fabrication methods.</li> <li>Independent Study Time 172, Study Time 5</li> <li>None</li> </ul>	dently different structural areas of the ship hull a		types and to defi
Social Competence Autonomy Workload in Hours Credit points Course achievement Examination	<ul> <li>Students are capable to present their structure</li> <li>Students are capable to design independent appropriate fabrication methods.</li> <li>Independent Study Time 172, Study Time 5</li> <li>Independent Study Time 172, Study Time 5</li> <li>Worket</li> <li>Written exam</li> </ul>	dently different structural areas of the ship hull a		types and to defi
Social Competence Autonomy Workload in Hours Credit points Course achievement Examination Examination duration and	<ul> <li>Students are capable to present their structure</li> <li>Students are capable to design independent appropriate fabrication methods.</li> <li>Independent Study Time 172, Study Time</li> <li>Independent Study Time 172, Study Time</li> <li>Mone</li> <li>Written exam</li> <li>3 hours</li> </ul>	dently different structural areas of the ship hull a		types and to def
Social Competence Autonomy Workload in Hours Credit points Course achievement Examination Examination duration and scale	<ul> <li>Students are capable to present their structure</li> <li>Students are capable to design independent appropriate fabrication methods.</li> <li>Independent Study Time 172, Study Time</li> <li>Independent Study Time 172, Study Time</li> <li>None</li> <li>Written exam</li> <li>A bours</li> </ul>	e in Lecture 98	and different ship	types and to defi
Social Competence Autonomy Workload in Hours Credit points Course achievement Examination Examination duration and scale	<ul> <li>Students are capable to present their structure</li> <li>Students are capable to design independent appropriate fabrication methods.</li> <li>Independent Study Time 172, Study Time</li> <li>Independent Study Time 172, Study Time</li> <li>None</li> <li>Written exam</li> <li>3 hours</li> <li>General Engineering Science (German present)</li> </ul>	dently different structural areas of the ship hull a	and different ship	types and to defi

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

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

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

Courses				
Title		Typ	Hrs/wk	СР
Fundamentals of Ship Structural De	sign (10411)	<b>Typ</b> Lecture	2	2
Fundamentals of Ship Structural De	-	Recitation Section (small)	1	2
Fundamentals of Ship Structural An	-	Lecture	2	2
Fundamentals of Ship Structural An		Recitation Section (small)	1	2
Module Responsible	Prof. Sören Ehlers			
Admission Requirements	None			
<b>Recommended Previous</b>	Mechanics I - III			
Knowledge	Fundamentals of Materials Science I - III			
_	Welding Technology I			
	Fundamentals of Mechanical Design I - III			
Educational Objectives	After taking part successfully, students have re	eached the following learning results		
Professional Competence				
Knowledge	Students can reproduce the basic contents of t	he structural behaviour of ship structures; the	ey can explain the	theory and metho
	for the calculation of deformations and stresse	s in beam-like structures.		
	Furthermore, they can reproduce the basis co		ied products, join	ing and principles
	structural design of components in the ship str	ucture.		
Skills	Students are capable of applying the method	ds and tools for the calculation of linear de	formations and s	tresses in the abo
	mentioned structures; they can choose calcula	tion models of typical ship structures.		
	Furthermore, they are capable to apply the m	othods of drawing and sizing the ship structu	ro: thoy can color	ct cuitable materia
	semi-finished products and joints.	ethous of drawing and sizing the ship structu	ie, they can selec	
	semi-mistica products and joints.			
Personal Competence				
	The students are able to communicate and c	opperate in a professional environment in th	e shipbuilding an	nd component sup
Social competence	industry.		ie snipbullang un	
Autonomy	The students are capable to independently id	ealize real ship structures and to select suita	ble methods for a	analysis of beam-li
	structures; they are capable to assess the resu	lts of structural analyses.		
	Furthermore, they are capable to assess d	rawings of complex ship structures and t	o docian chin ct	ructuros for vario
	requirements and boundary conditions.	rawings of complex ship structures and th	o design ship st	
	requirements and boundary conditions.			
Workload in Hours	Independent Study Time 156, Study Time in Le	octuro 84		
Credit points				
Course achievement				
Examination				
Examination duration and	3 hours			
scale				
	Conoral Engineering Science (Cormon program	n, 7 semester): Specialisation Naval Architectu	ro. Compulson	
Assignment for the Following Curricula	General Engineering Science (English program		, ,	

Course L0411: Fundamentals	s of Ship Structural Design
Тур	Lecture
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	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
CP	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
	9. Determining the scantlings of longitudinal structural members
	10. Determining the scantlings of bottom and side structures
	11. Decks and Hatch Openings
	12. Effective breadth
	13. Iterative determination of scantlings (POSEIDON)
Literature	Vorlesungsskript mit weiteren Literaturangaben wird über das Internet verfügbar gemacht

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

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

Courses				
Title		Тур	Hrs/wk	СР
Resistance and Propulsion (L1265)		Lecture	2	3
Resistance and Propulsion (L1266)		Recitation Section (large)	2	3
Module Responsible	Prof. Stefan Krüger			
Admission Requirements	None			
<b>Recommended Previous</b>	Mechanics			
Knowledge	<ul> <li>Fluid Dynamics for Naval Architects</li> </ul>			
	Hydrostratics			
Educational Objectives	After taking part successfully, students have reach	ned the following learning results		
Professional Competence				
Knowledge	The hydrodynamic basics that are relevant for	r resistance and propulsion of ships are	discussed. The	different resistant
	phenomena and their practical applications to hul	llform design as well as numerical and emp	irical prediction	methods are subje
	of the course. Furthermore, environmental addition	onal resistances are dealt with. The course	includes model	test techniques ar
	their application to full scale ships. This hold also		-	
	Main Focus is how hull forms can be optimized for	minimum and sustainable fuel consumption	<ol> <li>The following to</li> </ol>	pics are dealt with
	- Stillwater/added resistance, Wave resistance, I	Minimization of wave resistance, numeric	al prediction me	thods. friction law
	laminar/turbulent flow separation, Hull form des			
	resistance law,form factor method, thrust deducti	ion, wake, model scaling laws, resistance t	ests, free running	g propeller tests ar
	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		
Skills	The student shall learn to design competitve hull	forms with respect to fuel consumption by	applying numreic	al techniques and
D.M.D	evaluate these hulls by several progosis meth			
	minimize the required power including environmer			
Personal Competence				
•	The student learns to prepare technical matters in	such a way that he can compte with his bu	ildina suvervisior	i team.
Autonomy	The student learns to prepare technical matters in		-	
Workload in Hours	Independent Study Time 124, Study Time in Lectu	ro 56		
Credit points	Independent Study Time 124, Study Time in Lectu 6	iie 50		
Course achievement	None			
Examination				
Examination duration and				
scale				
Assignment for the	General Engineering Science (German program, 7	semester): Specialisation Naval Architectur	e: Compulsory	
		•		
Following Curricula	General Engineering Science (English program, 7 s	semester): Specialisation Naval Architecture	e: Compulsory	

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

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

Courses				
Title		Typ	Hrs/wk	СР
Computational Fluid Dynamics I (L0	235)	<b>Typ</b> Lecture	2	3
Computational Fluid Dynamics I (LO		Recitation Section (large)	2	3
Module Responsible	Prof. Thomas Rung			
Admission Requirements	None			
<b>Recommended Previous</b>				
Knowledge	<ul> <li>Mathematical Methods for Engineers</li> <li>Fundamentals of Differential/integral calculus</li> </ul>	and corios expansions		
	Fundamentals of Differential/Integral calculus			
Educational Objectives	After taking part successfully, students have reached	d the following learning results		
Professional Competence				
Knowledge	The students are able to list the basic numerics of pa	artial differential equations.		
Skills	The students are able develop appropriate numerica		overning partial d	ifferential equatio
	They can code computational algorithms in a structu	ired way.		
Personal Competence				
Social Competence	The students can arrive at work results in groups and	d document them.		
Autonomy	The students can independently analyse approaches	to solving specific problems.		
Workload in Hours	Independent Study Time 124, Study Time in Lecture	56		
Credit points	6			
Course achievement	None			
Examination	Written exam			
Examination duration and	2h			
scale				
Assignment for the	General Engineering Science (German program, 7 se	emester): Specialisation Mechanical Engir	neering, Focus Th	eoretical Mechani
Following Curricula	Engineering: Elective Compulsory			
	General Engineering Science (German program, 7	semester): Specialisation Mechanical	Engineering, Foo	us Aircraft Syste
	Engineering: Elective Compulsory			
	General Engineering Science (German program, 7	semester): Specialisation Mechanical	Engineering, Foc	us Energy Syster
	Elective Compulsory	meeter). Creciplication Neural Architecture	Commulation	
	General Engineering Science (German program, 7 se General Engineering Science (German program, 7 se	•		ring: Compulsory
	Energy Systems: Technical Complementary Course (		omentai Enginee	ring. compulsory
	General Engineering Science (English program, 7 ser		mental Engineer	ing: Compulsory
	General Engineering Science (English program, 7 General Engineering Science (English program, 7		-	
	Elective Compulsory		5 5,	3, ,,,,,,,,
	General Engineering Science (English program, 7 ser	mester): Specialisation Naval Architecture	e: Compulsory	
	General Engineering Science (English program, 7	semester): Specialisation Mechanical	Engineering, Foc	us Aircraft Syste
	Engineering: Elective Compulsory			
	Mechanical Engineering: Specialisation Energy Syste	ms: Elective Compulsory		
	Mechanical Engineering: Specialisation Aircraft Syste	ems Engineering: Elective Compulsory		
	Naval Architecture: Core Qualification: Compulsory			
	Technomathematics: Specialisation III. Engineering S			

Course L0235: Computationa	al Fluid Dynamics I			
Тур	Lecture			
Hrs/wk	2			
CP	3			
Workload in Hours	dependent Study Time 62, Study Time in Lecture 28			
Lecturer	rof. 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			

Course L0419: Computationa	rse 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				

itle		Тур	Hrs/wk	СР
hip Design (L1262)		Lecture	2	3
hip Design (L1264)		Recitation Section (large)	2	3
Module Responsible	Prof. Stefan Krüger			
Admission Requirements	None			
<b>Recommended Previous</b>				
Knowledge	<ul> <li>Fluid Dynamics for Naval Architects, Res</li> <li>Resistance and Propulsion, Hydrostatics</li> </ul>	istance and Propulsion		
Educational Objectives	After taking part successfully, students have re	ached the following learning results		
Professional Competence				
Knowledge	The lecture starts with an overview about the Ship Designs are thoroughly discussed. Typical main parameters of a ship are introduced and influence of alternated main parameters on the lecture, the design changes are dealt with b systems properly so that the relavent technical The lecture continues with an introduction into contract. Further, methods are introduced to g during the different design stages. In detail, the - Structure of a building specification - Determination of Light Ship Weight and Deade Components - Design of main section and hull form - Design of main propulsion plant - Design of subdivision - Determination of limiting GMrequ- Curves - Scantlings of most improtant structural memb - Longitudinal strength - Outfitting Components	bulding contracts and the related technical r d their influence on the competitiveness of e total performance of a ship design and the y simple models or formulae. The student conclusions can be drawn. • the different phases of design project, fror enerate bulding specfication relevant inform e following topics are adressed: weight ces	isk are introduced a design. The lec consecutive proc shall further lear n the initial design	. The most importa ture focusses on t ess elements. In t n to model compl n phase to a buildi
	- Relevant rules and regulations			
Skills	The student is made familiar with the basic of student shall be able to carry out a concept de the Marine Environment. The lecture deals wit of a ship design with respect to fulfillment prov relevant methods to determine and judge uopn	sign based on a vessel of comparison fulfilli h the basic design methods to determine the cedures of the contract values. Based on the	ng typical contract e fundamantal tec lecture "Principle	requirements with hnical characterist
Personal Competence				
Social Competence	The students learns to prepare technical m	atters in such a way the he can persuad	le his potantial c	ustomer against I
Autonomy	competitors. The students learns to prepare technical m competitors.	atters in such a way the he can persuad	le his potantial c	ustomer against
Workload in Hours	Independent Study Time 124, Study Time in Le	cture 56		
Credit points	6			
Course achievement	None			
Examination	Written exam			
Examination duration and	180 min			
scale				
Assignment for the	General Engineering Science (German program	, 7 semester): Specialisation Naval Architect	ure: Compulsory	
Following Curricula	General Engineering Science (English program,			

