

## **Module Manual**

Bachelor of Science (B.Sc.)

# General Engineering Science (German program, 7 semester)

Cohort: Winter Term 2020

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### **Program description**

### Content

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

### **Career prospects**

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

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

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

### Learning target

### Knowledge

Students can:

- Name and describe the mathematical and scientific principles and methods of the engineering sciences;
- · Ellucidate the principles and methods of the engineering sciences and present an overview of their subject;
- Explain in detail the foundations, methods and areas of application of their specialization, and, as necessary, their particular focus;
- Recite the foundations and methods of the engineering sciences and provide an overview of the relevant social, ethical, ecological and economic marginal conditions of their subject.

### Skills

Graduates are able to

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

### Social Competence

Graduates are able to

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

### Autonomy

Graduates are able to

- Familiarize themselves with the relevant literature and effectively use databases and other digital sources of information as well as present the results of their work comprehensively both orally and in writing
- Assess their existing competences realistically and develop and carry out strategies for compensating any deficits they identify
- Learn a range of subjects and work independently
- Expand and deepen their understanding through a process of lifelong learning

### **Program structure**

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

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

### **Core Qualification**

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

### Knowledge The Non-technical Academic Programms (NTA)

imparts skills that, in view of the TUHH's training profile, professional engineering studies require but are not able to cover fully. Self-reliance, self-management, collaboration and professional and personnel management competences. The department implements these training objectives in its **teaching architecture**, in its **teaching and learning arrangements**, in **teaching areas** and by means of teaching offerings in which students can qualify by opting for **specific competences** and a **competence level** at the Bachelor's or Master's level. The teaching offerings are pooled in two different catalogues for nontechnical complementary courses.

### The Learning Architecture

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

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

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

### **Teaching and Learning Arrangements**

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

### **Fields of Teaching**

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

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

### The Competence Level

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

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

### Specialized Competence (Knowledge)

### Students can

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

### kills Professional Competence (Skills)

In selected sub-areas students can

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

### **Personal Competence**

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

#### Courses

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

Module M0743: Electrical Engineering I: Direct Current Networks and Electromagnetic Fields						
Courses						
Title				Тур	Hrs/wk	СР
Electrical Engineering I: Direct Curr				Lecture	3	5
Electrical Engineering I: Direct Curr		omagnetic Fields (L06	576)	Recitation Section (small)	2	1
Module Responsible	Prof. Matthias Kuhl					
Admission Requirements	None					
Recommended Previous						
Knowledge						
Educational Objectives	After taking part succ	essfully, students h	ave reached the follow	ing learning results		
Professional Competence						
Knowledge						
Skills						
Personal Competence						
Social Competence						
Autonomy						
Workload in Hours	Independent Study Ti	Independent Study Time 110, Study Time in Lecture 70				
Credit points	6					
Course achievement	Compulsory Bonus	Form	Description			
	No 10 %	Excercises				
Examination	Written exam					
Examination duration and	120 Minutes					
scale						
Assignment for the	General Engineering	Science (German pr	ogram, 7 semester): Co	ore Qualification: Compulsory		
Following Curricula	Data Science: Specia	lisation Electrical Er	ngineering: Compulsory			
	Electrical Engineering					
			Core Qualification: Con	npulsory		
	Mechatronics: Core Qualification: Compulsory					
	Orientierungsstudium	n: Core Qualification	: Elective Compulsory			

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

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

Module M0889: Mech	anics I (Statics)			
Courses				
Title		Тур	Hrs/wk	СР
Mechanics I (Statics) (L1001)		Lecture	2	3
Mechanics I (Statics) (L1002)		Recitation Section (small)	2	2
Mechanics I (Statics) (L1003)		Recitation Section (large)	1	1
Module Responsible	Prof. Robert Seifried			
Admission Requirements	None			
Recommended Previous	Solid school knowledge in mathematics and phy	sics.		
Knowledge				
Educational Objectives	After taking part successfully, students have rea	ched the following learning results		
Professional Competence				
Knowledge	The students can			
	describe the axiomatic procedure used in	mechanical contexts:		
	<ul> <li>explain important steps in model design;</li> </ul>	,		
	present technical knowledge in stereostal	cics.		
Skills	The students can			
Simo	The stadents can			
	<ul> <li>explain the important elements of mathe</li> </ul>	• explain the important elements of mathematical / mechanical analysis and model formation, and apply it to the context of		
	their own problems;			
	apply basic statical methods to engineering problems;			
	estimate the reach and boundaries of star	tical methods and extend them to be appli	cable to wider prob	lem sets.
Personal Competence				
Social Competence	The students can work in groups and support ea	ch other to overcome difficulties.		
Autonomy	Students are capable of determining their own s	trengths and weaknesses and to organize	their time and learr	ing based on those.
Workload in Hours	Independent Study Time 110, Study Time in Lec	ture 70		
Credit points	6			
Course achievement	None			
Examination	Written exam			
Examination duration and	90 min			
scale				
Assignment for the	General Engineering Science (German program,	7 semester): Core Qualification: Compulso	ry	
Following Curricula	Civil- and Environmental Engineering: Core Qual	ification: Compulsory		
	Data Science: Specialisation Mechanics: Compul	sory		
	Digital Mechanical Engineering: Core Qualification	n: Compulsory		
	Logistics and Mobility: Core Qualification: Comp	ulsory		
	Mechanical Engineering: Core Qualification: Con	npulsory		
	Mechatronics: Core Qualification: Compulsory			
	Orientierungsstudium: Core Qualification: Electiv	ve Compulsory		
	Naval Architecture: Core Qualification: Compulso	pry		

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

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

Course L1003: Mechanics I (Statics)		
Тур	Recitation Section (large)	
Hrs/wk	1	
СР	1	
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14	
Lecturer	Prof. Robert Seifried	
Language	DE	
Cycle	WiSe	
Content	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: Matho	ematics I			
Courses				
Title Analysis I (L1010) Analysis I (11012)		Typ Lecture Recitation Section (small)	Hrs/wk 2 1	<b>CP</b> 2 1
Analysis I (L1012) Analysis I (L1013)		Recitation Section (Iarge)	1	1
Linear Algebra I (L0912)		Lecture	2	2
Linear Algebra I (L0913)		Recitation Section (small)	1	1
Linear Algebra I (L0914)		Recitation Section (large)	1	1
Module Responsible	Prof. Anusch Taraz			
Admission Requirements	None			
Recommended Previous				
Knowledge	Serios matrematics			
Educational Objectives	After taking part successfully, students have reached the	e following learning results		
Professional Competence	, , , , , , , , , , , , , , , , , , ,			
Knowledge				
Knowledge	<ul> <li>Students can name the basic concepts in analy</li> </ul>	sis and linear algebra. They are able	e to explain the	em using appropriate
	examples.			
	<ul> <li>Students can discuss logical connections between</li> </ul>	these concepts. They are capable	of illustrating th	ese connections with
	the help of examples.			
	<ul> <li>They know proof strategies and can reproduce the</li> </ul>	em.		
Skills	6			
	Students can model problems in analysis and line     the company of sale in the company in a case.		pts studied in tr	nis course. Moreover,
	they are capable of solving them by applying esta			
	Students are able to discover and verify further lo			
	For a given problem, the students can develop	and execute a suitable approach, ar	id are able to c	ritically evaluate the
	results.			
Personal Competence				
Social Competence	<ul> <li>Students are able to work together in teams. They</li> </ul>	are capable to use mathematics as a	common langu	200
	In doing so, they can communicate new concepts			-
	design examples to check and deepen the unders		eracing partiters	. Moreover, they can
	design examples to check and deepen the unders	tanding of their peers.		
Autonomy	Students are capable of checking their understan	ding of complex concepts on their or	vn. They can sp	ecify open questions
	precisely and know where to get help in solving th			
	Students have developed sufficient persistence to the students have developed and the students have developed at the students have		in a goal-orien	ted manner on hard
	problems.	· .	J	
	·			
Workload in Hours	Independent Study Time 128, Study Time in Lecture 112			
Credit points	8			
Course achievement	None			
Examination	Written exam			
Examination duration and	60 min (Analysis I) + 60 min (Linear Algebra I)			
scale				
Assignment for the	General Engineering Science (German program, 7 semes	ter); Core Qualification: Compulsory		
Following Curricula				
	Bioprocess Engineering: Core Qualification: Compulsory	,		
	Digital Mechanical Engineering: Core Qualification: Comp	pulsory		
	Electrical Engineering: Core Qualification: Compulsory	,		
	Energy and Environmental Engineering: Core Qualification	n: Compulsorv		
	Computational Science and Engineering: Core Qualification: Compulsory Logistics and Mobility: Core Qualification: Compulsory			
	Mechanical Engineering: Core Qualification: Compulsory			
	Mechatronics: Core Qualification: Compulsory			
	Orientierungsstudium: Core Qualification: Elective Comp	ulsorv		
	Naval Architecture: Core Qualification: Compulsory	3		
	Process Engineering: Core Qualification: Compulsory			

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

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

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

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

Course L0913: Linear Algebra	a I
Тур	Recitation Section (small)
Hrs/wk	1
СР	1
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14
Lecturer	Prof. Anusch Taraz, Prof. Marko Lindner
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	ourse L0914: Linear Algebra I	
Тур	Recitation Section (large)	
Hrs/wk	1	
СР	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 M1315: Physi	cs for Engineers (AIW)			
Courses				
Title		Тур	Hrs/wk	СР
Physics for Engineers (L0367)		Lecture	2	3
Physics for Engineers (Problem Solv	ving Course) (L0368)	Recitation Section (small)	1	1
Module Responsible	Prof. Manfred Eich			
Admission Requirements	None			
Recommended Previous	Calculus and linear algebra on high school level			
Knowledge				
	Physics on high school level			
Educational Objectives	After taking part successfully, students have reached the follow	wing learning results		
Professional Competence				
Knowledge	Students can explain fundamental topics and laws of physics s	uch as in the areas of mechanics,	oscillations,	
	waves, and optics.			
	Students can relate physics topics to technical problems.			
Skille	Students can describe physical problems mathematically a	and colve such problems within	the framework	of their acquired
SKIIIS	mathematical expertise.	ind solve such problems within	the framework	or their acquired
	mathematical expertise.			
Personal Competence				
Social Competence	Students can jointly solve subject related problems in groups. They can present their results effectively within the framework of the		ne framework of the	
	problem solving courses.			
Autonomy	Students are capable to extract relevant information from the	•		
	the lecture. They can reflect their acquired level of expertis	·		ires such as exam
	typical exam questions. Students are able to connect their kno	wledge with that acquired from o	ther lectures.	
Workload in Hours	Independent Study Time 78, Study Time in Lecture 42			
Credit points	4			
Course achievement	None			
Examination	Written exam			
Examination duration and	120 min	<u> </u>		
scale				
Assignment for the	General Engineering Science (German program, 7 semester): (	Core Qualification: Compulsory		
Following Curricula				

Course L0367: Physics for En	gineers
Тур	Lecture
Hrs/wk	2
СР	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Prof. Manfred Eich
Language	DE
Cycle	WiSe
Content	<ul> <li>Introduction</li> <li>Kinematics and dynamics</li> <li>Work, Energy, momentum</li> <li>Rotatory Motion, moments of inertia</li> <li>Gravitation</li> <li>Special Theory of Relativity</li> <li>Oscillations</li> <li>Waves</li> <li>Geometrical optics</li> <li>Wave optics</li> <li>Matter waves</li> <li>Fundamentals of quantum mechanics</li> </ul>
Literature	<ul> <li>Giancoli, Physics for Scientists &amp; Engineers Vol. 1, 2, Pearson</li> <li>Halliday/Resnik/Walker, Fundamentals of physics, Wiley</li> <li>K. Cummings, P. Laws, E. Redish, and P. Cooney ("CLRC"), Understanding Physics, Wiley</li> <li>Gerthsen/Vogel, Physik, Springer Verlag</li> <li>Hering/Martin/Stohrer, Physik für Ingenieure, VDI-Verlag</li> </ul>

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

Module M0687: Chem	istry			
Courses				
Title Chemistry I+II (L0460) Chemistry I+II (L0475)		<b>Typ</b> Lecture Recitation Section (large)	Hrs/wk 4 2	<b>CP</b> 4 2
	Dr. Dorothea Rechtenbach			
Admission Requirements				
Recommended Previous				
Knowledge				
Educational Objectives	After taking part successfully, students have reached the	following learning results		
Professional Competence  Knowledge	The students are able to name and to describe basic prir table, chemical bonds), physical chemistry (aggregal chemistry (acid/base, pH-value, salts, solubility, redox, r carbonyl compounds, aromates, reaction mechanisms, explain basic chemical terms.	te states, separating processes metals) and organic chemistry (al	, thermodynamics, iphatic hydrocarbor	kinetics), inorganic
Skills	After successful completion of this module students are a they are capable of explaining, choosing and applying sp	- '		oounds. On this basis,
Personal Competence				
Social Competence	Students are able to take part in discussions on chemica contribute to those discussion by their own statements.	l issues and problems as a memb	er of an interdiscipl	inary team. They can
Autonomy	After successful completion of this module students are approaches with arguments. They can also document the	·	s independently by	defending proposed
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			ery	
Following Curricula	Civil- and Environmental Engineering: Core Qualification: Technomathematics: Specialisation III. Engineering Scien			
	recomoniacientatics. Specialisation III. Engineering Scien	ce. Liective Compuisory		

Course L04	460: Chemistry I+II
Тур	Lecture
Hrs/wk	4
СР	4
Workload	Independent Study Time 64, Study Time in Lecture 56
in Hours	
Language	Dr. Christoph Wutz
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	I .
Тур	Recitation Section (large)
Hrs/wk	2
СР	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Dr. Dorothea Rechtenbach
Language	DE
Cycle	WiSe
Content	See interlocking course
Literature	See interlocking course

Module M1121: Progr				
Courses				
Fitle		Тур	Hrs/wk	CP
Programming in C (L0083) Programming in C (L1488)		Lecture Practical Course	1 1	1 1
Module Responsible	Prof. Siegfried Rump			
Admission Requirements	None			
Recommended Previous	Elementary PC handling skills			
Knowledge	Elementary mathematical skills			
Educational Objectives	After taking part successfully, students have rea	ched the following learning results		
Professional Competence				
Knowledge	The students know by heart the basic syntax of C programming as well as its meaning, intent and purpose.  They know the fundamental components and principles of elementary procedural programming			
	based on C programming and can explain them:	neiples of elementary procedural program	mining	
	basic data types (integers, floating point numb     advanced data types (pointers, arrays, strings)			
	<ul> <li>advanced data types (pointers, arrays, strings,</li> <li>operators (arithmetical operations, logical operations)</li> </ul>			
	control flow (choice, loops, jumps, conditional of the control flow)			
	functions and macros			
	important standard libraries and functions			
	• recursion			
	linked lists			
	The students are prepared for continuing progra	mming lectures like object oriented progr	ramming in C++.	
Skills The students know how to use an integrated development environment for C programming on a PC so that they can write, store, compile and execute C programs on it.			ng on a PC	
	Using their knowledge they are able to read and	understand given C Programs.		
	They can solve simple algorithmic problems on t in C language.	heir own and can model and program the	eir solutions	
	The students are able to solve selected exercise mechanics, electrical engineering or physics with	·		
Personal Competence				
Social Competence	The students are able to work in small teams to programming errors and to present their results.		analyze	
	They are able to explain simple phenomena to e	ach other directly at the PC.		
Autonomy	The students prepare themselves using the give programming exercises on their own.	n teaching material and solve the given		
	Additionally, they write small C programs to und gain a certain programming experience.	erstand and check addressed issues and	also to	
	For details beyond the scope of the lecture the s	tudents inform themselves using the state	ted	
	literature and / or by supplementary own research		ieu	
Workload in Hours	Independent Study Time 32, Study Time in Lectu	ire 28		
Credit points	2			
Course achievement	None			
Examination	Written elaboration			
Examination duration and	1-2 coding tasks weekly			
scale				
Assignment for the	General Engineering Science (German program,	7 semester): Core Qualification: Compuls	sory	
Following Curricula				

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

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

Module M0547: Electr	ical Engineering II: Alternating Cur	rent Networks and Basic	Devices	
Courses				
	g Current Networks and Basic Devices (L0178) g Current Networks and Basic Devices (L0179)	<b>Typ</b> Lecture Recitation Section (small)	<b>Hrs/wk</b> 3 2	<b>CP</b> 5 1
Module Responsible	Prof. Christian Becker			
Admission Requirements	None			
Recommended Previous	Electrical Engineering I			
Knowledge	Mathematics I			
	Direct current networks, complex numbers			
Educational Objectives	After taking part successfully, students have reache	ed the following learning results		
Professional Competence	-	•		
Knowledge	Students are able to reproduce and explain funda	amental theories, principles, and met	hods related to the	theory of alternating
	currents. They can describe networks of linear elements	- ·	-	
	an overview of applications for the theory of alter explaining the behavior of fundamental passive and			dents are capable of
Skills	Students are capable of calculating parameters within simple electrical networks at alternating currents by means of a complex notation for voltages and currents. They can appraise the fundamental effects that may occur within electrical networks at alternating currents. Students are able to analyze simple circuits such as oscillating circuits, filter, and matching networks quantitatively and dimension elements by means of a design. They can motivate and justify the fundamental elements of an electrical power supply (transformer, transmission line, compensation of reactive power, multiphase system) and are qualified to dimension their main features.			
Personal Competence Social Competence	Students are able to work together on subject relat	ed tasks in small groups. They are abl	e to present their res	ults effectively.
Autonomy	Students are capable to gather necessary information from the references provided and relate that information to the context of the lecture. They are able to continually reflect their knowledge by means of activities that accompany the lecture, such as onlinetests and exercises that are related to the exam. Based on respective feedback, students are expected to adjust their individual learning process. They are able to draw connections between their knowledge obtained in this lecture and the content of other lectures (e.g. Electrical Engineering I, Linear Algebra, and Analysis).			
Workload in Hours	Independent Study Time 110, Study Time in Lecture	e 70		
Credit points				
Course achievement		Description		
Examination	Written exam			
Examination duration and scale	90 - 150 minutes			
Assignment for the	General Engineering Science (German program, 7 s		sory	
Following Curricula	Data Science: Specialisation Electrical Engineering:	' '		
	Electrical Engineering: Core Qualification: Compulso	•		
	Computational Science and Engineering: Core Qual Mechatronics: Core Qualification: Compulsory	itication: Compulsory		
	Orientierungsstudium: Core Qualification: Elective (	Compulsory		
	S. S. S. S. G.	50pai50i y		

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		
Cycle		
Content	- General time-dependency of electrical networks	
	- Representation and properties of harmonic signals	
	- RLC-elements at alternating currents/voltages	
	- Complex notation for the representation of RLC-elements	
	- Power in electrical networks at alternating currents, compensation of reactive power	
	- Frequency response locus (Nyquist plot) and Bode-diagrams	
	- Measurement instrumentation for assessing alternating currents	
	- Oscillating circuits, filters, electrical transmission lines	
	- Transformers, three-phase current, energy converters	
	- Simple non-linear and active electrical devices	
Literature	- M. Albach, "Elektrotechnik", Pearson Studium (2011)	
	- T. Harriehausen, D. Schwarzenau, "Moeller Grundlagen der Elektrotechnik", Springer (2013)	
	- R. Kories, H. Schmidt-Walter, "Taschenbuch der Elektrotechnik", Harri Deutsch (2010)	
	- C. Kautz, "Tutorien zur Elektrotechnik", Pearson (2009)	
	- A. Hambley, "Electrical Engineering: Principles and Applications", Pearson (2013)	
	- R. Dorf, "The Electrical Engineering Handbook", CRC (2006)	

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

Module M0594: Funda	amentals of Mechanical Engineering	Design		
Courses				
<b>Title</b> Fundamentals of Mechanical Engine Fundamentals of Mechanical Engine		<b>Typ</b> Lecture Recitation Section (large)	Hrs/wk 2 2	<b>CP</b> 3
Module Responsible				
Admission Requirements				
Recommended Previous Knowledge	Basic knowledge about mechanics and producti     Internship (Stage I Practical)	on engineering		
<b>Educational Objectives</b>	After taking part successfully, students have reached t	the following learning results		
Professional Competence				
Knowledge	After passing the module, students are able to:			
	<ul> <li>explain basic working principles and functions o</li> <li>explain requirements, selection criteria, application the background of dimensioning calculations.</li> </ul>		es of basic machin	e elements, indicate
Skills	After passing the module, students are able to:  • accomplish dimensioning calculations of covere  • transfer knowledge learned in the module to ne  • recognize the content of technical drawings and  • technically evaluate basic designs.	w requirements and tasks (problem s	olving skills),	
Personal Competence Social Competence Autonomy	<ul> <li>Students are able to discuss technical informati</li> <li>Students are able to independently deepen thei</li> <li>Students are able to acquire additional knowle recordings of the lectures.</li> </ul>	r acquired knowledge in exercises.		. by using the video
Workload in Hours	Independent Study Time 124, Study Time in Lecture 5	6		
Credit points		<del>-</del>		
Course achievement				
Examination				
Examination duration and scale				
Assignment for the	General Engineering Science (German program, 7 sem	nester): Core Qualification: Compulsor	γ	
Following Curricula	Digital Mechanical Engineering: Core Qualification: Cor		-	
-	Energy and Environmental Engineering: Core Qualifica			
	Logistics and Mobility: Core Qualification: Compulsory			
	Mechanical Engineering: Core Qualification: Compulso	ry		
	Mechatronics: Core Qualification: Compulsory			
	Orientierungsstudium: Core Qualification: Elective Con	npulsory		
	Naval Architecture: Core Qualification: Compulsory			
	Technomathematics: Specialisation III. Engineering Sci	ience: Elective Compulsory		

Course L0258: Fundamentals	of Mechanical Engineering Design
Тур	Lecture
Hrs/wk	2
СР	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Prof. Dieter Krause, Prof. Josef Schlattmann, Prof. Otto von Estorff, Prof. Sören Ehlers
Language	DE
Cycle	SoSe
Content	Lecture
	<ul> <li>Introduction to design</li> <li>Introduction to the following machine elements</li> <li>Screws</li> </ul>
	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
	<ul> <li>Springs</li> </ul>
	Axis & shafts
Literature	Dubbel, Taschenbuch für den Maschinenbau; Grote, KH., Feldhusen, J.(Hrsg.); Springer-Verlag, aktuelle Auflage.
	Maschinenelemente, Band I-III; Niemann, G., Springer-Verlag, aktuelle Auflage.
	Maschinen- und Konstruktionselemente; Steinhilper, W., Röper, R., Springer Verlag, aktuelle Auflage.
	Einführung in die DIN-Normen; Klein, M., Teubner-Verlag.      And Andrew Community of the Community of
	Konstruktionslehre, Pahl, G.; Beitz, W., Springer-Verlag, aktuelle Auflage.
	<ul> <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> </ul>
	<ul> <li>Roloff/Matek Maschinenelemente; Wittel, H., Muhs, D., Jannasch, D., Voßiek, J., Springer Vieweg, aktuelle Auflage.</li> <li>Sowie weitere Bücher zu speziellen Themen</li> </ul>

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

Module M0696: Mech	anics II: Mechanics of Materials			
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	•			
	None			
Recommended Previous	Mechanics I			
Knowledge				
Educational Objectives	After taking part successfully, students have reached the	following learning results		
Professional Competence				
Knowledge	The students name the fundamental concepts and laws o	f statics such as stresses, strains, Ho	oke's linear law.	
Skills	The students apply the mathematical/mechanical analysis	s and modeling.		
	The students apply the fundamental methods of elasto st	atics to simply engineering problems	5.	
	The students estimate the validity and limitations of the i	ntroduced methods.		
Personal Competence				
Social Competence	-			
Autonomy	-			
Workload in Hours	Independent Study Time 96, Study Time in Lecture 84			
Credit points	6			
Course achievement	None			
Examination	Written exam			
Examination duration and	90 min			
scale				
Assignment for the	General Engineering Science (German program, 7 semest	er): Core Qualification: Compulsory		
Following Curricula	Civil- and Environmental Engineering: Core Qualification:	Compulsory		
	Data Science: Specialisation Mechanics: Compulsory			
	Digital Mechanical Engineering: Core Qualification: Comp	ulsory		
	Logistics and Mobility: Core Qualification: Compulsory			
	Mechanical Engineering: Core Qualification: Compulsory			
	Mechatronics: Core Qualification: Compulsory			
	Orientierungsstudium: Core Qualification: Elective Compu	Isory		
	Naval Architecture: Core Qualification: Compulsory			