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

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

## **Specialization Process Engineering**

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

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

Module M0886: Funda	amentals of Process Engine	ering and Material Engineering		
Courses				
Title		Тур	Hrs/wk	СР
Introduction into Process Engineeri	ng/Bioprocess Engineering (L0829)	Lecture	2	1
Fundamentals of material engineer	ing (L0830)	Lecture	2	2
Module Responsible	Prof. Michael Schlüter			
Admission Requirements	None			
Recommended Previous	none			
Knowledge				
Educational Objectives	After taking part successfully, students h	have reached the following learning results		
Professional Competence				
Knowledge	After passing this module the students h	have the ability to:		
	<ul> <li>give an overview of the most imp</li> </ul>	ortant fields on process and bioprocess enginee	ring	
		or different fields in process engineering.	ning,	
	- explain some working methods to	and characterized in process engineering.		
Skills	After passing this module the students s	hould have the ability to:		
	<ul> <li>list and outline the most important</li> </ul>	nt fields of process engineering,		
		g approaches or methods of the different fields of	of process engineering,	
	read and prepare an engineering	drawing,		
	explain the most important techn	ologies for wastewater and exhaust air treatment	nt	
	<ul> <li>scheme typical chemical and biot</li> </ul>	echnological processes independently with the	aid of pointers.	
Personal Competence				
	The students are able to			
Social competence	The statents are usic to			
	<ul> <li>work out results in groups and do</li> </ul>	cument them,		
	<ul> <li>provide appropriate feedback and</li> </ul>	handle feedback on their own performance cor	nstructively.	
Autonomy	The students are able to estimate their	progress of learning by themselves and to de	liberate their lack of kr	nowledge in Process
	Engineering and Bioprocess Engineering			5
	Independent Study Time 34, Study Time	in Lecture 56		
Credit points				
Course achievement		Description		
Evamination	No 5 % Written elaborati	UII		
Examination				
Examination duration and	90 min			
scale	Conoral Engineering Science (Correspond	rogram 7 competer), Encodeligation Processor	incoring, Compulse	
Assignment for the Following Curricula		rogram, 7 semester): Specialisation Process Eng		24
Following Curricula	Bioprocess Engineering: Core Qualification	rogram, 7 semester): Specialisation Bioprocess	Engineering: Compulsor	у
	Orientation Studies: Core Qualification: E			
	Process Engineering: Core Qualification:			

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

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

Courses							
Title				Ту	p	Hrs/wk	СР
Practical Course Measurement Tec	hnology (L22	270)			octical Course	2	2
Measurement Technology (L2268)			Leo	ture	2	2	
Physical Fundamentals of Measure	ment Techno	ology (L2269	9)	Leo	cture	2	2
Module Responsible	Prof. Alexa	ander Penn	1				
Admission Requirements	None						
Recommended Previous Knowledge		nterest, lo	ogical skills, integral-	and differential calculus,	basic physical conc	epts such as temperal	ture, mass, velocit
Educational Objectives	After takin	ig part suc	cessfully, students ha	ve reached the following l	earning results		
Professional Competence							
Knowledge	-			ics (theory of motion), m nperature and heat, ideal g		dies, energy and mo	mentum, electrici
	Metrology: SI units, measurement and measurement uncertainty, basics of sensor technology, physical principles, temperature measurement, pressure measurement, level measurement, flow measurement. Usage of Matlab scripts.						
				calorimetry, image data ac of solid concentrations, spe			
Skills	Literature research, categorisation of thematical topics, analysis of an experimental test stand, preparation of test protocol, fir programming with Matlab, use of relevant laboratory measurement technology, preparation of a test protocol, execution calculations.						
Personal Competence							
Social Competence	experimen	ntal stand		ctical training and learning tion with persons respor			-
	Time man	agement c					
Autonomy	-	equipmer		pendent development of tl g, practice of presentatio s by using clicker.			
Autonomy Workload in Hours	formulation	equipmer n of enquir	nt and work clothing	g, practice of presentations by using clicker.			
	formulation Independe	equipmer n of enquir	nt and work clothin ries/detailed question	g, practice of presentations by using clicker.			
Workload in Hours	formulation Independe 6 Compulsory	equipmer on of enquir ent Study T Bonus	nt and work clothin ries/detailed question rime 96, Study Time i Form	g, practice of presentations s by using clicker. n Lecture 84 Description	on in front of a gr	roup, active participat	
Workload in Hours Credit points Course achievement	formulation Independe 6 Compulsory No	equipmer n of enquir ent Study T Bonus 20 %	nt and work clothing ries/detailed question rime 96, Study Time i	g, practice of presentations s by using clicker. n Lecture 84 Description		roup, active participat	
Workload in Hours Credit points Course achievement Examination	formulation Independe 6 <b>Compulsory</b> No Written ex	equipmer n of enquir ent Study T Bonus 20 %	nt and work clothin ries/detailed question rime 96, Study Time i Form	g, practice of presentations s by using clicker. n Lecture 84 Description	on in front of a gr	roup, active participat	
Workload in Hours Credit points Course achievement Examination Examination duration and	formulation Independe 6 Compulsory No Written ex 120 min	equipmer n of enquir ent Study T Bonus 20 %	nt and work clothin ries/detailed question rime 96, Study Time i Form	g, practice of presentations s by using clicker. n Lecture 84 Description	on in front of a gr	roup, active participat	
Workload in Hours Credit points Course achievement Examination Examination duration and scale	formulation Independe 6 Compulsory No Written ex 120 min	equipmer n of enquir ent Study T Bonus 20 % cam	nt and work clothin ries/detailed question Time 96, Study Time i Form Excercises	g, practice of presentations s by using clicker. n Lecture 84 Description Popup-Quizzes w	n in front of a gr	g	
Workload in Hours Credit points Course achievement Examination Examination duration and scale Assignment for the	formulation Independe 6 Compulsory No Written ex 120 min General Er	equipmer n of enquir ent Study T Bonus 20 % cam	nt and work clothin ries/detailed question Time 96, Study Time i Form Excercises Science (German pro	g, practice of presentations s by using clicker. n Lecture 84 Description Popup-Quizzes w gram, 7 semester): Specia	n in front of a gr ähren der Vorlesung	g gineering: Compulsory	
Workload in Hours Credit points Course achievement Examination Examination duration and scale	formulation Independe 6 Compulsory No Written ex 120 min General Er General Er	equipmer n of enquir ent Study T Bonus 20 % cam	nt and work clothin ries/detailed question Time 96, Study Time i Form Excercises Science (German pro Science (German pro	g, practice of presentations s by using clicker. n Lecture 84 Description Popup-Quizzes w gram, 7 semester): Specia gram, 7 semester): Specia	n in front of a gr ähren der Vorlesung lisation Process Eng	g gineering: Compulsory jineering: Compulsory	ion in the lectur
Workload in Hours Credit points Course achievement Examination Examination duration and scale Assignment for the	formulation Independe 6 Compulsory No Written ex 120 min General Er General Er General Er	equipmer n of enquir ent Study T Bonus 20 % cam ngineering ngineering ngineering	nt and work clothing ries/detailed question rime 96, Study Time i Form Excercises Science (German pro Science (German pro Science (German pro	g, practice of presentations s by using clicker. In Lecture 84 Description Popup-Quizzes w gram, 7 semester): Specia gram, 7 semester): Specia gram, 7 semester): Specia	in in front of a gr ähren der Vorlesung lisation Process Eng lisation Process Eng lisation Bioprocess	g gineering: Compulsory jineering: Compulsory Engineering: Compulsory	ion in the lectur
Workload in Hours Credit points Course achievement Examination Examination duration and scale Assignment for the	formulation Independe 6 Compulsory No Written ex 120 min General Er General Er General Er General Er	equipmer n of enquir ent Study T Bonus 20 % cam ngineering ngineering ngineering ngineering	nt and work clothing ries/detailed question rime 96, Study Time i Form Excercises Science (German pro Science (German pro Science (German pro Science (German pro Science (German pro	g, practice of presentations s by using clicker. In Lecture 84 Description Popup-Quizzes w gram, 7 semester): Specia gram, 7 semester): Specia gram, 7 semester): Specia gram, 7 semester): Specia	in in front of a gr ähren der Vorlesung lisation Process Eng lisation Process Eng lisation Bioprocess	g gineering: Compulsory jineering: Compulsory Engineering: Compulsory	ion in the lectur
Workload in Hours Credit points Course achievement Examination Examination duration and scale Assignment for the	formulation Independe 6 Compulsory No Written ex 120 min General Er General Er General Er General Er Bioprocess	equipmer n of enquir ent Study T Bonus 20 % cam ngineering ngineering ngineering ngineering ngineering s Engineeri	nt and work clothing ries/detailed question rime 96, Study Time i Form Excercises Science (German pro Science (German pro Science (German pro Science (German pro Science (German pro Science (German pro Science (German pro	g, practice of presentations s by using clicker. In Lecture 84 Description Popup-Quizzes w gram, 7 semester): Specia gram, 7 semester): Specia	in in front of a gr ähren der Vorlesung lisation Process Eng lisation Process Eng lisation Bioprocess lisation Green Tech	g g gineering: Compulsory jineering: Compulsory Engineering: Compulsory Engineering: Compulsory	ion in the lectur
Workload in Hours Credit points Course achievement Examination Examination duration and scale Assignment for the	formulation Independe 6 Compulsory No Written ex 120 min I20 min General Er General Er General Er Bioprocess General Er	equipmer n of enquir ent Study T Bonus 20 % cam ngineering ngineering ngineering s Engineering ngineering	nt and work clothing ries/detailed question rime 96, Study Time i Form Excercises Science (German pro Science (English pro	g, practice of presentations s by using clicker. In Lecture 84 Description Popup-Quizzes w gram, 7 semester): Specia gram, 7 semester): Specia gram, 7 semester): Specia gram, 7 semester): Specia the Compulsory gram, 7 semester): Special	in in front of a gr ähren der Vorlesung lisation Process Eng lisation Bioprocess lisation Green Tech isation Process Engi	g g gineering: Compulsory jineering: Compulsory Engineering: Compulsory Engineering: Compulsory	ion in the lectur
Workload in Hours Credit points Course achievement Examination Examination duration and scale Assignment for the	formulation Independe 6 Compulsory No Written ex 120 min I20 min General Er General Er General Er Bioprocess General Er Bioprocess General Er	equipmer n of enquir ent Study T Bonus 20 % cam ngineering ngineering ngineering s Engineering hnologies:	nt and work clothing ries/detailed question rime 96, Study Time i Form Excercises Science (German pro Science (English pro	g, practice of presentations s by using clicker. In Lecture 84 Description Popup-Quizzes w gram, 7 semester): Specia gram, 7 semester): Specia gram, 7 semester): Specia gram, 7 semester): Special the Compulsory gram, 7 semester): Special the: Core Qualification: Core	in in front of a gr ähren der Vorlesung lisation Process Eng lisation Bioprocess lisation Green Tech isation Process Engi	g g gineering: Compulsory jineering: Compulsory Engineering: Compulsory Engineering: Compulsory	ion in the lectur

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.

	t Technology
,,	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	<ul> <li>Fraden, Jacob (2016): Handbook of Modern Sensors. Physics, Designs, and Applications. 5th ed. 2016. Cham, New York: Springer. Online verfügbar unter http://search.ebscohost.com/login.aspx?direct=true&amp;scope=site&amp;db=nlebk&amp;AN=1081958.</li> <li>Hering, Ekbert; Schönfelder, Gert (2018): Sensoren in Wissenschaft und Technik. Funktionsweise und Einsatzgebiete. 2. Aufl. 2018. Online verfügbar unter http://dx.doi.org/10.1007/978-3-658-12562-2.</li> <li>Strohrmann, Günther (2004): Messtechnik im Chemiebetrieb. Einführung in das Messen verfahrenstechnischer Größen. 10., durchges. Aufl. München: Oldenbourg.</li> <li>Tränkler, Hans-Rolf; Reindl, Leonhard M. (2014): Sensortechnik. Handbuch für Praxis und Wissenschaft. 2., völlig neu bearb. Aufl. Berlin: Springer Vieweg (VDI-Buch). Online verfügbar unter http://dx.doi.org/10.1007/978-3-642-29942-1.</li> <li>Webster, John G.; Eren, Halit B. (2014): Measurement, Instrumentation, and Sensors Handbook, Second Edition. Electromagnetic, Optical, Radiation, Chemical, and Biomedical Measurement. 2nd ed. Hoboken: Taylor and Francis. Online verfügbar unter http://gbv.eblib.com/patron/FullRecord.aspx?p=1407945.</li> </ul>