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

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

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

Module M0671: Technical Thermodynamics I				
Courses				
<b>Title</b> Technical Thermodynamics I (L043 Technical Thermodynamics I (L043		<b>Typ</b> Lecture Recitation Section (large)	Hrs/wk 2 1	<b>CP</b> 4 1
Technical Thermodynamics I (L044		Recitation Section (small)	1	1
Module Responsible	Prof. Gerhard Schmitz			
Admission Requirements	None			
Recommended Previous Knowledge	Elementary knowledge in Mathematics and Mechanics			
<b>Educational Objectives</b>	After taking part successfully, students have reached th	e following learning results		
<b>Professional Competence</b>				
Knowledge	Students are familiar with the laws of Thermodynamic	s. They know the relation of the kind	ds of energy acc	ording to 1 <sup>st</sup> law of
	Thermodynamics and are aware about the limits of ene distinguish between state variables and process varia enthalpy, entropy and also the meaning of exergy an related diagram. They know the physical difference bet state. They know the meaning of a fundamental state or	bles and know the meaning of differ id anergy. They are able to draw the tween an ideal and a real gas and are	rent state variable Carnot cycle in e able to use the	es like temperature, a Thermodynamics related equations of
Skills	Students are able to calculate the internal energy, the enthalpy, the kinetic and the potential energy as well as work and heat for simple change of states and to use this calculations for the Carnot cycle. They are able to calculate state variables for an ideal and for a real gas from measured thermal state variables.			
Personal Competence				
Social Competence	The students are able to discuss in small groups and de	velop an approach.		
Autonomy	Students are able to define independently tasks, to get knowledge in practice.	new knowledge from existing knowle	edge as well as to	find ways to use the
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56			
Credit points	6			
Course achievement	None			
Examination	Written exam			
Examination duration and	90 min			
scale	0 15 1 10 10 7			
Assignment for the	General Engineering Science (German program, 7 seme			
Following Curricula	Bioprocess Engineering: Core Qualification: Compulsory Digital Mechanical Engineering: Core Qualification: Com			
	Energy and Environmental Engineering: Core Qualification			
	Mechanical Engineering: Core Qualification: Compulsory			
	Mechatronics: Core Qualification: Compulsory			
	Orientierungsstudium: Core Qualification: Elective Comp	pulsory		
	Naval Architecture: Core Qualification: Compulsory			
	Technomathematics: Specialisation III. Engineering Scie	nce: Elective Compulsory		
	Process Engineering: Core Qualification: Compulsory			

Course L0437: Technical Thermodynamics I		
Тур	Lecture	
Hrs/wk	2	
СР	4	
Workload in Hours	Independent Study Time 92, Study Time in Lecture 28	
Lecturer	Prof. Gerhard Schmitz	
Language	DE	
Cycle	SoSe SoSe	
Content	1. Debuglioship	
	1. Introduction	
	2. Fundamental terms	
	3. Thermal Equilibrium and temperature	
	3.1 Thermal equation of state	
	4. First law	
	4.1 Heat and work	
	4.2 First law for closed systems	
	4.3 First law for open systems	
	4.4 Examples	
	5. Equations of state and changes of state	
	5.1 Changes of state	
	5.2 Cycle processes	
	6. Second law	
	6.1 Carnot process	
	6.2 Entropy	
	6.3 Examples	
	6.4 Exergy	
	7. Thermodynamic properties of pure fluids	
	7.1 Fundamental equations of Thermodynamics	
	7.2 Thermodynamic potentials	
	7.3 Calorific state variables for arbritary fluids	
	7.4 state equations (van der Waals u.a.)	
Literature		
	Schmitz, G.: Technische Thermodynamik, TuTech Verlag, Hamburg, 2009	
	Baehr, H.D.; Kabelac, S.: Thermodynamik, 15. Auflage, Springer Verlag, Berlin 2012	
	Security (1997), (additional),	
	Potter, M.; Somerton, C.: Thermodynamics for Engineers, Mc GrawHill, 1993	

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

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

Module M0851: Mathe	ematics II			
Courses				
Title Analysis II (L1025) Analysis II (L1026)		<b>Typ</b> Lecture Recitation Section (large)	Hrs/wk 2 1	<b>CP</b> 2 1
Analysis II (L1027) Linear Algebra II (L0915) Linear Algebra II (L0916)		Recitation Section (small) Lecture Recitation Section (small)	1 2 1	1 2 1
Linear Algebra II (L0917)		Recitation Section (large)	1	1
Module Responsible	Prof. Anusch Taraz			
Admission Requirements	None			
Recommended Previous	Mathematics I			
Knowledge	A Character Library and the second a	Laboration to a continuous solution		
Professional Competence	After taking part successfully, students have reached	the following learning results		
Knowledge	Students can name further concepts in ana examples. Students can discuss logical connections betw the help of examples. They know proof strategies and can reproduce	veen these concepts. They are capable		
Skills	<ul> <li>Students can model problems in analysis and they are capable of solving them by applying of the students are able to discover and verify further.</li> <li>For a given problem, the students can devel results.</li> </ul>	established methods. or logical connections between the conce	ots studied in the	e course.
Personal Competence Social Competence	<ul> <li>Students are able to work together in teams. T</li> <li>In doing so, they can communicate new conce design examples to check and deepen the unc</li> </ul>	epts according to the needs of their coop		-
Autonomy	Students are capable of checking their unders precisely and know where to get help in solvin     Students have developed sufficient persisten problems.	g them.		
Workload in Hours	Independent Study Time 128, Study Time in Lecture	112		
Credit points				
Course achievement				
Examination	Written exam	-		
Examination duration and	60 min (Analysis II) + 60 min (Linear Algebra II)			
scale				
Assignment for the Following Curricula	General Engineering Science (German program, 7 se Civil- and Environmental Engineering: Core Qualificat			
1 onowing curricula	Bioprocess Engineering: Core Qualification: Compulso	• •		
	Digital Mechanical Engineering: Core Qualification: Co	ompulsory		
	Electrical Engineering: Core Qualification: Compulsor			
	Energy and Environmental Engineering: Core Qualific			
	Computational Science and Engineering: Core Qualifi Logistics and Mobility: Core Qualification: Compulsor			
	Mechanical Engineering: Core Qualification: Compuls			
	Mechatronics: Core Qualification: Compulsory			
	Orientierungsstudium: Core Qualification: Elective Co	mpulsory		
	Naval Architecture: Core Qualification: Compulsory			
	Process Engineering: Core Qualification: Compulsory			

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

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

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

ourse L0915: Linear Algebra	a II
Тур	Lecture
Hrs/wk	2
СР	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Prof. Anusch Taraz, Prof. Marko Lindner
Language	DE
Cycle	SoSe 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 II			
Тур	Recitation Section (small)		
Hrs/wk	1		
СР	1		
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14		
Lecturer	Prof. Anusch Taraz, Prof. Marko Lindner		
Language	DE		
Cycle	SoSe		
Content	<ul> <li>linear mappings: basis transformation, orthogonal projection, orthogonal matrices, householder matrices</li> <li>linear regression: QR-decomposition, normal equations, linear discrete approximation</li> <li>eigenvalues: diagonalising matrices, normal matrices, symmetric and Hermite matrices, Jordan normal form, singular value decomposition</li> <li>system of linear differential equations</li> </ul>		
Literature	<ul> <li>W. Mackens, H. Voß: Mathematik I für Studierende der Ingenieurwissenschaften, HECO-Verlag, Alsdorf 1994</li> <li>W. Mackens, H. Voß: Aufgaben und Lösungen zur Mathematik I für Studierende der Ingenieurwissenschaften, HECO-Verlag, Alsdorf 1994</li> </ul>		

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

Courses				
Fitle		Тур	Hrs/wk	CP
Technical Thermodynamics II (L0449) Technical Thermodynamics II (L0450)		Lecture Recitation Section (large)	2	4
Fechnical Thermodynamics II (L045		Recitation Section (large)  Recitation Section (small)	1	1
Module Responsible	Prof. Dr. Arne Speerforck	Recitation Section (Small)		
Admission Requirements	None			
Recommended Previous	Elementary knowledge in Mathematics, Med	chanics and Technical Thermodynamics I		
Knowledge				
Educational Objectives	After taking part successfully, students have	e reached the following learning results		
<b>Professional Competence</b>				
Knowledge	derive energetic and exergetic efficiencies clockwise and clockwise cycles (heat-power draw the different cycles in Thermodynam	ocesses like Joule, Otto, Diesel, Stirling, Seiliger as and know the influence different factors. The recycle, cooling cycle). They have increased knownics related diagrams. They know the laws of combustion calculations. They are provided with and know about a Laval nozzle.	y know the differ ledge of steam c las mixtures, es	erence between an ycles and are able pecially of humid a
Skills	Students are able to use thermodynamic laws for the design of technical processes. Especially they are able to formulate energy, exergy- and entropy balances and by this to optimise technical processes. They are able to perform simple safety calculations in regard to an outflowing gas from a tank. They are able to transform a verbal formulated message into an abstract formal procedure.			
Personal Competence				
Social Competence	The students are able to discuss in small gro	oups and develop an approach.		
Autonomy	Students are able to define independently t knowledge in practice.	tasks, to get new knowledge from existing knowle	dge as well as to	find ways to use th
Workload in Hours	Independent Study Time 124, Study Time in	n Lecture 56		
Credit points				
Course achievement				
Examination	Written exam			
Examination duration and	90 min			
scale				
Assignment for the	General Engineering Science (German progr	ram, 7 semester): Core Qualification: Compulsory		
Following Curricula	Bioprocess Engineering: Core Qualification:	Compulsory		
	Energy and Environmental Engineering: Cor	re Qualification: Compulsory		
	Energy Systems: Technical Complementary	Course Core Studies: Elective Compulsory		
	Engineering Science: Specialisation Mechan			
		am, 7 semester): Specialisation Mechanical Engine	eering: Elective C	Compulsory
	Green Technologies: Energy, Water, Climate			- 1
	Mechanical Engineering: Core Qualification:	· ·		
	Mechatronics: Core Qualification: Compulsor	• •		
	·	• 1		
	Technomathematics: Specialisation III. Engis	neering Science: Flective Compulsory		

Course L0449: Technical Thermodynamics II		
Тур	Lecture	
Hrs/wk	2	
СР	4	
Workload in Hours	Independent Study Time 92, Study Time in Lecture 28	
Lecturer	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 Thermodynamics II		
Тур	Recitation Section (large)	
Hrs/wk	1	
СР	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
СР	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

Module M0959: Mecha	anics III (Dynamics)			
Courses				
Title Mechanics III (Dynamics) (L1134) Mechanics III (Dynamics) (L1135)		<b>Typ</b> Lecture Recitation Section (small)	<b>Hrs/wk</b> 3 2	<b>CP</b> 3 2
Mechanics III (Dynamics) (L1136)		Recitation Section (large)	1	1
Module Responsible	Prof. Robert Seifried			
Admission Requirements	None			
Recommended Previous	Mathematics I, II, Mechanics I (Statics)			
Knowledge				
Educational Objectives	After taking part successfully, students have reached the fol	lowing learning results		
Professional Competence				
Knowledge	The students can			
	describe the axiomatic procedure used in mechanical     explain important steps in model design;	contexts;		
	<ul> <li>present technical knowledge in stereostatics.</li> </ul>			
Skills	The students can			
	<ul> <li>explain the important elements of mathematical / method their own problems;</li> <li>apply basic hydrostatical, kinematic and kinetic method</li> <li>estimate the reach and boundaries of statical method</li> </ul>	ods to engineering problems;		
Borconal Compotonso				
Personal Competence	The students can work in groups and support each other to o	avorcomo difficultios		
30Clai Competence	The students can work in groups and support each other to	overcome difficulties.		
Autonomy	Students are capable of determining their own strengths and	d weaknesses and to organize the	ir time and learn	ing based on those.
Workload in Hours	Independent Study Time 96, Study Time in Lecture 84			
Credit points	6			
Course achievement	None			
Examination	Written exam			
Examination duration and	120 min			
scale				
Assignment for the	General Engineering Science (German program, 7 semester)	: Core Qualification: Compulsory		
Following Curricula	Data Science: Core Qualification: Elective Compulsory			
	Digital Mechanical Engineering: Core Qualification: Compulsi	•		
	Energy and Environmental Engineering: Core Qualification: E			
	Green Technologies: Energy, Water, Climate: Specialisation	Energy Technology: Elective Com	pulsory	
	Mechanical Engineering: Core Qualification: Compulsory			
	Mechatronics: Core Qualification: Compulsory Naval Architecture: Core Qualification: Compulsory			
	Technomathematics: Specialisation III. Engineering Science:	Flective Compulsory		
	recommendation action in Engineering Science.	Licetive Compulsory		

ourse L1134: Mechanics III	(Dynamics)
Тур	Lecture
Hrs/wk	3
СР	3
Workload in Hours	Independent Study Time 48, Study Time in Lecture 42
Lecturer	Prof. Robert Seifried
Language	DE
Cycle	WiSe
Content	Kinematics
	Kinematics of points and relative motion     Planar and spatial motion of point systems and rigid bodies  Dynamics     Terms     Fundamental equations     Motion of the rigid body in 3D-space     Dynamics of gyroscopes, rotors     Realtive kinetics     Systems with non-constant mass  Vibrations
Literature	K. Magnus, H.H. Müller-Slany: Grundlagen der Technischen Mechanik. 7. Auflage, Teubner (2009).
	D. Gross, W. Hauger, J. Schröder, W. Wall: Technische Mechanik 3 und 4. 11. Auflage, Springer (2011).