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

Courses				
Title		Тур	Hrs/wk	СР
Fundamentals of Fluid Mechanics (L0091)		Lecture	2	4
Fluid Mechanics for Process Engine		Recitation Section (large)	2	2
Module Responsible				
Admission Requirements	None			
Recommended Previous Knowledge	Mathematics I+II+III			
Kilowieuge	Technical Mechanics I+II			
	<ul> <li>Technical Thermodynamics I+II</li> </ul>			
	<ul> <li>Working with force balances</li> </ul>			
	<ul> <li>Simplification and solving of partial differential</li> </ul>	equations		
	Integration			
Educational Objectives	After taking part successfully, students have reached	the following learning results		
Professional Competence				
Knowledge	Students are able to:			
	explain the difference between different types	of flow		
	<ul> <li>give an overview for different applications of th</li> </ul>		ess engineering	
	<ul> <li>explain simplifications of the Continuity- and N</li> </ul>			ions
Skills	The students are able to			
	<ul> <li>describe and model incompressible flows math</li> </ul>	ematically		
	<ul> <li>reduce the governing equations of fluid mecha</li> </ul>	nics by simplifications to archive quanti	tative solutions e	.g. by integration
	<ul> <li>notice the dependency between theory and technology</li> </ul>	chnical applications		
	<ul> <li>use the learned basics for fluid dynamical appl</li> </ul>	ications in fields of process engineering		
Personal Competence				
Social Competence	The students			
	are capable to gather information from subjec	t related professional publications and	relate that inform	mation to the cont
	of the lecture and	related, professional publications 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 Engl
	(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			
Autonomy				
	<ul> <li>search further literature for each topic and to e</li> </ul>			
	<ul> <li>work on their exercises by their own and to evaluate the evaluation of the evaluation of</li></ul>	aluate their actual knowledge with the fe	eedback.	
Workload in Hours	Independent Study Time 124, Study Time in Lecture	56		
Credit points	6			
Course achievement		scription		
	Yes 5 % Midterm			
Examination				
Examination duration and scale	3 hours			
	General Engineering Science (German program, 7 ser	nostor), Englication Process Engineer	ing Compulsory	
5	General Engineering Science (German program, 7 ser		5 1 5	
. eening carricula	General Engineering Science (German program, 7 ser			
	Bioprocess Engineering: Core Qualification: Compulso		, ,	
	Energy and Environmental Engineering: Core Qualific			
	Green Technologies: Energy, Water, Climate: Core Qu	alification: Compulsory		
	Logistics and Mobility: Specialisation Traffic Planning	and Systems: Elective Compulsory		
	Technomathematics: Specialisation III. Engineering So	cience: Elective Compulsory		
	Process Engineering: Core Qualification: Compulsory			
	Engineering and Management - Major in Logistics and	Mobility: Specialisation Traffic Planning	and Systems: El	ective Compulsory

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

Course L0092: Fluid Mechani	ics for Process Engineering
Тур	Recitation Section (large)
Hrs/wk	2
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. Grundgleichungen, Lösungsmethoden, Softwarebeispiele. Vieweg+ Teubner Verlag / GWV Fachverlage GmbH, Wiesbaden, 2009</li> <li>Schade, H.; Kunz, E.: Strömungslehre. Verlag de Gruyter, Berlin, New York, 2007</li> <li>Truckenbrodt, E.: Fluidmechanik 1: Grundlagen und elementare Strömungsvorgänge dichtebeständiger Fluide. Springer-Verlag, Berlin, Heidelberg, 2008</li> <li>Schlichting, H.: Grenzschicht-Theorie. Springer-Verlag, Berlin, 2006</li> <li>van Dyke, M.: An Album of Fluid Motion. The Parabolic Press, Stanford California, 1882.</li> <li>White, F.: Fluid Mechanics, Mcgraw-Hill, ISBN-10: 0071311211, ISBN-13: 978-0071311212, 2011</li> </ol>

Courses				
Title		Тур	Hrs/wk	СР
Phase Equilibria Thermodynamics (		Lecture	2	2
Phase Equilibria Thermodynamics (		Recitation Section (small)	1	2
Phase Equilibria Thermodynamics (		Recitation Section (large)	1	Z
Module Responsible				
	None			
Recommended Previous Knowledge	Mathematics, Physical Chemistry, Thermodynamics	I and II		
Educational Objectives	After taking part successfully, students have reache	d the following learning results		
Professional Competence				
Knowledge Skills	<ul> <li>Starting from the very basics of thermodyna equilibria.</li> <li>They learn how state variables are influence these properties.</li> <li>Moreover, the students learn how phase equilibria, solid) coexist i</li> <li>For different phase (vapor, liquid, solid) coexist i</li> <li>For different phase equilibria, several exam knowledge for plotting and interpreting the example state and know how to simplify these equation.</li> <li>The students know models which can be used</li> </ul>	ed by the mixing of compounds and learn uilibria can be described mathematically in equilibrium. Furthermore the fundamen uples relevant for different kinds of proc quilibria are taught. able to identify the correct equation for ns meaningfully.	n concepts to qu and which pher tals of reaction e esses are shown the determinatio	uantitatively descr nomena may occu equilibria are taugi n and the necess on of the equilibri
	<ul> <li>The students know models which can be use are able to solve the resulting mathematical a</li> <li>For specific applications, they are able to sel model parameters in literature sources.</li> <li>Beside pure compound properties the student</li> <li>The students know how to visualize phase eq</li> <li>Based on their knowledge, the students a separation and reaction processes in chemical</li> </ul>	relations. f-reliantly find necessary physico-chemica ts are capable of describing the properties uilibria graphically and they know how to re able to understand fundamental cor	I properties of co of mixtures. interpret the occ	ompounds as well urring phenomena
Personal Competence				
Social Competence Autonomy	The students are able to find necessary information self-reliantly in literature sources and to judge their quality.			
	During the semester the students are able knowledge the students can adept their learn	ing process.	nuousiy in exer	cises. Based on
	Independent Study Time 124, Study Time in Lecture	00		
Credit points				
Course achievement				
Examination				
	120 minutes; theoretical questions and calculations			
scale				
-	General Engineering Science (German program, 7 se			
Following Curricula	General Engineering Science (German program, 7 se			-
	General Engineering Science (German program, 7 se	emester): Specialisation Green Technologi	es, Focus Renew	able Energy: Elec
	Compulsory			
	General Engineering Science (German program, 7 se	emester): Specialisation Green Technologi	es, Focus Renew	able Energy: Elec
	Compulsory			
	Bioprocess Engineering: Core Qualification: Compute	Sory		
	Green Technologies: Energy, Water, Climate: Specia	lisation Bioresource Technology: Elective	Compulsory	
	Green Technologies: Energy, Water, Climate: Specia	lisation Energy Systems: Elective Compute	sory	
	Process Engineering: Core Qualification: Compulsory			

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

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

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

Courses				
Title		Тур	Hrs/wk	СР
Bioprocess Engineering - Fundamentals (L0841)		Lecture	2	3
Bioprocess Engineering- Fundamentals (L0842)		Recitation Section (large)	2	1
Bioprocess Engineering - Fundame	ntal Practical Course (L0843)	Practical Course	2	2
Module Responsible	Prof. Andreas Liese			
Admission Requirements	None			
<b>Recommended Previous</b>	none, module "organic chemistry", module '	fundamentals for process engineering"		
Knowledge				
Educational Objectives	After taking part successfully, students have	reached the following learning results		
Professional Competence				
	enzymes and microorganisms, as well as rheology can be named and mass transpo fundamental bioprocess management, steril	epts of bioprocess engineering. They are able to differentiate different types of inhibition rt processes in bioreactors can be explaine ization technology and downstream processin	. The parameters o ed. The students are	of stoichiometry a
Skills	After successful completion of this module,	students should be able to		
	<ul> <li>describe different kinetic approaches for growth and substrate-uptake and to calculate the corresponding parameters</li> <li>predict qualitatively the influence of energy generation, regeneration of redox equivalents and growth inhibition 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 microa to compare them as well as to apply them to current biotechnical problem</li> <li>propose solutions to complicated biotechnological problems and to deduce the corresponding models</li> <li>to explore new knowledge resources and to apply the newly gained contents</li> <li>identify scientific problems with concrete industrial use and to formulate solutions.</li> <li>to document and discuss their procedures as well as results in a scientific manner</li> </ul>		wth inhibition on t	
	take position to their own opinions and incre	should be able to debate technical questions ase their capacity for teamwork in engineerin will be able to solve a technical problem in a	g and scientific envi	ronments.
Workload in Hours	Independent Study Time 96, Study Time in I	ecture 84		
Credit points	6			
Course achievement	Compulsory         Bonus         Form           Yes         5 %         Subject         theoretica           practical work	Description and		
Examination	Written exam			
Examination duration and	90 min			
scale				
Assignment for the	General Engineering Science (German progr	am, 7 semester): Specialisation Process Engir	eering: Compulsory	
		am, 7 semester): Specialisation Process Engin am, 7 semester): Specialisation Bioprocess Er		orv
i onowing curricula	Bioprocess Engineering: Core Qualification:		.gcernig. compulse	
		: Specialisation Bioresource Technology: Elect	ive Compulsory	
		cial Organs and Regenerative Medicine: Comp		
		ants and Endoprostheses: Elective Compulsory	-	
	5 5 1	cal Technology and Control Theory: Elective C		
		gement and Business Administration: Elective C		
	Technomathematics: Specialisation III. Engin	-		
		leering Science: Elective Compulsorv		

Course L0841: Bioprocess En	gineering - Fundamentals
Тур	Lecture
Hrs/wk	2
CP	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Prof. Andreas Liese
Language	DE
Cycle	SoSe
Content	<ul> <li>Introduction: state-of-the-art and development trends in the biotechnology, introduction to the lecture</li> <li>Enzyme kinetics: Michaelis-Menten, differnt types of enzyme inhibition, linearization, conversion, yield, selectivity (Prof. Liese)</li> <li>Stoichiometry: coefficient of respiration, electron balance, degree of reduction, coefficient of yield, theoretical oxygen demand (Prof. Liese)</li> <li>Microbial growth kinetic: batch- and chemostat culture (Prof. Zeng)</li> <li>Kinetic of subtrate consumption and product formation (Prof. Zeng)</li> <li>Rheology: non-newtonian fluids, viscosity, agitators, energy input (Prof. Liese)</li> <li>Transport process in a bioreactor (Prof. Zeng)</li> <li>Fundamentals of bioprocess management: bioreactors and calculation of batch, fed-batch and continuouse bioprocesses (Prof. Zeng/Prof. Liese)</li> <li>Downstream technology in biotechnology: cell breakdown, zentrifugation, filtration, aqueous two phase systems (Prof. Liese)</li> </ul>
Literature	<ul> <li>K. Buchholz, V. Kasche, U. Bornscheuer: Biocatalysts and Enzyme Technology, 2. Aufl. Wiley-VCH, 2012</li> <li>H. Chmiel: 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 Engineering- Fundamentals		
Тур	Recitation Section (large)	
Hrs/wk	2	
СР	1	
Workload in Hours	Independent Study Time 2, Study Time in Lecture 28	
Lecturer	Prof. Andreas Liese	
Language	DE	
Cycle	SoSe	
Content	1. Introduction (Prof. Liese, Prof. Zeng)	
	2. Enzymatic kinetics (Prof. Liese)	
	3. Stoichiometry I + II (Prof. Liese)	
	4. Microbial Kinetics I+II (Prof. Zeng)	
	5. Rheology (Prof. Liese)	
	6. Mass transfer in bioprocess (Prof. Zeng)	
	7. Continuous culture (Chemostat) (Prof. Zeng)	
	8. Sterilisation (Prof. Zeng)	
	9. Downstream processing (Prof. Liese)	
	10. Repetition (Reserve) (Prof. Liese, Prof. Zeng)	
Literature	siehe Vorlesung	

Course L0843: Bioprocess En	ngineering - Fundamental Practical Course
Тур	Practical Course
Hrs/wk	2
СР	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Prof. Andreas Liese, Prof. An-Ping Zeng
Language	DE
Cycle	SoSe
Content	In this course fermentation and downstream technologies on the example of the production of an enzyme by means of a recombinant microorganism is learned. Detailed characterization and simulation of enzyme kinetics as well as application of the enzyme in a bioreactor is carried out. The students document their experiments and results in a protocol.
Literature	Skript

Courses				
Title		Тур	Hrs/wk	СР
Power Industry (L0316)		Lecture	1	1
Energy Systems and Energy Industr	y (L0315)	Lecture	2	2
Renewable Energy (L0313)		Lecture	2	2
Renewable Energy (L1434)		Recitation Section (small)	1	1
-	Prof. Martin Kaltschmitt			
	None			
	none			
Knowledge				
Educational Objectives	After taking part successfully, students have r	eached the following learning results		
Professional Competence				
	distribution and power trading wih regard applicable to many energy systems in gener the students can explain the environmental b		n explain these nd critical discuss	aspects, which a
Skills	<ul> <li>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 t under certain given conditions. Therefore, they can choose the necessary subject-specific calculation rules, also for standardized solutions of a problem.</li> <li>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.</li> </ul>		ally and design the rules, also for r	
Personal Competence				
		echnical alternatives and to assess them with ws them to make an effective contribuition to a		
Autonomy	Students can independently exploit sources questions.	, acquire the particular knowledge about the :	subject area and	transform it to no
Workload in Hours	Independent Study Time 96, Study Time in Le	cture 84		
Credit points	6			
Course achievement				
Examination				
Examination duration and				
scale				
	General Engineering Science (German program	m, 7 semester): Specialisation Process Engineer	ing: Compulsorv	
-		m, 7 semester): Specialisation Process Engineer		
-		ram, 7 semester): Specialisation Mechanical		us Energy Systen
	Elective Compulsory			
	Civil- and Environmental Engineering: Speciali	isation Civil Engineering: Elective Compulsory		
	Civil- and Environmental Engineering: Speciali	isation Traffic and Mobility: Elective Compulsory	,	
	Civil- and Environmental Engineering: Speciali	isation Water and Environment: Elective Compu	lsory	
	Energy and Environmental Engineering: Core	Qualification: Compulsory		