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

Course L1136: Mechanics III (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	СР
Analysis III (L1028) Analysis III (L1029)		Lecture Recitation Section (small)	2 1	2
Analysis III (L1030)		Recitation Section (Iarge)	1	1
Differential Equations 1 (Ordinary I		Lecture	2	2
Differential Equations 1 (Ordinary I Differential Equations 1 (Ordinary I		Recitation Section (small) Recitation Section (large)	1	1
Module Responsible		Recitation Section (large)		1
Admission Requirements	None			
Recommended Previous				
Knowledge				
Educational Objectives	After taking part successfully, students have reached the f	ollowing learning results		
Professional Competence				
Knowledge	Students can name the basic concepts in the area o	f analysis and differential equations	. They are able '	to explain them using
	appropriate examples.		,	
	Students can discuss logical connections between t	hese concepts. They are capable	of illustrating th	ese connections with
	the help of examples.			
	They know proof strategies and can reproduce them	i.		
Skills				
	Students can model problems in the area of analysi		help of the cor	ncepts studied in this
	course. Moreover, they are capable of solving them		ate studied in the	COURCO
	Students are able to discover and verify further logic     For a given problem, the students can develop ar			
	results.	a execute a suitable approach, an	a are able to e	riceany evaluate the
Personal Competence				
Social Competence	Students are able to work together in teams. They a	re capable to use mathematics as a	common langu	age.
	In doing so, they can communicate new concepts a			-
	design examples to check and deepen the understa	nding of their peers.		
Autonomy	Students are capable of checking their understandi	ng of complex concepts on their ov	wn. They can sp	ecify open questions
	precisely and know where to get help in solving the	m.		
	Students have developed sufficient persistence to	be able to work for longer periods	in a goal-orien	ted manner on hard
	problems.			
Workload in Hours	Independent Study Time 128, Study Time in Lecture 112			
Credit points				
Course achievement	None			
Examination	Written exam			
Examination duration and	60 min (Analysis III) + 60 min (Differential Equations 1)			
scale	Constant Family and a Colonia (Common and a Colonia Co	a) Com Ovelification Communication		
Assignment for the Following Curricula	General Engineering Science (German program, 7 semeste Civil- and Environmental Engineering: Core Qualification: C			
	Bioprocess Engineering: Core Qualification: Compulsory	· (		
	Digital Mechanical Engineering: Core Qualification: Compu	sory		
	Electrical Engineering: Core Qualification: Compulsory			
	Energy and Environmental Engineering: Core Qualification:			
	Green Technologies: Energy, Water, Climate: Core Qualific Computational Science and Engineering: Core Qualification			
	Logistics and Mobility: Specialisation Traffic Planning and S			
	Logistics and Mobility: Specialisation Production Management		sory	
	Logistics and Mobility: Specialisation Information Technolo	gy: Compulsory		
	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 Mob	ility: Specialisation Traffic Planning	and Systems: FI	ective Compulsory
	Engineering and Management - Major in Logistics and Mob			
	Compulsory	•	-	
	Engineering and Management - Major in Logistics and Mob	lity: Specialisation Information Tech	ınology: Compul	sory

Course L1028: Analysis III	
Тур	Lecture
Hrs/wk	2
СР	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Dozenten des Fachbereiches Mathematik der UHH
Language	DE
Cycle	WiSe
Content	Main features of differential and integrational calculus of several variables
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> <li>http://www.math.uni-hamburg.de/teaching/export/tuhh/index.html</li> </ul>

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

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

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

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

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

Module M0672: Signa	ls 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 syst	ome Good knowledge in mathe	as covered by th	o module Mathematik
	1-3 is expected. Further experience with spectral transformation	-	-	
	but not required.	ations (Fourier Series, Fourier tre	ansionn, Euplace	dunsionny is ascial
Educational Objectives	After taking part successfully, students have reached the follo	owing learning results		
Professional Competence				
Knowledge	The students are able to classify and describe signals and lir	near time-invariant (LTI) systems	using methods	of signal and system
	theory. They are able to apply the fundamental transformati		_	
	can describe and analyse deterministic signals and systems	•	-	
	understand the effects in time domain and image domain	which are caused by the transit	tion of a continu	ious-time signal to a
	discrete-time signal.			
Skills	The students are able to describe and analyse deterministic	-		-
	system theory. They can analyse and design basic system response, stability, linearity etc They can assess the impact			
Personal Competence	response, stability, illiearity etc They can assess the impact	or Err systems on the signar prop	percies in cline ai	na frequency domain.
•	The students can jointly solve specific problems.			
	The students are able to acquire relevant information from	om annronriate literature sourc	es They can c	control their level of
Autonomy	knowledge during the lecture period by solving tutorial proble		-	ontrol then level of
Workload in Hours	Independent Study Time 110, Study Time in Lecture 70	and, soremand tools, ellerer syste		
Credit points	, ,			
Course achievement				
Examination	Written exam			
Examination duration and	90 min			
scale				
Assignment for the	General Engineering Science (German program, 7 semester):	Core Qualification: Compulsory		
Following Curricula				
	Computer Science: Specialisation II. Mathematics and Engine	ering Science: Elective Compulso	ory	
	Data Science: Core Qualification: Compulsory			
	Electrical Engineering: Core Qualification: Compulsory			
	Computational Science and Engineering: Core Qualification: C	Compulsory		
	Mechanical Engineering: Specialisation Mechatronics: Elective	e Compulsory		
	Mechatronics: Core Qualification: Compulsory			
	Technomathematics: Specialisation III. Engineering Science: E	Elective Compulsory		

Тур	Lecture
Hrs/wk	3
СР	4
Workload in Hours	Independent Study Time 78, Study Time in Lecture 42
Lecturer	Prof. Gerhard Bauch
Language	DE/EN
Cycle	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>
	Basic properties of signals and operations on signals
	Elementary signals
	Distributions (Generalized Functions)
	Power and energy of signals
	Correlation functions of deterministic signals
	<ul> <li>Autocorrelation function</li> </ul>
	<ul><li>Crosscorrelation function</li></ul>
	<ul> <li>Orthogonal signals</li> </ul>
	<ul><li>Applications of correlation</li></ul>
	Linear time-invariant (LTI) systems
	Linearity
	Time-invariance

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

## Literature

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

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

Module M0833: Intro	duction to Control Systems			
Courses				
Title		Тур	Hrs/wk	СР
Introduction to Control Systems (LC		Lecture	2	4
Introduction to Control Systems (LC		Recitation Section (small)	2	2
Module Responsible				
Admission Requirements	None			
Recommended Previous Knowledge	Representation of signals and systems in time and frequence	y domain, Lapiace transform		
Kilowieuge				
Educational Objectives	After taking part successfully, students have reached the fol	llowing learning results		
Professional Competence	Arter taking part successionly, students have reached the lo	nowing rearring results		
Knowledge				
	Students can represent dynamic system behavior in	time and frequency domain, and	can in particular	explain properties of
	first and second order systems			
	They can explain the dynamics of simple control loop root locus	s and interpret dynamic propertie	s in terms of fred	luency response and
	They can explain the Nyquist stability criterion and the	e stability margins derived from it	-	
	They can explain the role of the phase margin in anal			
	They can explain the way a PID controller affects a co			
	They can explain issues arising when controllers design.			digitally
CL '''				
Skills	Students can transform models of linear dynamic sys	tems from time to frequency dom	ain and vice vers	a
	They can simulate and assess the behavior of system	s and control loops		
	They can design PID controllers with the help of heuri	stic (Ziegler-Nichols) tuning rules		
	They can analyze and synthesize simple control loops			
	They can calculate discrete-time approximations	of controllers designed in con-	tinuous-time and	d use it for digital
	implementation	T " 6' " 1' 1' 6		
	They can use standard software tools (Matlab Control	Toolbox, Simulink) for carrying or	it these tasks	
Personal Competence				
Social Competence	Students can work in small groups to jointly solve technical	problems, and experimentally vali	date their contro	ller designs
Autonomy	Students can obtain information from provided sources (le	ecture notes, software document	ation, experimen	t guides) and use it
	when solving given problems.			
	They can assess their knowledge in weekly on-line tests and	I thereby control their learning pro	gress.	
Workload in Hours	Independent Study Time 124 Study Time in Lecture 56			
Credit points	Independent Study Time 124, Study Time in Lecture 56			
Course achievement				
	Written exam			
Examination duration and				
scale	120 11111			
Assignment for the		): Core Qualification: Compulsory		
Assignment for the Following Curricula	Bioprocess Engineering: Core Qualification: Compulsory	, ,		
-	Bioprocess Engineering: Core Qualification: Compulsory Chemical and Bioprocess Engineering: Core Qualification: Co	, ,		
-	Bioprocess Engineering: Core Qualification: Compulsory Chemical and Bioprocess Engineering: Core Qualification: Co Data Science: Core Qualification: Elective Compulsory	ompulsory		
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Course L0654: Introduction t	o Control Systems
Тур	Lecture
Hrs/wk	2
СР	4
Workload in Hours	Independent Study Time 92, Study Time in Lecture 28
Lecturer	Prof. Herbert Werner
Language	DE
Cycle	WiSe
Content	Signals and systems  Linear systems, differential equations and transfer functions First and second order systems, poles and zeros, impulse and step response Stability  Feedback systems  Principle of feedback, open-loop versus closed-loop control Reference tracking and disturbance rejection Types of feedback, PID control System type and steady-state error, error constants Internal model principle  Root locus techniques Root locus design of PID controllers  Frequency response techniques  Bode diagram Minimum and non-minimum phase systems Nyquist plot, Nyquist stability criterion, phase and gain margin Loop shaping, lead lag compensation
	Frequency response interpretation of PID control  Time delay systems     Root locus and frequency response of time delay systems     Smith predictor  Digital control
	Sampled-data systems, difference equations Tustin approximation, digital implementation of PID controllers  Software tools Introduction to Matlab, Simulink, Control toolbox Computer-based exercises throughout the course
Literature	<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 to Control Systems	
Тур	Recitation Section (small)
Hrs/wk	2
СР	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Prof. Herbert Werner
Language	DE
Cycle	WiSe
Content	See interlocking course
Literature	See interlocking course

Module M0829: Found	dations of Management			
Courses		Ŧ	H fl-	C.D.
Title Management Tutorial (L0882)		<b>Typ</b> Recitation Section (small)	Hrs/wk 2	<b>CP</b> 3
Introduction to Management (L088	0)	Lecture	3	3
Module Responsible	Prof. Christoph Ihl			
Admission Requirements	None			
Recommended Previous	Basic Knowledge of Mathematics and Business			
Knowledge				
Educational Objectives	After taking part successfully, students have reached the	following learning results		
Professional Competence  Knowledge	After taking this module, students know the important b	asics of many different areas in Busir	ness and Manage	ment, from Planning
	and Organisation to Marketing and Innovation, and also t	o Investment and Controlling. In part	icular they are al	ole to
	explain the differences between Economics an	d Management and the sub-discip	lines in Manage	ment and to name
	important definitions from the field of Managemer			
	<ul> <li>explain the most important aspects of and goals</li> </ul>	in Management and name the most	important aspe	cts of entreprneuria
	projects			
	describe and explain basic business functions			
	organization and human ressource management, • explain the relevance of planning and decision	-	-	_
	uncertainty, and explain some basic methods from		dons under mu	upie objectives and
	state basics from accounting and costing and sele			
Ckilla	Students are able to analyse business units with respect	to different criteria (organization, oh	viactivas stratag	inc atc.) and to carry
SKIIIS	Students are able to analyse business units with respect out an Entrepreneurship project in a team. In particular,		njectives, strateg	es etc.) and to carry
	analyse Management goals and structure them ap	nronriately		
	analyse organisational and staff structures of com			
	apply methods for decision making under multiple		nder risk	
	analyse production and procurement systems and			
	analyse and apply basic methods of marketing			
	<ul> <li>select and apply basic methods from mathematical</li> </ul>	I finance to predefined problems		
	<ul> <li>apply basic methods from accounting, costing and</li> </ul>	controlling to predefined problems		
Personal Competence				
Social Competence	Students are able to			
	<ul> <li>work successfully in a team of students</li> </ul>			
	<ul> <li>to apply their knowledge from the lecture to an er</li> </ul>	trepreneurship project and write a co	herent report on	the project
	to communicate appropriately and			
	to cooperate respectfully with their fellow students	5.		
Autonomy	Students are able to			
	work in a team and to organize the team themselv	P.S.		
	to write a report on their project.	es es		
Workload in Hours	Independent Study Time 110, Study Time in Lecture 70			
Credit points	6			
Course achievement	None			
Examination	,			
	several written exams during the semester			
scale	Constant Familia and a Colombia (Common and a constant a Colombia	hank Cana Qualification Communication		
Assignment for the Following Curricula	General Engineering Science (German program, 7 semes Civil- and Environmental Engineering: Specialisation Civil			
i Showing Curricula	Civil- and Environmental Engineering: Specialisation Civil Civil- and Environmental Engineering: Specialisation Wat		sory	
	Civil- and Environmental Engineering: Specialisation Traf	·	,	
	Bioprocess Engineering: Core Qualification: Compulsory			
	Computer Science: Core Qualification: Compulsory			
	Data Science: Core Qualification: Compulsory			
	Data Science: Core Qualification: Compulsory			
	Electrical Engineering: Core Qualification: Compulsory	nnulsary		
	Computer Science in Engineering: Core Qualification: Con Integrated Building Technology: Core Qualification: Comp			
	Logistics and Mobility: Core Qualification: Compulsory	· · · · · · · · · · · · · · · · · · ·		
	Mechanical Engineering: Core Qualification: Compulsory			
	Mechatronics: Core Qualification: Compulsory			
	Orientation Studies: Core Qualification: Elective Compuls	•		
	Orientation Studies: Core Qualification: Elective Compuls	ory		
	Naval Architecture: Core Qualification: Compulsory			
	Technomathematics: Core Qualification: Compulsory Process Engineering: Core Qualification: Compulsory			
	Engineering and Management - Major in Logistics and Mc	bility: Core Qualification: Compulsory	/	
		, (xzzz.z compaisor)		

Course L08	882: Management Tutorial
Тур	Recitation Section (small)
Hrs/wk	2
СР	3
Workload	Independent Study Time 62, Study Time in Lecture 28
in Hours	
Lecturer	Prof. Christoph Ihl, Katharina Roedelius
Language	DE
Cycle	WiSe/SoSe
Content	In the management tutorial, the contents of the lecture will be deepened by practical examples and the application of the discussed tools.
	If there is adequate demand, a problem-oriented tutorial will be offered in parallel, which students can choose alternatively. Here, students work in groups on se selected projects that focus on the elaboration of an innovative business idea from the point of view of an established company or a startup. Again, the busine knowledge from the lecture should come to practical use. The group projects are guided by a mentor.
Literature	Relevante Literatur aus der korrespondierenden Vorlesung.

Course L0880: Introduction t	o Management
Тур	Lecture
Hrs/wk	3
СР	3
Workload in Hours	Independent Study Time 48, Study Time in Lecture 42
Lecturer	Prof. Christoph Ihl, Prof. Thorsten Blecker, Prof. Christian Lüthje, Prof. Christian Ringle, Prof. Kathrin Fischer, Prof. Cornelius Herstatt, Prof. Wolfgang Kersten, Prof. Matthias Meyer, Prof. Thomas Wrona
Language	DE DE
Cycle	WiSe/SoSe
Content	<ul> <li>Introduction to Business and Management, Business versus Economics, relevant areas in Business and Management</li> <li>Important definitions from Management,</li> <li>Developing Objectives for Business, and their relation to important Business functions</li> <li>Business Functions: Functions of the Value Chain, e.g. Production and Procurement, Supply Chain Management, Innovation Management, Marketing and Sales</li> <li>Cross-sectional Functions, e.g. Organisation, Human Ressource Management, Supply Chain Management, Information Management</li> <li>Definitions as information, information systems, aspects of data security and strategic information systems</li> <li>Definition and Relevance of innovations, e.g. innovation opporunities, risks etc.</li> <li>Relevance of marketing, B2B vs. B2C-Marketing</li> <li>different techniques from the field of marketing (e.g. scenario technique), pricing strategies</li> <li>important organizational structures</li> <li>basics of human ressource management</li> <li>Introduction to Business Planning and the steps of a planning process</li> <li>Decision Analysis: Elements of decision problems and methods for solving decision problems</li> <li>Selected Planning Tasks, e.g. Investment and Financial Decisions</li> <li>Introduction to Accounting: Accounting, Balance-Sheets, Costing</li> <li>Relevance of Controlling and selected Controlling methods</li> <li>Important aspects of Entrepreneurship projects</li> </ul>
Literature	Bamberg, G., Coenenberg, A.: Betriebswirtschaftliche Entscheidungslehre, 14. Aufl., München 2008  Eisenführ, F., Weber, M.: Rationales Entscheiden, 4. Aufl., Berlin et al. 2003
	Heinhold, M.: Buchführung in Fallbeispielen, 10. Aufl., Stuttgart 2006.
	Kruschwitz, L.: Finanzmathematik. 3. Auflage, München 2001.
	Pellens, B., Fülbier, R. U., Gassen, J., Sellhorn, T.: Internationale Rechnungslegung, 7. Aufl., Stuttgart 2008.
	Schweitzer, M.: Planung und Steuerung, in: Bea/Friedl/Schweitzer: Allgemeine Betriebswirtschaftslehre, Bd. 2: Führung, 9. Aufl. Stuttgart 2005.
	Weber, J., Schäffer, U.: Einführung in das Controlling, 12. Auflage, Stuttgart 2008.
	Weber, J./Weißenberger, B.: Einführung in das Rechnungswesen, 7. Auflage, Stuttgart 2006.

Module M1273: Adva	nced Internship AIW/ ES			
Courses				
Title		Тур	Hrs/wk	СР
Advanced Intenship AIW/ ES: Intern Advanced Internship AIW/ ES: Prepa	ıship-accompanying Seminar (L2687) aration (L2682)	Seminar Seminar	1	0
Module Responsible			<del>-</del>	-
Admission Requirements				
Recommended Previous	150 Creditpoints in General Engineering Science			
Knowledge				
Educational Objectives	After taking part successfully, students have rea	ched the following learning results		
Professional Competence				
Knowledge	Students of the different specialisations get experiences in typical scope of duties of engineers, who are working in a development division, planning division or in the management of a company. In the framework of this environment the knowledge from university can used a first time for real engineering tasks.			
Skills	Students of the different specialisations should be integrated in typical day's work. By this they are learning typical tasks and functions of engineers. They are able to structure and organize their working day and to finish tasks in a certain time.			
Personal Competence				
Social Competence	Students are able to cooperate with co-workers i	in a company and to understand the la	nguage of engineers.	
Autonomy	Students can finish own tasks.			
Workload in Hours	Independent Study Time 512, Study Time in Lec	ture 28		
Credit points	18			
Course achievement	None			
Examination	Written elaboration (accord. to Internship Regulations)			
Examination duration and	see Internship Regulations			
scale				
•	General Engineering Science (German program,		ulsory	
Following Curricula	Engineering Science: Core Qualification: Compul	sory		

Course L2687: Advanced Intenship AIW/ ES: Internship-accompanying Seminar			
Тур	Seminar		
Hrs/wk	1		
СР	0		
Workload in Hours	Independent Study Time -14, Study Time in Lecture 14		
Lecturer	Prof. Robert Seifried, Eilika Schwenke		
Language	DE/EN		
Cycle	WiSe/SoSe		
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			

Course L2682: Advanced Internship AIW/ ES: Preparation		
Тур	Seminar	
Hrs/wk	1	
СР	0	
Workload in Hours	Independent Study Time -14, Study Time in Lecture 14	
Lecturer	Prof. Robert Seifried, Eilika Schwenke	
Language	DE/EN	
Cycle	WiSe/SoSe	
Content	The aim of the internship preparation (recommended in the 5th semester) is to acquire competences that are relevant for successfully searching for and doing the advanced internship in the 7th semester. Participation increases the students' chances of finding an internship of at least three months length and, if applicable, in English language, at the specified time. It also serves as a networking opportunity for the AIW/ES students. Participation in the 5th semester is recommended for a timely internship application.  The seminar focuses on the topics of internship search, application and transfer competence. The students reflect on their already existing competences, skills and interests and learn which different employers are available for the engineering profession and how to find them. They continue to reflect on which topics of their studies they would like to try out in practical transfer in activities (theory-practice transfer) and look for suitable employers (if necessary under guidance). Contact is made with companies and other employers in the Hamburg metropolitan region who are potential employers for TUHH graduates. The students are supported in creating an appealing CV and cover letter. They practise presenting themselves in a job interview and complete a mock interview. They receive feedback from their fellow students and the teachers, gain self-confidence and increase their chances of finding an internship that is a good fit for them.  The seminar strengthens the students' independence. The concrete application example of the advanced internship promotes the acquisition and consolidation of competences of career management skills, which can be transferred to later career steps. It also contributes to the interaction of theory and practice. Transfer in this context is "the successful application of previously acquired knowledge or 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.

Module M0580: Princi	ples of Building Materials and	Building Physics		
Courses				
Title		Тур	Hrs/wk	СР
Building Physics (L0217)		Lecture	2	2
Building Physics (L0219)		Recitation Section (large)	1	1
Building Physics (L0247)	ME)	Recitation Section (small)	1	1
Principles of Building Materials (L02	Prof. Frank Schmidt-Döhl	Lecture	2	2
Admission Requirements				
	Knowledge of physics, chemistry and mathem	natics from school		
Knowledge	introvicage of physics, elembery and matricin	adies from serioor		
Educational Objectives	After taking part successfully, students have r	reached the following learning results		
Professional Competence				
Knowledge	The students are able to identify fundamental	effects of action to materials and structures, to	explain different	types of mechanical
	behaviour, to describe the structure of bui	ilding materials and the correlations between	structure and	other properties, to
	show methods of joining and of corrosion pr	ocesses and to describe the most important r	egularities and p	roperties of building
	materials and structures and their measureme	ent in the field of protection against moisture, c	oldness, fire and	noise.
Sville	The students are able to work with the most	important standardized methods and regulariti	es in the field of	moisture protection
Skills		protection and noise protection in the case of a		moisture protection,
		F		
Personal Competence				
Social Competence	The students are able to support each other to	o learn the very extensive specialist knowledge.		
Autonomy	The students are able to make the timing and the operation steps to learn the specialist knowledge of a very extensive field.			
Workload in Hours	Independent Study Time 96, Study Time in Le	cture 84		
Credit points	6			
Course achievement	None			
Examination	Written exam			
Examination duration and	2 h written exam			
scale				
Assignment for the	General Engineering Science (German program	m, 7 semester): Specialisation Civil Engineering	: Compulsory	
Following Curricula	Civil- and Environmental Engineering: Core Qu	ualification: Compulsory		
	Orientation Studies: Core Qualification: Electiv	ve Compulsory		
	Technomathematics: Specialisation III. Engine	ering Science: Elective Compulsory		

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

Course L0247: Building 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 Building Materials	
Тур	Lecture
Hrs/wk	2
СР	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Prof. Frank Schmidt-Döhl
Language	DE
Cycle	WiSe
Content	Structure of building materials
	Effects of action
	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