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

Course L1434: Renewable Er	nerav
	Recitation Section (small)
Hrs/wk	
CP	
	Independent Study Time 16, Study Time in Lecture 14
	Prof. Martin Kaltschmitt
Language	
Cycle	
	Students work on different tasks in the field of renewable energies. They present their solutions in the exercise lesson and discuss
	<ul> <li>it with other students and the lecturer.</li> <li>Possible tasks in the field of renewable energies are: <ul> <li>Solar thermal heat</li> <li>Concentrating solare power</li> <li>Photovoltaic</li> <li>Windenergie</li> <li>Hydropower</li> <li>Heat pump</li> <li>Deep geothermal energy</li> </ul> </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>

<b>6</b>	and Mass Transfer			
Courses				
Title		Тур	Hrs/wk	СР
Heat and Mass Transfer (L0101)		Lecture	2 1	2 2
Heat and Mass Transfer (L0102) Heat and Mass Transfer (L1868)		Recitation Section (small) Recitation Section (large)	1	2
	Prof. Irina Smirnova	Reclation Section (arge)	-	L
Module Responsible				
Admission Requirements				
Recommended Previous	5 ,			
Knowledge				
Educational Objectives	After taking part successfully, students have	reached the following learning results		
Professional Competence				
Knowledge		g qualitative and determining quantitative heat t	ransfor in proco	dural apparatus (o
	heat exchanger, chemical reactors).	g quantative and determining quantitative near t		
	-	naracterize different kinds of heat transfer mech	anisms namoly l	hast conduction h
	transfer and thermal radiation.			leat conduction, n
		plain the physical basis for mass transfer in d	lotail and to do	scribo mass tran
			ietali anu to ue	SCIDE mass trans
	qualitative and quantitative by using s		Ballandar	
	<ul> <li>They are able to depict the analogy be</li> </ul>	tween heat- and mass transfer and to describe c	ompiex linked p	rocesses in detail.
Skills				
Skiib		ble system boundaries for a given transport pro	blem by using t	he gained knowle
	and to balance the corresponding energy	gy and mass flow, respectively.		
	They are capable to solve specific he	at transfer problems (e.g. heated chemical reac	tors, temperatur	re alteration in flu
	and to calculate the corresponding her	at flows.		
	Using dimensionless quantities, the stress	udents can execute scaling up of technical proces	sses or apparatu	IS.
		diffusion, convective mass transition and mass t		
		ratus (e.g. extraction column, rectification colum	-	
		le to choose and design fundamental types of he		changer for a spec
				changer for a spec
	application considering their advantag			hua
		eady-state and non-steady-state processes in pro		
		ct their knowledge obtained in this course v	-	
		cs, fluid mechanics and chemical process engi	neering) to solv	/e concrete techn
	problems.			
Personal Competence				
Social Competence	• The students are capable to work on	subject-specific challenges in teams and to pres	opt the reculte	
	<ul> <li>The students are capable to work on manner to tutors and other students.</li> </ul>	subject-specific chanenges in teams and to pres	ent the results of	arally in a reasons
	manner to tutors and other students.			orally in a reasona
				orally in a reasona
				orally in a reasona
				orally in a reasona
4utonomu				orally in a reasona
Autonomy	<ul> <li>The students are able to find and eval</li> </ul>	uate necessary information from suitable sources	5	orally in a reasona
Autonomy	<ul> <li>The students are able to find and evaluation</li> </ul>	uate necessary information from suitable sources r knowledge during the course with accompany		
Autonomy	<ul><li>The students are able to find and evalue</li><li>They are able to prove their level of</li></ul>	,	ing procedure	
Autonomy	<ul><li>The students are able to find and evalue</li><li>They are able to prove their level of</li></ul>	knowledge during the course with accompany	ing procedure	
Autonomy	<ul><li>The students are able to find and evalue</li><li>They are able to prove their level of</li></ul>	knowledge during the course with accompany	ing procedure	
	<ul> <li>The students are able to find and evalue.</li> <li>They are able to prove their level of system, exam-like assignments) and one of the system.</li> </ul>	knowledge during the course with accompany n this basis they can control their learning proce	ing procedure	
Workload in Hours	<ul> <li>The students are able to find and evaluation</li> <li>They are able to prove their level of system, exam-like assignments) and on a system study Time 124, Study Time in a system.</li> </ul>	knowledge during the course with accompany n this basis they can control their learning proce	ing procedure	
Workload in Hours Credit points	<ul> <li>The students are able to find and evaluation</li> <li>They are able to prove their level of system, exam-like assignments) and on the system study Time 124, Study Time in 6</li> </ul>	knowledge during the course with accompany n this basis they can control their learning proce	ing procedure	
Workload in Hours Credit points Course achievement	The students are able to find and evalue     They are able to prove their level of system, exam-like assignments) and o     Independent Study Time 124, Study Time in     6     None	knowledge during the course with accompany n this basis they can control their learning proce	ing procedure	
Workload in Hours Credit points Course achievement Examination	The students are able to find and evaluations     They are able to prove their level of system, exam-like assignments) and of system exam-like assignments and of the system for the system for the system of the system exameter of the system examete	knowledge during the course with accompany n this basis they can control their learning proce Lecture 56	ing procedure	
Workload in Hours Credit points Course achievement Examination	The students are able to find and evalue     They are able to prove their level of system, exam-like assignments) and o     Independent Study Time 124, Study Time in     6     None	knowledge during the course with accompany n this basis they can control their learning proce Lecture 56	ing procedure	
Workload in Hours Credit points Course achievement Examination	The students are able to find and evaluations of the students are able to prove their level of system, exam-like assignments) and of the system study Time 124, Study Time in 6 None Written exam 120 minutes; theoretical questions and calculated study are study to study the study to study to study the study to study the study to study the study to study to study to study the study to study the study to stu	knowledge during the course with accompany n this basis they can control their learning proce Lecture 56	ing procedure	
Workload in Hours Credit points Course achievement Examination Examination duration and	The students are able to find and evalue     They are able to prove their level of system, exam-like assignments) and o Independent Study Time 124, Study Time in 6 None Written exam 120 minutes; theoretical questions and calcue	knowledge during the course with accompany n this basis they can control their learning proce Lecture 56	ving procedure sses.	continuously (click
Workload in Hours Credit points Course achievement Examination Examination duration and scale	The students are able to find and evalue     They are able to prove their level of system, exam-like assignments) and o     Independent Study Time 124, Study Time in     6     None     Written exam     120 minutes; theoretical questions and calcue     General Engineering Science (German programe)	knowledge during the course with accompany n this basis they can control their learning proce Lecture 56	ving procedure sses.	continuously (click
Workload in Hours Credit points Course achievement Examination Examination duration and scale Assignment for the	The students are able to find and evalue     They are able to prove their level of system, exam-like assignments) and o     Independent Study Time 124, Study Time in     6     None     Written exam     120 minutes; theoretical questions and calcue     General Engineering Science (German programe)	knowledge during the course with accompany n this basis they can control their learning proces Lecture 56 lations m, 7 semester): Specialisation Process Engineer	ving procedure sses.	continuously (click
Workload in Hours Credit points Course achievement Examination Examination duration and scale Assignment for the	The students are able to find and evalue     They are able to prove their level of system, exam-like assignments) and o     system, exam-like assignments) and o     Independent Study Time 124, Study Time in     6     None     Written exam     120 minutes; theoretical questions and calcue     General Engineering Science (German progra     General E	knowledge during the course with accompany n this basis they can control their learning proces Lecture 56 lations m, 7 semester): Specialisation Process Engineeri m, 7 semester): Specialisation Bioprocess Engineeri	ving procedure sses. ing: Compulsory eering: Compuls es: Compulsory	continuously (click
Workload in Hours Credit points Course achievement Examination Examination duration and scale Assignment for the	The students are able to find and evalue     They are able to prove their level of system, exam-like assignments) and o Independent Study Time 124, Study Time in 6 None Written exam 120 minutes; theoretical questions and calcue General Engineering Science (German progra General	knowledge during the course with accompany n this basis they can control their learning proces Lecture 56 lations m, 7 semester): Specialisation Process Engineeri m, 7 semester): Specialisation Bioprocess Engine m, 7 semester): Specialisation Green Technologi m, 7 semester): Specialisation Green Technologi	ving procedure sses. ing: Compulsory eering: Compuls es: Compulsory	continuously (click
Workload in Hours Credit points Course achievement Examination Examination duration and scale Assignment for the	The students are able to find and evalue     They are able to prove their level of system, exam-like assignments) and of system, exam-like assignments) and of a system, exam-like assignments) and of a system, exam-like assignments and constrained by the system and constraned by the system and constrained by the system and constrained b	knowledge during the course with accompany n this basis they can control their learning proces Lecture 56 num, 7 semester): Specialisation Process Engineeri m, 7 semester): Specialisation Bioprocess Engine m, 7 semester): Specialisation Green Technologi m, 7 semester): Specialisation Green Technologi m, 7 semester): Specialisation Energy and Enviro ompulsory	ving procedure sses. ing: Compulsory eering: Compuls es: Compulsory	continuously (click
Workload in Hours Credit points Course achievement Examination Examination duration and scale Assignment for the	The students are able to find and evalue     They are able to prove their level of system, exam-like assignments) and of system, exam-like assignments) and of a system, exam-like assignments) and of a system, exam-like assignments and complexity of the system and the system andet as a system and the system and the system and the system ande	knowledge during the course with accompany n this basis they can control their learning proces Lecture 56 num, 7 semester): Specialisation Process Engineeri m, 7 semester): Specialisation Bioprocess Engine m, 7 semester): Specialisation Green Technologi m, 7 semester): Specialisation Green Technologi m, 7 semester): Specialisation Energy and Enviro ompulsory Qualification: Compulsory	ving procedure sses. ing: Compulsory eering: Compuls es: Compulsory pomental Enginee	continuously (click
Workload in Hours Credit points Course achievement Examination Examination duration and scale Assignment for the	The students are able to find and evalu     They are able to prove their level of system, exam-like assignments) and o     Independent Study Time 124, Study Time in     6     None     Written exam     120 minutes; theoretical questions and calcu     General Engineering Science (German progra     General Engineering: Core Qualification: C     Energy and Environmental Engineering: Core     General Engineering Science (English program	knowledge during the course with accompany n this basis they can control their learning proces Lecture 56 num, 7 semester): Specialisation Process Engineeri m, 7 semester): Specialisation Bioprocess Engine m, 7 semester): Specialisation Green Technologi m, 7 semester): Specialisation Energy and Enviro ompulsory Qualification: Compulsory n, 7 semester): Specialisation Bioprocess Engine	ving procedure sses. ing: Compulsory eering: Compuls es: Compulsory pomental Enginee ering: Compulsory	continuously (click
Workload in Hours Credit points Course achievement Examination Examination duration and scale Assignment for the	The students are able to find and evalu     They are able to prove their level of system, exam-like assignments) and o     Independent Study Time 124, Study Time in     A     None     Written exam     120 minutes; theoretical questions and calcu     General Engineering Science (German progra     General Engineering Science (English program     General Engineering Science (English program	knowledge during the course with accompany n this basis they can control their learning proces Lecture 56 num, 7 semester): Specialisation Process Engineeri m, 7 semester): Specialisation Bioprocess Engine m, 7 semester): Specialisation Green Technologi m, 7 semester): Specialisation Energy and Enviro ompulsory Qualification: Compulsory n, 7 semester): Specialisation Bioprocess Engine m, 7 semester): Specialisation Energy and Enviro	ving procedure sses. ing: Compulsory eering: Compuls es: Compulsory pomental Enginee ering: Compulsory	continuously (click
Workload in Hours Credit points Course achievement Examination Examination duration and scale Assignment for the	The students are able to find and evalu     They are able to prove their level of system, exam-like assignments) and o     Independent Study Time 124, Study Time in     A     None     Written exam     120 minutes; theoretical questions and calcu     General Engineering Science (German progra     General Engineering Science (English progra     General Engineering Scie	knowledge during the course with accompany n this basis they can control their learning proces Lecture 56 normality of the second secon	ving procedure sses. ing: Compulsory eering: Compuls es: Compulsory pomental Enginee ering: Compulsory	continuously (click
Workload in Hours Credit points Course achievement Examination Examination duration and scale Assignment for the	The students are able to find and evalu     They are able to prove their level of system, exam-like assignments) and o     Independent Study Time 124, Study Time in     A     None     Written exam     120 minutes; theoretical questions and calcu     General Engineering Science (German progra     General Engineering Science (English program     General Engineering Science (English program	knowledge during the course with accompany n this basis they can control their learning proces Lecture 56 num, 7 semester): Specialisation Process Engineeri m, 7 semester): Specialisation Bioprocess Engine m, 7 semester): Specialisation Green Technologi m, 7 semester): Specialisation Energy and Enviro ompulsory Qualification: Compulsory n, 7 semester): Specialisation Bioprocess Engine n, 7 semester): Specialisation Process Engine n, 7 semester): Specialisation Process Engineeri n, 7 semester): Specialisation Process Engineeri Core Qualification: Compulsory	ving procedure sses. ing: Compulsory eering: Compuls es: Compulsory pomental Enginee ering: Compulsory	continuously (click