Module M0740: Struc	tural Analysis I				
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				
Recommended Previous	Mechanics I, Mathem	atics I			
Knowledge					
Educational Objectives	After taking part succ	cessfully, students have re	ached the following learning results		
Professional Competence					
Knowledge	After successfully consystems.	mpleting this module, stud	ents can express the basic aspects of linear	frame analysis of s	statically determinate
Skills		able to analyze state va	e students are able to distinguish between striables and to construct influence lines of s	-	
Personal Competence Social Competence	Students can				
	defend their or	subject-specific and interd wn work results in front of cientific development of co	others		
	·	•	professional constructive criticism		
Autonomy		le work in-term homeworl ring the lecture period, alr	c assignments. Due to the in-term feedback eady.	k, they are enable	d to self-assess their
Workload in Hours	Independent Study T	ime 124, Study Time in Le	cture 56		
Credit points	6				
Course achievement	No 10 %	Form Written elaboration	<b>Description</b> Hausübungen mit Testat, betreut durch	Studentische Tuto	ren (Tutorium)
Examination	Written exam				
Examination duration and scale	90 Minuten				
Assignment for the	General Engineering	Science (German program	, 7 semester): Specialisation Civil Engineerin	g: Compulsory	
Following Curricula	Civil- and Environmen	ntal Engineering: Core Qua	alification: Compulsory		
	Logistics and Mobility	: Specialisation Traffic Pla	nning and Systems: Elective Compulsory		
	Technomathematics:	Specialisation III. Enginee	ring Science: Elective Compulsory		
	Engineering and Man	agement - Major in Logisti	cs and Mobility: Specialisation Traffic Plannir	ng and Systems: El	ective Compulsory

Course L0666: Structural Ana	alysis I
Тур	Lecture
Hrs/wk	2
СР	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Prof. Uwe Starossek
Language	DE
Cycle	WiSe
Content	basics: statically determinacy, equilibrium, method of sections     forces: determination of support reactions and internal forces     influence lines of forces     displacements: calculation of discrete displacements and rotations, calculation of deflection curves     principle of virtual displacements and virtual forces     work-engergy theorem     differential equation of beam
Literature	Krätzig, W.B., Harte, R., Meskouris, K., Wittek, U.: Tragwerke 1 - Theorie und Berechnungsmethoden statisch bestimmter Stabtragwerke. 4. Aufl., Springer, Berlin, 1999.

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

Module M0590: Buildi	ing Materials an	d Building C	hemistry			
Courses						
Title				Тур	Hrs/wk	СР
Building Materials and Building Che	-			Lecture	4	4
Building Materials and Building Che	1				2	
·	Prof. Frank Schmidt-Dö	oni				
		None				
	Module Principles of Bu	Module Principles of Building Materials and Building Physics				
Knowledge	After telder a sect our					
Educational Objectives	After taking part succe	ssfully, students h	ave reached the followi	ng learning results		
Professional Competence	The students are ab-					
Knowieage		mechanical behav	•	ponents, the manufacture behaviour, the material te		
Skills	The students are able to assess the usability of building materials for different applications and to select building materials according to their specific advantages and disadvantages. The students are able to prepare the mixture of a normal type concrete and to consider the mixture in respect to the actual rules and the connections between the characteristic concrete parameters. They are able to select suitable materials and mixtures to avoid damage processes.					
Personal Competence						
Social Competence	The students are able exercises in small grou		ther to learn the very e	extensive specialist knowled	dge in learning gro	ups and to carry out
Autonomy	The students are able	to make the timing	g and the operation step	s to learn the specialist kno	owledge of a very e	xtensive field.
Workload in Hours	Independent Study Tin	ne 110, Study Time	e in Lecture 70			
Credit points						
Course achievement	Compulsory Bonus No 10 %	Form Presentation	Description			
Examination						
Examination duration and	2 h written exam					
scale						
Assignment for the	General Engineering So	cience (German pr	ogram, 7 semester): Sp	ecialisation Civil Engineerin	ıg: Compulsory	
-	Civil- and Environment		-	-		
	Orientation Studies: Co	ore Qualification: E	lective Compulsory			

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

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

Module M0613: Reinfo	orced Concrete Structures	I			
Courses					
Title	Title		Тур	Hrs/wk	СР
Project Seminar Concrete I (L0896)			Seminar	1	1
Reinforced Concrete Design I (L030			Lecture Recitation Section (large)	2	3
Reinforced Concrete Design I (L030  Module Responsible			Recitation Section (large)	2	2
Admission Requirements					
-	Basic knowledge in structural analysis	and building materials.			
Knowledge	Modules: Structural Analysis I, Mechanics I+II				
Educational Objectives	After taking part successfully, students	s have reached the following	ng learning results		
Professional Competence					
Knowledge	The students can outline the history of concrete construction and explain the basics of structural engineering, including usual load combinations and safety concepts. They are able to draft and dimension simple structures, as well as to evaluate and discuss the				
Skills	behaviour of the materials and of structures.  The students are able to apply basic properties of the students are able to apply basic properties of the students are able to apply basic properties. The students are able to apply basic properties of the students are able to apply basic properties.	procedures of the concepti lesign them for bending	and bending with axial for	ce, and to plan	·
Personal Competence Social Competence					
Autonomy	The students are able to carry out simple	ple tasks in the conception	and dimensioning of structur	res and to critical	lly reflect the results.
Workload in Hours	Independent Study Time 110, Study Ti	me in Lecture 70			
Credit points	6				
Course achievement	CompulsoryBonusFormYesNoneExcercises	Description			
Examination	Written exam				
Examination duration and	120 minutes				
scale					
Assignment for the				Compulsory	
Following Curricula	Civil- and Environmental Engineering:	Core Qualification: Compu	sory		

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

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

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

Educational Objectives After taking part Professional Competence Knowledge After successful indeterminate states of the successful indeterminate of the succes	issek	<b>Typ</b> Lecture Recitation Section (large)	Hrs/wk 2 2	СР
Title Structural Analysis II (L0673) Structural Analysis II (L0674)  Module Responsible Admission Requirements Recommended Previous Knowledge  Educational Objectives Professional Competence Knowledge  Structural  After taking particular indeterminate structurals	issek	Lecture	2	-
Module Responsible Admission Requirements Recommended Previous Knowledge  Mechanie Mathema Different Structura  Educational Objectives Frofessional Competence Knowledge  Knowledge After successful	ossek			3
Admission Requirements Recommended Previous Knowledge  Mechania Mathema Different Structura  Educational Objectives Professional Competence Knowledge After taking part indeterminate structural  Skills After successful				
Knowledge  Mathema Different Structura  Educational Objectives Professional Competence Knowledge After successfue indeterminate structural  Skills After successfue				
Professional Competence  Knowledge After successful indeterminate statements  Skills After successful				
Knowledge After successful indeterminate successful skills After successful skills	rt successfully, students have r	eached the following learning results		
indeterminate s  Skills After successfu				
	systems.	the students are able to analyze state varial and truss structures.		
Personal Competence Social Competence Students can • participa	ate in subject-specific and inter	disciplinary discussions,		
<ul><li>promote</li><li>Furtherm</li></ul> Autonomy The students a		colleagues professional constructive criticism work assignments. Due to the in-term feedbac	ck, they are enabled	d to self-assess their
Workload in Hours Independent St	tudy Time 124, Study Time in L	ecture 56		
Credit points 6				
Course achievement Compulsory Bond		Description  Hausübungen mit Testat, betreut durch	Studentische Tutor	en (Tutorium)
Examination Written exam		aasasangen mit restat, betreat durch		(1000110111)
Examination duration and 90 Minuten scale				
Assignment for the General Engine Following Curricula Civil- and Envir				

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

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

Module M0611: Steel	Structures I			
Courses				
Title		Тур	Hrs/wk	СР
Steel Structures I (L0299)		Lecture	2	3
Steel Structures I (L0300)	_	Recitation Section (large)	2	3
Module Responsible	Prof. Marcus Rutner			
Admission Requirements	None			
Recommended Previous Knowledge	Structural analysis I Structural analysis II	cs		
Educational Objectives	After taking part successfully, students have reached th	e following learning results		
Professional Competence				
Knowledge	After passing this module students are able to			
Skills	give a summary of the security concept     explain the priciples of the design process     describe and illustrate the bhaviour of memers in Students can rate and apply the material steel appropia	tely with respect to its properties and	usage.	
	They can use the security concept with respect to loads  They can check the ultimate limit state and the services		compression and I	pending.
Personal Competence				
Social Competence	After participation of an optional course (building of a	simple truss) they are able to organiz	e themselves in	groups. They will be
	successful in guided building a truss with bolted connec	tions according to design drawings.		
Autonomy				
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56			
Credit points	6			
Course achievement	None			
Examination	Written exam			
Examination duration and	120 minutes			
scale				
Assignment for the	General Engineering Science (German program, 7 seme	ster): Specialisation Civil Engineering:	Compulsory	
Following Curricula	Civil- and Environmental Engineering: Core Qualification	: Compulsory		

Course L0299: Steel Structur	res I
Тур	Lecture
Hrs/wk	2
СР	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Prof. Marcus Rutner
Language	DE
Cycle	WiSe
Content	Introduction to steel constructions  Materials  Design and security model  Tension rods  Beams (elsatic and plastic design  Column design  Bolted connections
Literature	Petersen, C.: Stahlbau, 4. Auflage 2013, Springer-Vieweg Verlag  Wagenknecht, G.: Stahlbau-Praxis nach Eurocode 3, Bauwerk-Verlag 2011  Band 1 Tragwerksplanung, Grundlagen Band 2 Verbindungen und Konstruktionen

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

Module M0706: Geote	echnics I					
Courses						
Title				Тур	Hrs/wk	СР
Soil Mechanics (L0550)				Lecture	2	2
Soil Mechanics (L0551)				Recitation Section (large)	2	2
Soil Mechanics (L1493)				Recitation Section (small)	2	2
Module Responsible	Prof. Jürgen Grabe					
Admission Requirements	None					
Recommended Previous	Modules :					
Knowledge	Mechanics I-II					
Educational Objectives	After taking part succ	essfully, students	have reached the followi	ng learning results		
Professional Competence						
Knowledge	The students know th	ne basics of soil m	echanics as the structure	and characteristics of soil, s	tress distribution	due to weight, water
	or structures, consoli	dation and settlen	nent calculations, as well	as failure of the soil due to g	round- or slope fa	ilure.
Skills	After the successful of	completion of the	module the students sho	uld be able to describe the r	mechanical prope	rties and to evaluate
	them with the help of	them with the help of geotechnical standard tests. They can calculate stresses and deformation in the soils due to weight or				
	influence of structures. They are are able to prove the usability (settlements) for shallow foundations.					
Personal Competence						
Social Competence						
Autonomy						
	Independent Study Ti	me 96, Study Tim	ne in Lecture 84			
Credit points						
Course achievement	No 20 %	Form	Description			
F		Attestation				
Examination						
Examination duration and	90 minutes					
scale						
Assignment for the				ecialisation Civil Engineering	: Compulsory	
Following Curricula			Core Qualification: Compu	•		
		•	raffic Planning and System			
		•	Engineering Science: Elec			
	Engineering and Man	agement - Major i	n Logistics and Mobility: S	Specialisation Traffic Planning	and Systems: Ele	ective Compulsory

Course L0550: Soil Mechanic	s
Тур	Lecture
Hrs/wk	2
СР	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Prof. Jürgen Grabe
Language	DE
Cycle	WiSe/SoSe
Content	<ul> <li>Structure of the soil</li> <li>Ground surveying</li> <li>Compsitition 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 Mechanics		
Тур	Recitation Section (large)	
Hrs/wk	2	
СР	2	
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28	
Lecturer	Prof. Jürgen Grabe	
Language	DE	
Cycle	WiSe/SoSe	
Content	See interlocking course	
Literature	See interlocking course	