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

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

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

Courses				
Title		Тур	Hrs/wk	СР
Thermal Separation Processes (L01		Lecture	2	2
Thermal Separation Processes (LO1		Recitation Section (small)	2	2 1
Thermal Separation Processes (L01 Separation Processes (L1159)	41)	Recitation Section (large) Practical Course	1	1
Module Responsible	Prof. Irina Smirnova			
Admission Requirements	None			
<b>Recommended Previous</b>	Recommended requirements: Thermodynamics III			
Knowledge				
Educational Objectives	After taking part successfully, students have reached	the following learning results		
Professional Competence				
Knowledge				
	<ul> <li>The students can distinguish and describe of adsorption</li> <li>The students develop an understanding for the energy demand of a process, the possibilities of the the theory have good knowledge of designing methesis and the theory of the theory and the theory of the theor</li></ul>	ne course of concentration during a s of energy saving, and the selection of	eparation process, separation systems	the estimation of t
Skills	<ul> <li>Using the gained knowledge the students can close the associated energy and material bala</li> <li>The students can use different graphical metheoretical stages required</li> <li>They can select and design a basic type of disadvantages of the process</li> <li>The students are capable to obtain independentables)</li> <li>They can calculate continuous and discontinuous</li> <li>The students are able to prove their theoretica</li> <li>The students are able to discuss the theoretica</li> <li>The students are able to discuss the theoretica</li> </ul>	nces ethods for the designing of a separa thermal separation process for a giv ently the needed material properties bus processes al knowledge in the experimental lab	ition process and d ven case based on from appropriate so work.	lefine the amount the advantages a purces (diagrams a
Personal Competence Social Competence	technical problems. Other lectures such as thermody <ul> <li>The students can work technical assignments</li> </ul>			utorial
Autonomy	<ul> <li>The students are able to carry out practical l them. They are able to discuss their results an</li> <li>The students are capable to obtain the needed</li> <li>The students can proof the state of their ke learning process</li> </ul>	nd to document them scientifically in a	report. / themselves and as	sess their quality
Workload in Hours	Independent Study Time 96, Study Time in Lecture 8	4		
Credit points	6			
Course achievement	None			
Examination				
Examination duration and scale	120 minutes; theoretical questions and calculations			
Scule	General Engineering Science (German program, 7 se General Engineering Science (German program, 7 se		gineering: Compulso	-
	Compulsory General Engineering Science (German program, 7 Compulsory General Engineering Science (German program, 7 Bioprocess Engineering: Core Qualification: Compulsor Energy and Environmental Engineering: Core Qualific General Engineering Science (English program, 7 sen General Engineering Science (English program, 7 sen General Engineering Science (English program, 7 sen	mester): Specialisation Energy and Er ory cation: Elective Compulsory mester): Specialisation Bioprocess Eng mester): Specialisation Energy and En	viromental Enginee jineering: Compulso viromental Engineer	ring: Compulsory ry

Process Engineering: Core Qualification: Compulsory

L

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	
Content	
Literature	<ul> <li>G. Brunner: Skriptum Thermische Verfahrenstechnik</li> <li>J. King: Separation Processes, McGraw-Hill, 2. Aufl. 1980</li> <li>Sattler: Thermische Trennverfahren, VCH, Weinheim 1995</li> <li>J.D. Seader, E.J. Henley: Separation Process Principles, Wiley, New York, 1998.</li> <li>Mersmann: Thermische Verfahrenstechnik, Springer, 1980</li> <li>Grassmann, Widmer, Sinn: Einführung in die Thermische Verfahrenstechnik, 3. Aufl., Walter de Gruyter, Berlin 1997</li> <li>Brunner, G.: Gas extraction. An introduction to fundamentals of supercritical fluids and the application to separation processes. Steinkopff, Darmstadt; Springer, New York; 1994. ISBN 3-7985-0944-1; ISBN 0-387-91477-3.</li> <li>R. Goedecke (Hrsg.): Fluid-Verfahrenstechnik, Wiley-VCH Verlag, Weinheim, 2006.</li> <li>Perry"s Chemical Engineers" Handbook, R.H. Perry, D.W. Green, J.O. Maloney (Hrsg.), 6th ed., McGraw-Hill, New York 1984 Ullmann"s Enzyklopädie der Technischen Chemie</li> </ul>

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

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

se L1159: Separation Pr		
	Practical Course	
Hrs/wk		
CP	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 colloquiu takes place in which the students explain and discuss the theoretical background and its translation into practice with staff an fellow students. The students work small groups with a high degree of division of labor. For every experiment, the students write a report. The receive instructions in terms of scientific writing as well as feedback on their own reports and level of scientific writing so they ca 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 processes</li> <li>Advance overview of separation processes</li> <li>Selection of separation processes</li> </ul>	
Literature	<ul> <li>G. Brunner: Skriptum Thermische Verfahrenstechnik</li> <li>J. King: Separation Processes, McGraw-Hill, 2. Aufl. 1980</li> <li>Sattler: Thermische Trennverfahren, VCH, Weinheim 1995</li> <li>J.D. Seader, E.J. Henley: Separation Process Principles, Wiley, New York, 1998.</li> <li>Mersmann: Thermische Verfahrenstechnik, Springer, 1980</li> <li>Grassmann, Widmer, Sinn: Einführung in die Thermische Verfahrenstechnik, 3. Aufl., Walter de Gruyter, Berlin 1997</li> <li>Brunner, G.: Gas extraction. An introduction to fundamentals of supercritical fluids and the application to separatic processes. Steinkopff, Darmstadt; Springer, New York; 1994. ISBN 3-7985-0944-1; ISBN 0-387-91477-3.</li> <li>R. Goedecke (Hrsg.): Fluid-Verfahrenstechnik, Wiley-VCH Verlag, Weinheim, 2006.</li> <li>Perry"s Chemical Engineers" Handbook, R.H. Perry, D.W. Green, J.O. Maloney (Hrsg.), 6th ed., McGraw-Hill, New York 198. Ullmann"s Enzyklopädie der Technischen Chemie</li> </ul>	

Module M0892: Chem	ical Reaction Engineering				
Courses					
Title		Тур	)	Hrs/wk	СР
Chemical Reaction Engineering (Fundamentals) (L0204)		Lect		2	2
Chemical Reaction Engineering (Fundamentals) (L0204)		Reci	itation Section (large)	2	2
Experimental Course Chemical Eng	ineering (Fundamentals) (L0221)	Prac	tical Course	2	2
Module Responsible	Prof. Raimund Horn				
Admission Requirements	None				
<b>Recommended Previous</b>	Contents of the previous modules mathematics I-III, physical chemistry, technical thermodynamics I+II as well as computationa				
Knowledge	methods for engineers.				
Educational Objectives	After taking part successfully, students have	reached the following le	arning results		
Professional Competence					
Knowledge	The students are able to explain basic conce	pts of chemical reactior	engineering. They are	able to point out	differences betweer
	thermodynamical and kinetical processes. T	he students have a stro	ong ability to outline pa	rts of isotherma	l and non-isotherma
	ideal reactors and to describe their properties	5.			
Skills	After successful completion of the module, st	udents are able to:			
	- apply different computational methods to di	mension isothermal and	l non-isothermal ideal re	actors,	
	- determine and compute stable operation po	ints for these reactors ,			
	- conduct experiments on a lab-scale pilot pla	ints and document these	e according to scientific o	guidelines.	
Personal Competence					
-	After successful completition of the lab-course the students have a strong ability to organize themselfes in small groups to solve				
,	issues in chemical reaction engineering. The				
	their teachers.		-		
Autonomy	The students are able to obtain further i	information and assess	their relevance autor	nomously. Stude	nts can apply thei
	knowldege discretely to plan, prepare and co	nduct 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				
Examination	Written exam				
Examination duration and	120 min				
scale					
Assignment for the	General Engineering Science (German progra	m, 7 semester): Special	isation Process Engineer	ing: Compulsory	
Following Curricula	General Engineering Science (German progra	m, 7 semester): Special	isation Bioprocess Engin	eering: Compulso	ory
	Bioprocess Engineering: Core Qualification: Co	ompulsory			
	General Engineering Science (English program	m, 7 semester): Specialis	sation Bioprocess Engine	ering: Compulso	ry
	General Engineering Science (English program	n, 7 semester): Specialis	sation Process Engineeri	ng: Compulsory	
	Green Technologies: Energy, Water, Climate:	Specialisation Bioresour	rce Technology: Elective	Compulsory	
	Process Engineering: Core Qualification: Com	pulsory			

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

	equation, activation energy and pre-exponential factor for komplex reactions, reactions of 0., 1. and 2. order, analytical integration of rate laws, Damköhler-number, differential and integral method of kinetic analysis, laboratory reactors for kinetic measurements, half life, kinetics of complex reactions, parallel reactions, reversible reactions, sequence of reactions, irreversible reaction with pre- equilibrium, reduction of reaction mechanisms, quasi-stationarity principle of Bodenstein, rate limiting step, Michaelis-Menten kinetics, analytical integration of first order differential equations - integrating factor, numerical integration of complex kinetics) Types of chemical Reaktors (chemical reactors in industry and laboratory, ideal vs. real reaktors, discontinuous, half continuous and continuous reactors, single phase - biphasic- and multiphase reactors, batch-reactor, semi-batch reactor, CSTR, Plug Flow reactor, fixed bed reactor, adiabatic staged reactors, rotating furnaces, fluidized bed reactors, integration of the batch reactor mole balance for various kinetics, partial fraction decomposition, mole balance of a batch reactor, mole balance of the plug flow reactor, analogy batch reactor - plug flow reactor, design of plug flow reactors for reactions with volume change and complex reactions, mole balance of a fixed bed reactor, design of a membrane reactor, mole balance of a continuously stirred tank reactor, comparison of CSTR and PFR with respect to conversion and selectivity, mole-balance of a cascade of tank reactors) non-isothermal ideal reactors (energy balance of a reactor, adiabatic reactor, adiabatic temperature rise, staged reactor for adiabatic exothermic reactions limited by chemical equilibrium, design of an adiabatic plug flow reactor, Levenspiel-plots, heat transfer through a reactor wall, heat transfer by convection, heat conduction, heat transfer through a cylindrical wall, design of a plug flow reactor in parallel and counter flow, heat balance of the cooling fluid, CSTR with heat e
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, rireversible reaction with pre-equilibrium, reduction of reaction mechanisms, quasi-stationarity principle of Bodenstein, rate limiting step, Michaelis-Menten kinetics, analytical integration of first order differential equations - integrating factor, numerical integration of complex kinetics) Types of chemical Reaktors (chemical reactors in industry and laboratory, ideal vs. real reaktors, discontinuous, half continuous and continuous reactor, single phase - biphasic- and multiphase reactors, batch-reactor, semi-batch reactor, CSTR, Plug Flow reactor, fixed bed reactor, adiabatic staged reactors, rotating furnaces, fluidized bed reactor, integration of the batch reactor mole balance for various kinetics, partial fraction decomposition, mole balance of a batch reactor, mole balance of the balance of the plug flow reactor, design of plug flow reactors for reactions with volume change and
Literature	comparison of CSTR and PFR with respect to conversion and selectivity, mole-balance of a cascade of tank reactors, numerical- interative calculation of a cascade of tank reactors, Newton-Raphson method, graphical analysis of a cascade of tank reactors) non-isothermal ideal reactors (energy balance of a reactor, adiabatic reactor, adiabatic temperature rise, staged reactor for adiabatic exothermic reactions limited by chemical equilibrium, design of an adiabatic plug flow reactor, Levenspiel-plots, heat transfer through a reactor wall, heat transfer by convection, heat conduction, heat transfer through a cylindrical wall, design of a plug flow reactor in parallel and counter flow, heat balance of the cooling fluid, CSTR with heat exchange, multiple stationary states, ignition-extinction behavior, stability of a CSTR, complex reactions in non-isothermal reactors, optimum temperature profile of a reactor)
	skript Frerich Keil Books: M. Baerns, A. Behr, A. Brehm, J. Gmehling, H. Hofmann, U. Onken, A. Renken, Technische Chemie, Wiley-VCH G. Emig, E. Klemm, Technische Chemie, Springer A. Behr, D. W. Agar, J. Jörissen, Einführung in die Technische Chemie E. Müller-Erlwein, Chemische Reaktionstechnik 2012, 2. Auflage, Teubner Verlag J. Hagen, Chemiereaktoren: Auslegung und Simulation, 2004, Wiley-VCH H. S. Fogler, Elements of Chemical Reaction Engineering, Prentice Hall B
	<ul> <li>H. S. Fogler, Essentials of Chemical Reaction Engineering, Prentice Hall</li> <li>O. Levenspiel, Chemical Reaction Engineering, John Wiley &amp; Sons, 1998</li> <li>L. D. Schmidt, The Engineering of Chemical Reactions, Oxford Univ. Press, 2009</li> <li>J. B. Butt, Reaction Kinetics and Reactor Design, 2000, Marcel Dekker</li> <li>R. Aris, Elementary Chemical Reactor Analysis, Dover Pubn. Inc., 2000</li> <li>M. E. Davis, R. J. Davis, Fundamentals of Chemical Reaction Engineering, McGraw Hill</li> <li>G. F. Froment, K. B. Bischoff, J. De Wilde, Chemical Reactor Analysis and Design, John Wiley &amp; Sons, 2010</li> <li>A. Jess, P. Wasserscheid, Chemical Technology An Integrated Textbook, WILEY-VCH</li> </ul>

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

Module M1275: Envir	onmental Tech	nology				
-						
Courses						
Title			<b>Typ</b> Practical Course	Hrs/wk	<b>CP</b> 1	
Practical Exercise Environmental Te Environmental Technologie (L0326			Lecture	2	2	
Module Responsible	1	i++	Lecture	2	2	
Admission Requirements						
Recommended Previous		ganic/organic chemistry	and biology			
Knowledge		game/organic chemistry	and blology			
5	After taking part succ	essfully students have r	reached the following learning results			
Professional Competence	Arter taking part succ	essivity, scuterits have i	eached the following learning results			
-	With the completion (	of this modul the student	ts obtain profound knowledge of enviro	nmental technology. They	are able to describ	
Kilowieuge			nt. Students can give an overview of s			
		em to related methods.	in statents can give an overview of s		ea. mey can exple	
Skills	Students are able to	propose appropriate m	anagement and mitigation measures	for environmental probler	ms. They are able	
	-		ssess the potential of pollutants to mi	-		
			onmental Technology contributes to su	istainable development, a	and they can prese	
	and defend these opi	nons in front of and agai	nst the group.			
Personal Competence						
Social Competence	The students are able	to discuss the various to	echnical and scientific tasks, both subje	ect-specific and multidisci	plinary. They are al	
	to develop different a	pproaches to the task as	s a group as well as to discuss their the	oretical or practical imple	mentation.	
Autonomy	Students can indeper	idently exploit sources a	bout of the subject, acquire the particu	lar knowledge and tranfer	r it to new problems	
Workload in Hours	Independent Study Ti	me 48, Study Time in Le	cture 42			
Credit points	3					
Course achievement	Compulsory Bonus	Form	Description			
	Yes None	Subject theoretical	and			
		practical work				
	Written exam					
Examination duration and	1 hour					
scale						
-			m, 7 semester): Specialisation Process			
Following Curricula			m, 7 semester): Specialisation Bioproce			
	General Engineering Science (German program, 7 semester): Specialisation Energy and Enviromental Engineering: Compulsory Bioprocess Engineering: Core Qualification: Elective Compulsory					
		-				
	5,	5 5	Qualification: Compulsory			
	General Engineering Science (English program, 7 semester): Specialisation Bioprocess Engineering: Elective Compulsory					
	General Engineering Science (English program, 7 semester): Specialisation Energy and Enviromental Engineering: Compulsory General Engineering Science (English program, 7 semester): Specialisation Process Engineering: Elective Compulsory					
				ingineering: Elective Com	puisory	
	Process Engineering:	Core Qualification: Election	ive compulsory			

Course L1387: Practical Exer	cise Environmental Technology
Тур	Practical Course
Hrs/wk	1
СР	1
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14
Lecturer	Prof. Martin Kaltschmitt, Dr. Isabel Höfer
Language	DE
Cycle	SoSe
Content	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	I Technologie
Тур	Lecture
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Prof. Martin Kaltschmitt, Dr. Isabel Höfer
Language	DE
Cycle	WiSe
Content	<ol> <li>Introductory seminar on environmental science:</li> <li>Environmental impact and adverse effects</li> <li>Wastewater technology</li> <li>Air pollution control</li> <li>Noise protection</li> <li>Waste and recycling management</li> <li>Soil and ground water protection</li> <li>Renewable energies</li> <li>Resource conservation and energy efficiency</li> </ol>
Literature	Förster, U.: Umweltschutztechnik; 2012; Springer Berlin (Verlag) 8., Aufl. 2012; 978-3-642-22972-5 (ISBN)

Courses				
Title		Тур	Hrs/wk	СР
Environmental Assessment (L0860)		Lecture	2	2
Environmental Assessment (L1054)		Recitation Section (small)	1	1
Module Responsible	Prof. Martin Kaltschmitt			
Admission Requirements	None			
<b>Recommended Previous</b>	Fundamentals of inorganic/organic chemistry a	nd biology		
Knowledge				
Educational Objectives	After taking part successfully, students have re	ached the following learning results		
Professional Competence				
Knowledge	With the completion of this module the stu environmental problems which might occur fro about the methodological diversity and are con impacts. Besides the students are able to estin difficulties with their measurement.	om production processes, projects or constru- mpetent in dealing with different methods an	uction measures. The instruments to	They have knowled assess environmen
Skills	The students are able to select a suitable method for the respective case from the variety of assessment methods. Thereby the can develop suitable solutions for managing and mitigating environmental problems in a business context. They are able to can out Life Cycle Impact Assessments independently and can apply the software programs OpenLCA and the database Econvert After finishing the course the students have the competence to critically judge research results or other publications environmental impacts.			
Personal Competence				
Social Competence	The students are able to discuss the various te to develop jointly different solutions and to topics, the students receive insights into the m Their sensitivity and consciousness towards t social responsibilities in their role as engineers	discuss their theoretical or practical implem nulti-layered issues of the environment prote hese subjects are raised and which helps t	nentation. Due to ection and the con	the selected lectu cept of sustainabili
Autonomy	The students learn to research, process and scientific work. They can solve an environment			
Workload in Hours	Independent Study Time 48, Study Time in Lec	ture 42		
Credit points				
Course achievement				
Examination				
Examination duration and scale				
	Conoral Engineering Science (Cormon and	7 competer), Charlestian Presses Frank	oring, Elective Co	mulcon
-	General Engineering Science (German program		-	
ronowing curricula	a General Engineering Science (German program, 7 semester): Specialisation Bioprocess Engineering: Elective Compulsory General Engineering Science (German program, 7 semester): Specialisation Energy and Enviromental Engineering: Compulsory			
	Bioprocess Engineering: Core Qualification: Ele		Lighter	
	Energy and Environmental Engineering: Core Q			
	General Engineering Science (English program,		neering: Elective (	Compulsory
	General Engineering Science (English program, General Engineering Science (English program,	7 semester): Specialisation Process Enginee	ring: Elective Com	pulsory

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

Course L0860: Environmenta	I Assessment					
Тур	Lecture					
Hrs/wk	2					
СР	2					
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28					
Lecturer	Dr. Anne Rödl, Dr. Christoph Hagen Balzer					
Language	DE/EN					
Cycle	WiSe					
Content	Contaminants: Impact- and Risk Assessment					
	Environmental damage & precautionary principle: Environmental Risk Assessment (ERA)					
	Resource and water consumption: Material flow analysis					
	ergy consumption: Cumulated energy demand (CED), cost analysis e cycle concept: Life cycle assessment (LCA)					
	stainability: Comprehensive product system assessment , SEE-Balance					
	anagement: 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
CP	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

Courses						
Title				Тур	Hrs/wk	СР
Process and Plant Engineering I (L0095)				Lecture	2	2
Process and Plant Engineering I (L0096) Process and Plant Engineering I (L1214)				Recitation Section (large) Recitation Section (small)	1	2
Module Responsible				vectation section (smail)	T	Z
	None	KI				
Admission Requirements Recommended Previous		mal an dmochanical con	aration processos			
Kecommended Previous	unic operation of them	mal an dmechanical sepa	aración processes			
Knowledge	chemical reactor eingi	ineering				
Educational Objectives	After taking part succe	essfully, students have r	eached the following	g learning results		
<b>Professional Competence</b>						
Knowledge	students can:					
	classify and formulate	blobal balance equation	ns of chemical proce	sses		
	specify linear compone	ent equations of comple	x chemical process	25		
	explain linear regression and data reconcilliation problems					
	explain pfd-diagrams					
Skills	s students are capable of					
	- formulation of mass and energy balance equations and estimation of product streams					
	- estimation of component streams of chemical plants using linear component balance models					
	- solution of data reconcilliation tasks					
	- conduction of process synthesis					
	- economic evaluation	of processes and the es	timation of product	on costs		
Personal Competence						
Social Competence						
Autonomy						
Workload in Hours	Independent Study Tin	me 124, Study Time in L	ecture 56			
Credit points	6					
Course achievement	Compulsory Bonus	Form	Description			
	Yes 10 %	Subject theoretical	and			
		practical work				
Examination		a and heals				
Examination duration and scale	120 Min. lectures note	es and books				
Assignment for the	General Engineering S	cience (German program	n 7 comostor): Sno	cialisation Process Engineer	ing: Compulsory	
Following Curricula				cialisation Bioprocess Engineer		orv
i onowing curricula		ig: Core Qualification: Co		elanoution proprocess Eligin	compulse	
				ialisation Bioprocess Engine	erina: Compulso	rv
				Specialisation Energy and		-
	Compulsory	seconde (English progr	an, / semester).	specialisation Energy and	Livitomental L	
		Science (English program	1. 7 semester): Spec	ialisation Process Engineeri	na: Compulsory	
				ource Technology: Elective		
	Process Engineering: (			is a rectificition of the rectifice	compaisory	

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

	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)
	<ol> <li>Process safety</li> <li>Cost estimation of production plants         Production costs, capital costs, economic evaluation     </li> </ol>
Literature	S.D. Barnicki, J.R. Fair, Ind. End. Chem., 29(1990), S. 421, Ind. End. Chem., 31(1992), S. 1679
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	M. H. Bauer, J. Stichlmair, ChemIngTech., 68(1996), Nr. 8, 911-916
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	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
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	H.J. Lang, Chem. Eng. 54(10),117, 1947
	H.J. Lang, Chem. Eng. 55(6), 112, 1948
	F. Lestak, C. Collins, Chemical Engineering, July 1997, S. 72-76

Course L0096: Process and P	urse L0096: Process and Plant Engineering I			
Тур	Recitation Section (large)			
Hrs/wk	1			
CP	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 F	purse 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	Mirko Skiborowski, Dr. Thomas Waluga			
Language	DE			
Cycle	SoSe			
Content	See interlocking course			
Literature	See interlocking course			

Courses						
Title			Тур	Hrs/wk	СР	
Particle Technology I (L0434)			Lecture	2	3	
Particle Technology I (L0435)			Recitation Section (sma	all) 1	1	
Particle Technology I (L0440)			Practical Course	2	2	
Module Responsible	Prof. Stefan Heinric	h				
Admission Requirements	None					
<b>Recommended Previous</b>	keine					
Knowledge						
Educational Objectives	After taking part su	ccessfully, students have	reached the following learning results			
Professional Competence						
Knowledge	After successful cor	mpletion of the module stu	idents are able to			
	• name and ex	valain processes and unit	anarations of solids process anginearing			
			operations of solids process engineering, tions and to discuss their bulk properties			
	• characterize	particles, particle distribu	tions and to discuss their burk properties			
Skille	Students are able to	0				
SKIIIS	Students are able to	0				
	choose and design apparatuses and processes for solids processing according to the desired solids properties of the produ					
	<ul> <li>asses solids</li> </ul>	with respect to their behav	vior in solids processing steps			
	<ul> <li>document th</li> </ul>	eir work scientifically.				
Personal Competence						
	The students are a	able to discuss scientific t	opics orally with other students or scie	ntific norconal and to	dovelop colutions	
Social Competence	technical-scientific		opics orany with other students of scie	tille personal and to	develop solutions	
Autonomy			ons regarding solid particles independent	-14		
Autonomy	Students are able t	o analyze and solve quest		iy.		
Workload in Hours	Independent Study	Time 110, Study Time in I	Lecture 70			
Credit points	6					
Course achievement	Compulsory Bonus	Form	Description			
	Yes None	Written elaboration	sechs Berichte (pro Versuch ein Be	icht) à 5-10 Seiten		
Examination	Written exam					
Examination duration and	90 minutes					
scale						
Assignment for the	General Engineerin	g Science (German progra	m, 7 semester): Specialisation Process Er	gineering: Compulsory		
Following Curricula	General Engineerin	g Science (German progra	m, 7 semester): Specialisation Bioprocess	Engineering: Compuls	ory	
	General Engineering Science (German program, 7 semester): Specialisation Green Technologies, Focus Water and Environmental					
	Engineering: Elective Compulsory					
	General Engineering Science (German program, 7 semester): Specialisation Energy and Enviromental Engineering: Compulsory					
	Bioprocess Engineering: Core Qualification: Compulsory					
	Energy and Environ	nmental Engineering: Core	ualification: Elective Compulsory			
	General Engineerin	eral Engineering Science (English program, 7 semester): Specialisation Bioprocess Engineering: Compulsory				
	General Engineerin	g Science (English prograr	n, 7 semester): Specialisation Energy and	Enviromental Enginee	ring: Compulsory	
	General Engineerin	g Science (English prograr	n, 7 semester): Specialisation Process Eng	jineering: Compulsory		
	Green Technologies	s: Energy, Water, Climate:	Specialisation Water: Elective Compulsor	Y		