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

Module M0728: Hydro	mechar	nics and	d Hydrology				
Courses							
Title Hydrology (L0909) Hydrology (L0956) Hydromechanics (L0615)					<b>Typ</b> Lecture Project-/problem-based Learning Lecture	Hrs/wk 1 1 2	CP 1 2 2
Hydromechanics (L0616)	1				Project-/problem-based Learning	1	1
Module Responsible	Prof. Peter	Fröhle					
Admission Requirements	None						
Recommended Previous Knowledge	Mathemati Mechanics	,	III				
Educational Objectives	Δfter takin	a nart succ	cessfully, students have r	eached the followi	ng learning results		
Professional Competence	Arter takin	g part sact	essiany, seadenes have i	cuerica ene ronowi	ing rearring results		
·	They are a and quant rainfall-run	The students are able to define the basic terms of hydromechanics, hydrology groundwater hydrology and water management. They are able to derive the basic formulations of i) hydrostatics, ii) kinematics of flows and iii) conservation laws and to describe and quantify the relevant processes of the hydrological water cycle. Besides, the students can describe the main aspects of rainfall-run-off-modelling and of established reservoir / storage models as well as the concepts of the determination of a unit-hydrograph.					
Skills	able to run Besides, th	The students are able to apply the fundamental formulations of hydromechanics to basic practical problems. Furthermore, they are able to run, explain and document basic hydraulic experiments.  Besides, they are able to apply basic hydrological approaches and methods to simple hydrological problems. The students have the capability to exemplarily apply simple reservoir/storage models and a unit-hydrograph to given problems.					
		In addition, the basic concepts of field-measurements of hydrological and hydrodynamic values can be described and the students are able to perform, analyze and assess respective measurements.					
Personal Competence Social Competence	The students are able to work in groups in a goal-orientated, structured manner. They can explain their results sustainably in plenary sessions by use of peer learning approaches. Furthermore, they are able to prepare and present technical presentations for given topics in groups.						
Autonomy	specific kn	Students are capable of organising their individual work flow to contribute to the conduct of experiments and to present discipline- specific knowledge. They can provide each other with feedback and suggestions on their results. They are capable of reflecting their study techniques and learning strategy on an individual basis.					
Workload in Hours	Independe	nt Study T	ime 110, Study Time in L	ecture 70			
Credit points	6						
Course achievement	Yes Yes Yes	None None None	Form Group discussion  Excercises Subject theoretical practical work	Hydrologie ir Übungsaufga andDurchführun	ine Posters zu einer Themat n Gruppen und Präsentation nben Hydrologie g, Dokumentation und Prä: nik oder Hydraulik in Gruppen		
Examination	Written ex	am		,	7		
Examination duration and scale							
Assignment for the Following Curricula	Civil- and E Logistics a	Environments and Mobility	ntal Engineering: Core Qu r: Specialisation Traffic Pl	ualification: Compu anning and Systen	•	, ,	ective Compulsory

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

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

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

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

Module M0579: Struc	tural Design			
Courses				
Title	Тур		Hrs/wk	СР
Basics in Structural Design (L0209)		roblem-based Learning	2	4
Basics of Structural Design (L0205)	Lecture		2	1
Basics in Structural Design (L0208)		n Section (large)	1	1
Module Responsible	Sebastian Rybczynski			
Admission Requirements	None			
Recommended Previous  Knowledge	Contents of module "Principles of Building Materials and Building Physics"			
Educational Objectives	After taking part successfully, students have reached the following learnin	a recults		
Professional Competence	After taking part successfully, students have reached the following learning	g results		
•	After attending the "Building Construction" module students are able			
	to define the basics of building regulations law			
	to explain load effects and associated concepts			
	<ul> <li>to describe overriding conventions of the construction industry</li> </ul>			
	<ul> <li>to specify typical building components</li> </ul>			
	<ul> <li>to distinguish between different possibilities of load bearing behavior</li> </ul>	our and risks due to lac	k of stability	
	<ul> <li>to explain the main objectivs of fire control.</li> </ul>			
Skills	After the successful completion of the "Building Construction" module, stu	dents will be able		
	to apply industry-specific drawing conventions			
	carry out preliminary dimensioning of basic building components			
	<ul> <li>develop stability and foundation concepts</li> </ul>			
	use BIM software			
	and to design and construct standard cross-sections due to structur	al aspects.		
Personal Competence				
•	After attending the course students are able			
	• to work in a team and to persent the results of the team work			
	<ul> <li>to use the feedback from other students to improve the own results</li> </ul>			
	to give a feedback to other students in a constructive manner			
Autonomy	After attending the course students are able			
	to control and improve their knowledge with the help of weeekly pro-	esentations (lecture roc	m) and tests	(STUD.IP)
	to divide the main task in different parts, to deduce the needed kno			
Workload in Hours	Independent Study Time 110, Study Time in Lecture 70			
Credit points	6			
Course achievement	None			
Examination	Subject theoretical and practical work			
Examination duration and scale	Desing, Construction and prelimnary design in a written form			
Assignment for the	General Engineering Science (German program, 7 semester): Specialisation	n Civil Engineering: Co	mpulsory	
Following Curricula	Civil- and Environmental Engineering: Core Qualification: Compulsory	5	,	
<b>3</b>	Integrated Building Technology: Core Qualification: Compulsory			

Course L0209: Basics in Stru	ctural Design
Тур	Project-/problem-based Learning
Hrs/wk	2
СР	4
Workload in Hours	Independent Study Time 92, Study Time in Lecture 28
Lecturer	
Language	
Cycle	
Content	
	Constructing a small individuell building in groups of 4 persons
	Analysing the informations and the contents of development plans and buildling regulation laws
	Design of building components and approving of the funcionality (sealing, facades, roofs)  And the first state of the funcionality (sealing, facades, roofs)
	Design and approve of the funcionality of the component interconnections  Proof is an advantage of maintage has been in the component interconnections.
	Proofing and assessing of moisture behaviour, energy comsumption, acoustic protection and fire control  Assessing the building stability.
	Assessing the building stability      Region of building sonitors
	Basics of building services     Fach week the results of different work stops are presented in oral and written form.
	Each week the results of different work steps are presented in oral and written form
Literature	Vortragsfolien der Lehrveranstaltung stehen über STUD.IP zum download zur Verfügung
	Neumann, Dietrich (Hestermann, Ulf.; Rongen, Ludwig.; Weinbrenner, Ulrich)
	Frick/Knöll Baukonstructionslehre 1 / [Internet-Ressource]
	ISBN: 978-3-8351-9121-1 Wischaden - P. C. Taubner Verlag / CMV Fachverlage CmbH, Wischaden 2006
	Wiesbaden : B.G. Teubner Verlag / GWV Fachverlage GmbH, Wiesbaden, 2006
	Frick[Begr.], Otto (Knöll[Begr.], Karl.; Neumann, Dietrich.; Hestermann, Ulf.; Rongen, Ludwig.)
	Baukonstruktionslehre 2 / [Internet-Ressource]
	ISBN: 978-3-8348-9486-1
	Wiesbaden : Vieweg+Teubner Verlag / GWV Fachverlage GmbH, Wiesbaden, 2008
	Dierks, Klaus (Wormuth, Rüdiger.)
	Baukonstruktion : [Einführung, Grundlagen, Gründungen, technische Ausrüstung, Wände, Geschossdecken, Treppen, Dächer,
	Fenster, Türen, Konstruktionsatlas]
	ISBN: 3804150454 (Gb.) ISBN: 978-3-8041-5045-4
	Neuwied : Werner, 2007
	Schneider, Klaus-Jürgen (Goris, Alfons.; Berner, Klaus)
	Bautabellen für Ingenieure : mit Berechnungshinweisen und Beispielen ; [auf CD-ROM: Stabwerksprogramm IQ 100 B, Tools für
	den konstr. Ingenieurbau, Fachinformationen, Normentexte]
	ISBN: 3804152287 Neuwied : Werner, 2006
	Neuwieu . Werner, 2000
	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 für
	Gebäude, Räume, Einrichtungen, Geräte mit dem Menschen als Maß und Ziel ; Handbuch für den Baufachmann, Bauherrn
	Lehrenden und Lernenden ISBN: 978-3-8348-0732-8 (GB.)
	Wiesbaden : Vieweg + Teubner, 2009

Course L0205: Basics of Stru	ictural Design
Тур	Lecture
Hrs/wk	2
СР	1
Workload in Hours	Independent Study Time 2, Study Time in Lecture 28
Lecturer	Sebastian Rybczynski
Language	
Cycle	
Content	
555	Basics of building regulation laws
	Foundation of buildings
	Sealing of basements
	facades
	Ceilings
	Roofs
	Windows, doors and post-and-beam constructions
	Staircases
	Basics of strucural engineering design
	Structural fire prevention
	Optional tests on STUD.IP
Literature	Vortragsfolien der Lehrveranstaltung stehen über STUD.IP zum download zur Verfügung
	Schneider Bautabellen (Hrsg. A. Albert)
	23., überarbeitete Aufl.
	ISBN 978-3-8462-0880-9
	Reguvis Fachmedien GmbH, 2018
	Neumann, Dietrich (Hestermann, U.; Rongen, L.; Weinbrenner, U.)
	Frick/Knöll Baukonstructionslehre 1 / [Internet-Ressource]
	ISBN: 978-3-8351-9121-1
	Wiesbaden: Vieweg+Teubner Verlag, 2006
	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
	wicebouden . Vieweg + Teablier, 2010
	Wendehorst, Reinhard (Wetzell, O. W.,; Baumgartner, H.,)
	Wendehorst Bautechnische Zahlentafeln
	ISBN: 978-3-8351-0055-8
	Stuttgart/Berlin: Teubner/Beuth, 2018

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

Module M0631: Reinfo	orced Concrete Structures II			
Courses				
Title		Тур	Hrs/wk	СР
Project Concrete Structures II (L089	94)	Project Seminar	1	1
Concrete Structures II (L0348)		Lecture	2	3
Concrete Structures II (L0349)		Recitation Section (large)	2	2
Module Responsible	Prof. Günter Rombach			
Admission Requirements	None			
Recommended Previous Knowledge	<ul> <li>Knowledge of loads on structures and cor</li> <li>Basics of safety format are required.</li> </ul>	nbination of actions		
	Knowledge in design of beams and colum	ns for ultimate limit state		
	Modules: Reinforced Concrete Structures			
		,		
Educational Objectives	After taking part successfully, students have rea	ched the following learning results		
Professional Competence				
Knowledge	The students know the basic principles which are required for design of reinforced concrete structures. They know the various			
	methods to estimate the member forces in simple one and two-way slabs.			
Skills	• The students can design reinforced cor	acrete structure in the ultimate limit state	(shoar bonding	torsion) and in the
		tion control) including detailing (anchorage a		torsion) and in the
	The students can estimate the member for		id iiiks etc.).	
	The students know the content and the la	•		
	The students know the content and the la	your of a structural allalysis		
Personal Competence				
Social Competence	Cooperation in a project work, where they desig	n in a team a real concrete building and prese	ent the results at	the end.
Autonomy				
Workload in Hours	Independent Study Time 110, Study Time in Lec	ture 70		
Credit points	6			
Course achievement	Compulsory Bonus Form	Description		
	No None Excercises			
Examination duration and	120 minutes			
scale	Consent Foreign series Co.' (C	7	Floribus C	
Assignment for the	General Engineering Science (German program,		Elective Compul	sory
Following Curricula	Civil- and Environmental Engineering: Specialisa			
	Civil- and Environmental Engineering: Specialisa	•		
	Civil- and Environmental Engineering: Specialisa	tion water and Environment: Elective Compu	sory	

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

Course L0348: Concrete Structures II		
Тур	Lecture	
Hrs/wk	2	
СР	3	
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28	
Lecturer	Prof. Günter Rombach	
Language	DE	
Cycle	WiSe	
Content	<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

Module M1634: Computational Structural Mechanics				
Courses				
Title		Тур	Hrs/wk	СР
Computational Stuctural Mechanics Computational Structural Mechanics		Integrated Lecture Recitation Section (small)	2	2 1
		Recitation Section (Smail)	1	1
Module Responsible	, , , , , , , , , , , , , , , , , , ,			
Admission Requirements				
Kecommended Previous  Knowledge	Engineering Mechanics I, Engineering Mechanics	II, Mathematics I, Mathematics II		
	After taking part successfully, students have rea	shed the following learning results		
Professional Competence	After taking part successfully, students have rea	cried the following learning results		
-	Students now commonly used models for linea	ar and planar structures in structural mos	hanics Maragyar	thou understand the
Kriowieage	importance of computational methods in model	·		•
	element method.	ii solid mechanics and in particular also	the theoretical lou	iluations of the fiffice
Skills	Students are able to develop simple computation	ional methods and programs to solve p	roblems in solid n	nechanics Moreover
Skiiis	student have sufficient basic knowledge abou	, ,		
	successful solution of at least simple problems (a			
		J		, 3.
Personal Competence				
Social Competence				
Autonomy				
Workload in Hours	Independent Study Time 48, Study Time in Lectu	re 42		
Credit points	3			
Course achievement	None			
Examination	Written exam			
Examination duration and	90 min			
scale				
Assignment for the	General Engineering Science (German program,	7 semester): Specialisation Civil Engineeri	ng: Compulsory	
Following Curricula	Civil- and Environmental Engineering: Specialisa	tion Civil Engineering: Compulsory		