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

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

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

Courses						
Courses				_		
Title	Programming Concents	Data Uandling & Communicati	an (12680)	<b>Typ</b> Lecture	Hrs/wk 3	<b>СР</b> 3
Computer Science for Engineers - P Computer Science for Engineers - P				Recitation Section (small)	2	3
Module Responsible			011 (22050)	Recitation Section (Smail)	-	5
Admission Requirements	None					
Recommended Previous	None					
Knowledge						
Educational Objectives	After taking part succ	essfully, students have rea	chod the follow	ing loarning rocults		
Professional Competence	Arter taking part succ	essiully, students nave rea		ing learning results		
Knowledge						
Skills						
JKIIIS						
Personal Competence						
Social Competence						
Autonomy						
Workload in Hours	Independent Study Ti	ime 110, Study Time in Lec	ture 70			
Credit points	6					
Course achievement	Compulsory Bonus	Form	Description			
	No 10 %	Attestation	Testate find	en semesterbegleitend statt.		
Examination						
Examination duration and	120 min					
scale		a.) (a				
Assignment for the		Science (German progra	m, 7 semeste	er): Specialisation Mechanica	I Engineering, F	ocus Biomechani
Following Curricula	Compulsory					
				pecialisation Process Engineer		
	General Engineering	Science (German program,	7 semester): S	pecialisation Biomedical Engin	eering: Compulso	ory
	General Engineering	Science (German program,	7 semester): S	pecialisation Green Technolog	ies, Focus Renew	able Energy: Elect
	Compulsory					
	General Engineering Compulsory	Science (German program	n, 7 semester	): Specialisation Mechanical I	Engineering, Foc	us Energy Systen
	General Engineering Engineering: Compuls		n, 7 semester	): Specialisation Mechanical	Engineering, Foc	us Aircraft Syste
	General Engineering Engineering Sciences		am, 7 semes	ter): Specialisation Mechanic	al Engineering,	Focus Materials
			am, 7 semest	er): Specialisation Mechanica	al Engineering, I	ocus Mechatroni
			7 semester): S	pecialisation Mechanical Engir	neering, Focus Th	eoretical Mechani
		Science (German program,	7 semester):	Specialisation Mechanical Eng	ineering, Focus P	roduct Developme
			7 semester): S	pecialisation Electrical Enginee	ering: Elective Co	mpulsory
				pecialisation Green Technologi		
	Compulsory					5,
	Bioprocess Engineerin	ng: Core Qualification: Com	pulsory			
		g: Core Qualification: Compu				
			alification. Con			
		ental Engineering: Core Qu		npulsory		
	Energy and Environm	ental Engineering: Core Qu Science (English program, 7		npulsory pecialisation Process Engineerii	ng: Elective Com	oulsory
	Energy and Environm General Engineering General Engineering	Science (English program, 7	/ semester): Sp			-
	Energy and Environm General Engineering General Engineering Compulsory	Science (English program, 7 Science (English program	7 semester): Sp n, 7 semester	ecialisation Process Engineerii ): Specialisation Energy and	Enviromental E	-
	Energy and Environm General Engineering General Engineering Compulsory Green Technologies:	Science (English program, 7 Science (English program	7 semester): Sp n, 7 semester ecialisation Ene	ecialisation Process Engineeri	Enviromental E	-
	Energy and Environm General Engineering General Engineering Compulsory Green Technologies: Logistics and Mobility	Science (English program, 7 Science (English program Energy, Water, Climate: Sp 7: Core Qualification: Compu	7 semester): Sp n, 7 semester ecialisation Ene ilsory	ecialisation Process Engineerin ): Specialisation Energy and ergy Systems: Elective Compul	Enviromental E	
	Energy and Environm General Engineering General Engineering Compulsory Green Technologies: Logistics and Mobility Logistics and Mobility	Science (English program, 7 Science (English program Energy, Water, Climate: Sp 7: Core Qualification: Compu 7: Specialisation Information	7 semester): Sp n, 7 semester ecialisation Ene ilsory	ecialisation Process Engineerin ): Specialisation Energy and ergy Systems: Elective Compul	Enviromental E	-
	Energy and Environm General Engineering General Engineering Compulsory Green Technologies: Logistics and Mobility Logistics and Mobility Mechatronics: Core Q	Science (English program, 7 Science (English program Energy, Water, Climate: Sp 7: Core Qualification: Compu	7 semester): Sp n, 7 semester ecialisation Ene ilsory i Technology: C	ecialisation Process Engineerin ): Specialisation Energy and ergy Systems: Elective Compul	Enviromental E	-

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

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

dr daufy (fact, theories, and methods).     or the basis of their innomenals knowledge of their subject the students are capable in relation to a specific issue 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 that they have acquired in their studies to a subject-related problems.     With the aid of the methods they have learnt during their studies the students can analyze problems, make decisions 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.     Social Competence     Social Competence     The students can take up a critical position on the findings of their own research work from a specialized perspective.     The students can take up a critical position on the findings of their own research work from a specialized perspective.     The students are capable of structuring an extensive work process in terms of time and of dealing with an issue with specified there frame.     The students are capable of structuring an extensive work process in terms of time and of dealing with an issue with specified there frame.     The students are able to identify, open up, and connect knowledge and material necessary for working on a scient problem.     The students are able to identify, open up, and connect knowledge and material necessary for working on a scient problem.     The students are able to identify, open up, and connect knowledge and material necessary for working on a scient problem.     The students are able to identify, open up, and connect knowledge and material necessary for working on a scient problem.     The students are able to identify, open up, and connect knowledge and material necessary for working on a scient problem.     The students are able to identify, open up, and connect knowledge and material necessary for working on a scient problem.     Theis science The		Thesis
THE         Typ         Healwik         CP           Medula Requirements         According to German Regulations (21.11): A closed to Regulation (20.11): A closed to Regulation (20.11): A closed to Regulation (20.11): A closed to Regulation (20.11): A closed to Regulation (20.11): Becommanded Previous         According to German Regulations (21.11): A closed to Regulation (20.11): Becommanded Previous           Professional Competence Activational Depictives         After Lating part successfully, students have reached the following learning results           Professional Competence Activational Depictives         I be students can select, autiline and, if need bit, critically discuss the most important scientific fundamental scientific optimits (and methods). Or the basis of their fundamental scientific optimits are capable in relation to a specific base optimits (and establishing links with started specialized scientific and activation in their studies to as subject-related problems.           Solidi         The students can make targeted use of the subject that they have acquired in their studies to as subject-related problems.           Solidi         The students can labe up a critical position on the findings of their own research work from a specialized prespective.           Personal Competence Social Compe	Module M-001: Bache	lor Thesis
THE         Typ         Healwik         CP           Medula Requirements         According to German Regulations (21.11): A closed to Regulation (20.11): A closed to Regulation (20.11): A closed to Regulation (20.11): A closed to Regulation (20.11): A closed to Regulation (20.11): Becommanded Previous         According to German Regulations (21.11): A closed to Regulation (20.11): Becommanded Previous           Professional Competence Activational Depictives         After Lating part successfully, students have reached the following learning results           Professional Competence Activational Depictives         I be students can select, autiline and, if need bit, critically discuss the most important scientific fundamental scientific optimits (and methods). Or the basis of their fundamental scientific optimits are capable in relation to a specific base optimits (and establishing links with started specialized scientific and activation in their studies to as subject-related problems.           Solidi         The students can make targeted use of the subject that they have acquired in their studies to as subject-related problems.           Solidi         The students can labe up a critical position on the findings of their own research work from a specialized prespective.           Personal Competence Social Compe	Courses	
Module Responsible Motissource dor TURH         - According to General Regulations (\$2):1(1):           Admission Requirement         - According to General Regulations (\$2):1(1):           Ad least 126 ECTS credit points have to be achieved in study programme. The examinations board decides on exceptions.           Recommended Previous Knowledge         - The students can solect, outline and, if need be, critically discuss the most important scientific fundamentals of their courd of study (facts, theories, and methods).           Professional Competence         - The students can make targeted uso of the basic fundamentals or their subject area.           State         - The students can make targeted uso of the basic fundamental experime.           - The students can make targeted uso of the basic fundamental experime.         - The students can make targeted uso of the basic fundamental experime.           State         - The students can make targeted uso of the basic fundamental experiment on a solected insulin their subject area.           State         - The students can make targeted uso of the basic fundamental experiment.           - The students can make targeted uso of the basic fundaments on analyze problems, make decidents to the mathematical solecal and develop solution.           - The students are capable of structuring an extent discustion and answert them in a manner that is appropriate to addresses.           - The students are capable of structuring an extent discustion and animetial necessary for working on a soleri poblem.           - The students are capable of structuring to facinitic wo		Typ Hrs/wk CP
Admission Requirements <ul> <li>According to General Regulations 521 (1):</li> <li>At loss 126 ECIS cridit points have to be achieved in study programme. The examinations board decides on exceptions.</li> <li>Recommended Previous</li> <li>Solvedage</li></ul>		
At least 126 ECTS credit points have to be achieved in study programme. The examinations board decides on exceptions:           Recommended Previous convoltage         Met relating part successfully, students have reached the following learning results           Professional Competence Knowledge         Met relating part successfully, students have reached the following learning results           Professional Competence Knowledge         The students can select, outline and, if need bit, critically discuss the most important scientific fundamental howedge of their subject the students are capable in relation to a specific lisse opening up and establishing links with actended specification approximate.           9 The students can make targeted us of the back knowledge of their subject that they have acquired in their studies to a subject-student problem.         • The students can make targeted us of the back knowledge of their subject that they have acquired in their studies to a subject-student problem.           9 The students can make targeted us of the back knowledge of their subject that they have acquired in their studies to a subject-stude problem.         • The students can deal with issues in an expert discussion and answer them in a manner that is appropriate to advective approximate.           9 Sociol Competence Sociol		
Recommended Previous Knowledge           Educational Objective Roomidge         After taking part successfully, students have reached the following learning results           Professional Competence Roomidge              • The students can select, autine and, if need be, critically discuss the most important scientific fundamentals of their roug of study (facts, theories, and methods). <ul> <li>• The students can select autine and, if need be, critically discuss the most important scientific fundamentals of their subject the students are capable in relation to a specific issue or study (facts, theories, and methods).</li> <li>• The students can make targeted use of the basic involvedge of their subject that they have acquired in their students or solution is a structured specific darget da</li></ul>		
Resultant           Educational Objectives         Affer taking part successfully, students have reached the following learning results           Professional Competence <ul> <li>The students can select, quitine and, if need be, critically discuss the most important scientific fundamentals of their coulding particulare discussion in the students are capable in relation to a specific issue opening qui and estabiling links with the students depending experime.</li> </ul> <ul> <li>The students can make targeted use of the basic knowledge of their subject the students are capable in relation to a specific issue goeing qui and estabiling links with the students depending experiment.</li> <li>With the all of the methods they have learnt during their students can analyze problems, make decisions subject related problems.</li> <li>With the all of the methods they have learnt during their students can analyze problems, make decisions students can take up a critical position on the findings of their own research work from a specialized perspective.</li> </ul> Personal Competence <ul> <li>Both in writing and orally the students can outline a scientific issue for an expert audience accurately, understandably in a situadrated way.</li> <li>The students can able to learthy, open up, and connect knowledge and material incessary for working on a scient is specified to the frame.</li> <li>The students can bell with issues in an expert discussion and answer them in a manner that is appropriate to a datessees. In doing so they can upblied their own assessments and viewpoints convincingly.</li> </ul> <ul></ul>		
Educational Objectives         After taking part successfully, students have reached the following learning results           Professional Competence Roowledge <ul></ul>		
Professional Competence <ul> <li>The students can select, outline and, if need be, critically discuss the most important scientific fundamentals of their court of stady (facts, theories, and methods).</li> <li>On the basis, of their fundamental knowledge of their subject the students are capable in relation to a specific issue opening up and eradisplain flinks with extended speciatione deporting.</li> <li>The students can make target use of the basic knowledge of their subject that they have acquired in their studies to a subject-triated anotherin.</li> <li>With the aid of the methods they have learnt during their studies the students can analyze problems, make decisions technical issue, and develop solutions.</li> <li>The students can take a pareat use of their available of their own research work from a specialized perspective.</li> <li>Bash in writing and orally the students can outline a scientific issue for an expert audience accurately, understandably in a structured way.</li> <li>The students can able up obtains.</li> <li>The students can able up obtains and excepted discussion and answer them in a moment that is appropriate to addresses. In doing so they can uphol their own assessments and viewpoints convincing.</li> <li>The students are capable of structuring an extensive work process in terms of time and of dealing with an issue withi specified time trans.</li> <li>The students are able to identify, open up, and connect knowledge and material necessary for working on a scient problem.</li> <li>The students can apply the essential techniques of scientific work to research of their own.</li> <li>Workload in Hours</li> <li>Independent Study Time 360, Study Time in Lecture 0</li> <li>Cortise achievement forme</li> <li>Beamination of According to Generel Regulat</li></ul>	-	After taking part successfully, students have reached the following learning results
Knowledge     The students can select, autline and, if need be, critically discuss the most important scientific fundamentals of their courd of study (racis, theories, and methods).     On the basis of their fundamental knowledge of their subject the students are capable in relation to a specific issue opening up and establishing links with teatended specifics.     The students can make targeted use of the basic knowledge of their subject the students are capable in relation to a specific issue opening up and establishing links with teatended specifics.     The students can make targeted use of the basic knowledge of their subject that they have acquired in their studies to as subject related problems. make decisions technical issues, and develop soutions.     The students can take up a critical position on the findings of their own research work from a specialized perspective.     Social Competence     Social Competence     Social Competence     Social Competence     The students can deal with issues in an expert discussion and answer them in a manner that is appropriate to addressees. In daing so they can upload their own sessesments and vergonist convincingy.     The students are capable of structuring an extensive work process in terms of time and of dealing with an issue with specified time frame.     The students are capable of istructuring an extensive work process in terms of time and of dealing with an issue with specified time frame.     The students can apply the estential techniques of scientific work to research of their own.     Workload in Hours     Independent Study Time 360, Study Time in Lecture 0     Ceclet points 12     Course a schewement Mone     Examination Computery     Digits Mechanic Science (Gomma program). Thesis: Computory     Computer Science: Thesis: Computory     Digits Mechanical Engineeting: Thesis: Computory     Computer Science: Thesis: Computory     Computer Science: Information program). Thesis: Computory     Computeres Science: Informating Science (Gomma program). The		······································
The students can deal with issues in an expert discussion and answer them in a manner that is appropriate to addressees. In doing so they can uphold their own assessments and viewpoints convincingly.     The students are capable of structuring an extensive work process in terms of time and of dealing with an issue withi specified time frame.     The students are able to identify, open up, and connect knowledge and material necessary for working on a scient problem.     The students can apply the essential techniques of scientific work to research of their own.     Workload in Hours Independent Study Time 360, Study Time in Lecture 0     Correctit points 12     Course achievement None     Examination Thesis     General Engineering Science (German program): Thesis: Compulsory     Following Curricus     General Engineering Science (German program, 7 semester): Thesis: Compulsory     Civil: and Environmental Engineering: Thesis: Compulsory     Bioprocess Engineering: Thesis: Compulsory     Computer Science: Thesis: Compulsory     Digital Mechanical Engineering: Thesis: Compulsory     Electrical Engineering: Science (English program): Thesis: Compulsory     Engineering Science (English program): Thesis: Compulsory     Engineering Science (English program): Thesis: Compulsory     Engineering: Science (English program): Thesis: Compu	<i>Skills</i> Personal Competence	<ul> <li>On the basis of their fundamental knowledge of their subject the students are capable in relation to a specific issue of opening up and establishing links with extended specialized expertise.</li> <li>The students are able to outline the state of research on a selected issue in their subject area.</li> <li>The students can make targeted use of the basic knowledge of their subject that they have acquired in their studies to solv subject-related problems.</li> <li>With the aid of the methods they have learnt during their studies the students can analyze problems, make decisions of technical issues, and develop solutions.</li> <li>The students can take up a critical position on the findings of their own research work from a specialized perspective.</li> <li>Both in writing and orally the students can outline a scientific issue for an expert audience accurately, understandably and</li> </ul>
Credit points         12           Course achievement         None           Examination         Thesis           Examination duration and scale         According to General Regulations           Scale         General Engineering Science (German program): Thesis: Compulsory           Following Curricula         General Engineering Science (German program): Thesis: Compulsory           Gioreard Engineering: Thesis: Compulsory         General Engineering: Thesis: Compulsory           Bioprocess Engineering: Thesis: Compulsory         Computer Science: Thesis: Compulsory           Data Science: Thesis: Compulsory         Digital Mechanical Engineering: Thesis: Compulsory           Bioprocess Engineering: Thesis: Compulsory         Digital Mechanical Engineering: Thesis: Compulsory           Bigital Mechanical Engineering: Thesis: Compulsory         Electrical Engineering: Thesis: Compulsory           Engineering Science: Thesis: Compulsory         General Engineering Science (English program, 7 semester): Thesis: Compulsory           General Engineering Science (English program, 7 semester): Thesis: Compulsory         General Engineering Science (English program, 7 semester): Thesis: Compulsory           General Engineering Science and Engineering: Thesis: Compulsory         Computational Science and Engineering: Thesis: Compulsory           General Engineering: Thesis: Compulsory         Mechatronics: Thesis: Compulsory           Mechatronics: Thesis: Compulsory	Autonomy	<ul> <li>The students can deal with issues in an expert discussion and answer them in a manner that is appropriate to the addressees. In doing so they can uphold their own assessments and viewpoints convincingly.</li> <li>The students are capable of structuring an extensive work process in terms of time and of dealing with an issue within specified time frame.</li> <li>The students are able to identify, open up, and connect knowledge and material necessary for working on a scientif problem.</li> </ul>
Course achievement         None           Examination         Thesis           Examination duration and scale         According to General Regulations           Scale         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           Data Science:         Thesis: Compulsory           Digital Mechanical Engineering:         Thesis: Compulsory           Electrical Engineering:         Thesis: Compulsory           Electrical Engineering:         Thesis: Compulsory           Energy and Environmental Engineering:         Thesis: Compulsory           Engineering Science:         Thesis: Compulsory           General Engineering Science (English program):         Thesis: Compulsory           General Engineering Science (English program):         Thesis: Compulsory           General Engineering Science and Engineering:         Thesis: Compulsory           General Engineering Science and Engineering:         Thesis: Compulsory           General Engineering Science and Engineering:         Thesis: Compulsory           General Engineering:         Thesis: Compulsory           General Engineering:         Thesis: Compulsory	Workload in Hours	Independent Study Time 360, Study Time in Lecture 0
Examination         Thesis           Examination duration and scale         According to General Regulations scale           Assignment for the Following Curricula         General Engineering Science (German program): 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 General Engineering Science (English program): Thesis: Compulsory General Engineering Science (English program): Thesis: Compulsory Green Technologies: Energy, Water, Climate: Thesis: Compulsory Green Technologies: Energy, Water, Climate: Thesis: Compulsory Logistics and Mobility: Thesis: Compulsory Mechanical Engineering: Thesis: Compulsory Mechatronics: Thesis: Compulsory Mechatronics: Thesis: Compulsory Naval Architecture: Thesis: Compulsory Technomathematics: Thesis: Compulsory Teilstudiengang Lehrant Elektrotechnik-Informationstechnik: Thesis: Compulsory Teilstudiengang Lehrant Elektrotechnik-Informationstechnik: Thesis: Compulsory	Credit points	12
Examination duration and scale       According to General Regulations         Assignment for the Following Curricula       General Engineering Science (German program, 7 semester): Thesis: Compulsory         General Engineering Science (German program, 7 semester): Thesis: Compulsory       Civil- and Environmental Engineering: Thesis: Compulsory         Bioprocess Engineering: Thesis: Compulsory       Data Science: Thesis: Compulsory         Data Science: Thesis: Compulsory       Digital Mechanical Engineering: Thesis: Compulsory         Electrical Engineering: Thesis: Compulsory       Electrical Engineering: Thesis: Compulsory         Energy and Environmental Engineering: Thesis: Compulsory       Engineering Science: Thesis: Compulsory         General Engineering: Science (English program, 7 semester): Thesis: Compulsory       Engineering Science (English program, 7 semester): Thesis: Compulsory         General Engineering Science (English program, 7 semester): Thesis: Compulsory       General Engineering: Thesis: Compulsory         General Engineering Science (English program, 7 semester): Thesis: Compulsory       General Engineering: Thesis: Compulsory         General Engineering: Thesis: Compulsory       Computational Science and Engineering: Thesis: Compulsory         Logistics and Mobility: Thesis: Compulsory       Mechanical Engineering: Thesis: Compulsory         Naval Architecture: Thesis: Compulsory       Naval Architecture: Thesis: Compulsory         Naval Architecture: Thesis: Compulsory       Technomathematics: T	Course achievement	None
scale           Assignment for the Following Curricula         General Engineering Science (German program): Thesis: Compulsory           General Engineering Science (German program, 7 semester): Thesis: Compulsory           Diprocess Engineering: Thesis: Compulsory           Bioprocess Engineering: Thesis: Compulsory           Data Science: Thesis: Compulsory           Digital Mechanical Engineering: Thesis: Compulsory           Electrical Engineering: Thesis: Compulsory           Energy and Environmental Engineering: Thesis: Compulsory           Energy and Environmental Engineering: Thesis: Compulsory           Energy and Environmental Engineering: Thesis: Compulsory           General Engineering Science (English program): Thesis: Compulsory           General Engineering Science (English program): Thesis: Compulsory           General Engineering Science (English program): Thesis: Compulsory           General Engineering Science (English program, 7 semester): Thesis: Compulsory           Green Technologies: Energy, Water, Climate: Thesis: Compulsory           Computational Science and Engineering: Thesis: Compulsory           Logistics and Mobility: Thesis: Compulsory           Mechanical Engineering: Thesis:		
Assignment for the Following Curricula       General Engineering Science (German program): Thesis: Compulsory         General Engineering Science (German program, 7 semester): Thesis: Compulsory       Civil- and Environmental Engineering: Thesis: Compulsory         Bioprocess Engineering: Thesis: Compulsory       Data Science: Thesis: Compulsory         Data Science: Thesis: Compulsory       Data Science: Thesis: Compulsory         Digital Mechanical Engineering: Thesis: Compulsory       Electrical Engineering: Thesis: Compulsory         Electrical Engineering: Thesis: Compulsory       Electrical Engineering: Thesis: Compulsory         Energy and Environmental Engineering: Thesis: Compulsory       Engineering Science: Thesis: Compulsory         General Engineering Science (English program): Thesis: Compulsory       General Engineering Science (English program, 7 semester): Thesis: Compulsory         Green Technologies: Energy, Water, Climate: Thesis: Compulsory       Greena Engineering: Thesis: Compulsory         Logistics and Mobility: Thesis: Compulsory       Logistics and Mobility: Thesis: Compulsory         Mechanical Engineering: Thesis: Compulsory       Mechatronics: Thesis: Compulsory         Maxial Architecture: Thesis: Compulsory       Naval Architecture: Thesis: Compulsory         Technomathematics: Thesis: Compulsory       Technomathematics: Thesis: Compulsory         Technomathematics: Thesis: Compulsory       Technomathematics: Thesis: Compulsory         Technomathematics: Thesis: Compul		According to General Regulations
Following CurriculaGeneral 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 General Engineering Science (English program): Thesis: Compulsory General Engineering Science (English program): Thesis: Compulsory General Engineering Science (English program, 7 semester): Thesis: Compulsory General Engineering Science (English program, 7 semester): Thesis: Compulsory General Engineering Science and Engineering: Thesis: Compulsory Computational Science and Engineering: Thesis: Compulsory Logistics and Mobility: Thesis: Compulsory Mechanical Engineering: Thesis: Compulsory Mechanical Engineering: Thesis: Compulsory Technomathematics: Thesis: Compulsory Technomathematics: Thesis: Compulsory		Conoral Engineering Science (Corman program): Thesis: Compulsery
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 Energy and Environmental Engineering: Thesis: Compulsory Engineering Science: Thesis: Compulsory General Engineering Science (English program): Thesis: Compulsory General Engineering Science (English program): 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 Technomathematics: Thesis: Compulsory Technomathematics: Thesis: Compulsory	-	
Teilstudiengang Lehramt Metalltechnik: Thesis: Compulsory Process 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 General Engineering Science (English program): 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 Mechanical: Engineering: Thesis: Compulsory Naval Architecture: Thesis: Compulsory Technomathematics: Thesis: Compulsory Technomathematics: Thesis: Compulsory Teilstudiengang Lehramt Elektrotechnik-Informationstechnik: Thesis: Compulsory Teilstudiengang Lehramt Metalltechnik: Thesis: Compulsory