Course L2475: Computational Stuctural Mechanics		
Тур	Integrated 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	The lecture Computational Structural Mechanics extends the content of the lecture Engineering Mechanic II. It bridges the gap between the manual calculation of mechanical stress and deformation in systems with a particularly simple geometry and the efficent computer-based computation of general mechanical systems:  Basics of linear continuum mechanics Planar structures: plate, membrane, slab Linientragwerke: beam, cable, truss Weak form and Galerkin's method Finite element method: theory and application Principles of mechanics: principle of virtual work, virtual displacements, virtual forces	
Literature	Gross, Hauger, Wriggers, "Technische Mechanik 4", Springer	

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

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

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

Module M0612: Steel	Structures II			
Courses				
Title		Тур	Hrs/wk	СР
Steel Structures II (L0301)		Lecture	2	3
Steel Structures II (L0302)		Recitation Section (large)	2	3
Module Responsible	Prof. Marcus Rutner			
Admission Requirements	None			
Recommended Previous	Steel Structures I			
Knowledge				
<b>Educational Objectives</b>	After taking part successfully, students have	ve reached the following learning results		
<b>Professional Competence</b>				
Knowledge	After successful completition students can			
	•	<ul> <li>describe and explain the behaviour of bolted and welded connections</li> </ul>		
	design and check simple halls and buildings			
		ple structures (trusses, beams, frames)		
	Illustrate and dimension ne main de	etails (framework, column base, load application	ooints)	
Skills	Students are able to design simple structu	ares and connections, describe the load distribut	ion and recognize t	ne possible modes of
	failure. They can apply structural imperfec	tions, calculate according to 2nd order theory ar	d verify their result	s.
Barranal Commistance				
Personal Competence				
Social Competence				
Autonomy	Index and art Chada Time 124 Chada Time	in Landaura EC		
	Independent Study Time 124, Study Time	In Lecture 56		
Credit points				
Course achievement				
Examination				
Examination duration and	120 minutes			
scale				
-		General Engineering Science (German program, 7 semester): Specialisation Civil Engineering: Elective Compulsory		sory
Following Curricula	Civil- and Environmental Engineering: Spec			
		cialisation Traffic and Mobility: Elective Compulso	-	
	Civil- and Environmental Engineering: Spec	cialisation Water and Environment: Elective Com	pulsory	

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

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

Courses				
Title		Тур	Hrs/wk	СР
Foundation Engineering (L0552)		Lecture	2	2
Foundation Engineering (L0553)		Recitation Section (large)	2	2
Foundation Engineering (L1494)		Recitation Section (small)	2	2
Module Responsible	Prof. Jürgen Grabe			
Admission Requirements	None			
<b>Recommended Previous</b>	Modules:			
Knowledge	Markanian I II			
	Mechanics I-II			
	Geotechnics I			
Educational Objectives	After taking part successfully, students ha	ave reached the following learning results		
<b>Professional Competence</b>				
Knowledge	The students know the basic principles an	nd methods which are required to verificate the sta	bility of geotechni	cal structures.
Skills	After successful completion of the module	e the students are able to:		
	<ul> <li>verificate the stability and usability</li> </ul>	of foundations		
	·	I improvement and apply them in their range of ap	alication	
	<ul> <li>design retaining walls.</li> </ul>	i improvement and apply them in their range of ap	Jilcation,	
	design retaining waits.			
<b>Personal Competence</b>				
Social Competence				
Autonomy				
Workload in Hours	Independent Study Time 96, Study Time in	n Lecture 84		
Credit points	6			
Course achievement	Compulsory Bonus Form	Description		
	No 20 % Attestation			
Examination	Written exam			
<b>Examination duration and</b>	90 minutes			
scale				
Assignment for the	General Engineering Science (German pro	ogram, 7 semester): Specialisation Civil Engineering	g: Elective Compu	sory
Following Curricula	Civil- and Environmental Engineering: Spe	ecialisation Civil Engineering: Compulsory		
	Civil- and Environmental Engineering: Spe	ecialisation Traffic and Mobility: Elective Compulsor	у	
	Civil- and Environmental Engineering: Spe	ecialisation Water and Environment: Elective Comp	ulsory	
	Technomathematics: Specialisation III. En	•	-	

Course L0552: Foundation Engineering		
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>	

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

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

## **Specialization Bioprocess Engineering**

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

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

Courses				
itle		Тур	Hrs/wk	СР
ntroduction into Process Engineering		Lecture	2	1
undamentals of material engineering	g (L0830)	Lecture	2	2
Module Responsible P	rof. Michael Schlüter			
Admission Requirements N	lone			
Recommended Previous	ione			
Knowledge				
Educational Objectives A	after taking part successfully, students hav	e reached the following learning results		
Professional Competence				
Knowledge A	after passing this module the students have	e the ability to:		
	give an overview of the most importa-	ant fields on process and bioprocess enginee	rina.	
	explain some working methods for d		3.	
	3	,		
Skills I	After passing this module the students sho	uld have the ability to:		
JKIII3 F	titel passing this module the students shot	and have the ability to.		
	<ul> <li>list and outline the most important fi</li> </ul>	elds of process engineering,		
	<ul> <li>name the most important working appropriate appropriate the most important working appropriate approp</li></ul>	oproaches or methods of the different fields of	of process engineering,	
	<ul> <li>read and prepare an engineering dra</li> </ul>			
	,	gies for wastewater and exhaust air treatme		
	<ul> <li>scheme typical chemical and biotech</li> </ul>	nnological processes independently with the	aid of pointers.	
Personal Competence				
Social Competence T	he students are able to			
	work out results in groups and docur			
	provide appropriate feedback and ha	andle feedback on their own performance cor	nstructively.	
Autonomy T	The students are able to estimate their pr	ogress of learning by themselves and to de	liberate their lack of k	nowledge in Proces
E	ingineering and Bioprocess Engineering.			
	ndependent Study Time 34, Study Time in	Lecture 56		
Credit points 3		Desavinkian		
	Tompulsory Bonus Form  No 5 % Written elaboration	Description		
	Vritten exam			
	00 min			
scale				
	General Engineering Science (German prog	ram, 7 semester): Specialisation Process End	nineering: Compulsory	
-		ram, 7 semester): Specialisation Process Englished		nrv
	Bioprocess Engineering: Core Qualification:		Engineering, compuise	'' y
	Orientation Studies: Core Qualification: Elec			
	Process Engineering: Core Qualification: Co			

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

Course L0830: Fundamentals	of material engineering
Тур	Lecture
Hrs/wk	2
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	T	Hen fools	СР
Title Computer Engineering (L0321)	<b>Typ</b> Lecture	Hrs/wk 3	4
Computer Engineering (L0324)	Recitation Section (small)	1	2
Module Responsible	Prof. Heiko Falk		
Admission Requirements	None		
Recommended Previous	Basic knowledge in electrical engineering		
Knowledge	After teling youth augregation, attribute house you should be following looming youths		
Educational Objectives Professional Competence	After taking part successfully, students have reached the following learning results		
•	This module deals with the foundations of the functionality of computing systems. It covers programming down to gates. The module includes the following topics:  • Introduction	s the layers fron	n the assembly-lev
	<ul> <li>Combinational logic: Gates, Boolean algebra, Boolean functions, hardware synthesis, co</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, Memories: Memory hierarchies, SRAM, DRAM, caches</li> <li>Input/output: I/O from the perspective of the CPU, principles of passing data, point-to-points.</li> </ul>	pipelining	
Skills	The students perceive computer systems from the architect's perspective, i.e., they identify the composition of computer systems. The students can analyze, how highly specific and individual collection of few and simple components. They are able to distinguish between and to explain today's computing systems - from gates and circuits up to complete processors.  After successful completion of the module, the students are able to judge the interdepending system and the software executed on it. In particular, they shall understand the consequence on the hardware-centric abstraction layers from the assembly language down to gates. This is the impact that these low abstraction levels have on an entire system's performance and to perform the performance and the performance a	al computers can bin the different encies between es that the execu	n be built based or abstraction layers a physical comput ution of software h enabled to evalua
Personal Competence Social Competence	Students are able to solve similar problems alone or in a group and to present the results according	ordingly.	
Autonomy	Students are able to acquire new knowledge from specific literature and to associate this know	wledge with othe	r classes.
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56		
Credit points	6		
Course achievement	Compulsory Bonus Form Description		
Examination	Yes 10 % Excercises		
	90 minutes, contents of course and labs		
scale	30 minutes, contents of course and lass		
Assignment for the	General Engineering Science (German program, 7 semester): Specialisation Computer Science	: Compulsory	
	General Engineering Science (German program, 7 semester): Specialisation Process Engineering General Engineering Science (German program, 7 semester): Specialisation Mechanical Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering Sciences: Compulsory General Engineering Sciences: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engined Production: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineerial Engineering Science (German program, 7 semester): Specialisation Mechanical Engineerial Engineering Science (German program, 7 semester): Specialisation Mechanical Engineerial Engineering Science (German program, 7 semester): Specialisation Mechanical	I Engineering, I Engineering, Focus Th Beering, Focus Th Beering, Focus P Engineering, Focus P	eus Aircraft Syster neoretical Mechanic Focus Materials Product Developme us Energy System
	Compulsory General Engineering Science (German program, 7 semester): Specialisation Naval Architecture General Engineering Science (German program, 7 semester): Specialisation Biomedical Engine General Engineering Science (German program, 7 semester): Specialisation Bioprocess Engine General Engineering Science (German program, 7 semester): Specialisation Electrical Enginee General Engineering Science (German program, 7 semester): Specialisation Green Technologi Compulsory Computer Science: Core Qualification: Compulsory Data Science: Core Qualification: Elective Compulsory Electrical Engineering: Core Qualification: Compulsory	e: Compulsory eering: Compulso eering: Compulsory ring: Compulsory	ory ory

Technomathematics: Specialisation II. Informatics: Elective Compulsory

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

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

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

Module M0536: Funda	amentals of Fluid Mechanics			
Courses				
Title		Тур	Hrs/wk	СР
Fundamentals of Fluid Mechanics (	L0091)	Lecture	2	4
Fluid Mechanics for Process Engine	ering (L0092)	Recitation Section (large)	2	2
Module Responsible	Prof. Michael Schlüter			
Admission Requirements	None			
Recommended Previous	Mathematics I+II+III			
Knowledge	Technical Mechanics I+II			
	Technical Thermodynamics I+II			
	Working with force balances			
	Simplification and solving of partial difference	erential equations		
	Integration			
Educational Objectives	After taking part successfully, students have re	eached the following learning results		
Professional Competence				
Knowledge	Students are able to:			
	a cyplain the difference between differen	t types of flow		
	explain the difference between difference     give an overview for different application	ens of the Reynolds Transport-Theorem in proce	ess engineering	
		- and Navier-Stokes-Equation by using physica		ions
		, , , , ,	,	
Skills	The students are able to			
	<ul> <li>describe and model incompressible flow</li> </ul>	s mathematically		
	<ul> <li>reduce the governing equations of fluid</li> </ul>	mechanics by simplifications to archive quant	tative solutions e	.g. by integration
	notice the dependency between theory	• • • • • • • • • • • • • • • • • • • •		
	<ul> <li>use the learned basics for fluid dynamic</li> </ul>	al applications in fields of process engineering		
Personal Competence				
Social Competence	The students			
	are canable to gather information from	subject related, professional publications and	relate that inform	nation to the context
	of the lecture and	subject related, professional publications and	relate that illion	nation to the context
		d tasks in small groups. They are able to pre	sent their results	effectively in English
	(e.g. during small group exercises)			
	<ul> <li>are able to work out solutions for exerci</li> </ul>	ses by themselves, to discuss the solutions or	ally and to presen	t the results.
Autonomy	The students are able to			
Autonomy	The students are able to			
		and to expand their knowledge with this literat		
	work on their exercises by their own and	d to evaluate their actual knowledge with the f	eedback.	
Workload in Hours	Independent Study Time 124, Study Time in Lo	ecture 56		
Credit points	6			
Course achievement		Description		
	Yes 5 % Midterm			
	Written exam			
Examination duration and scale	3 nours			
Assignment for the	General Engineering Science (German prograr	n 7 samastar). Spacialisation Process Enginee	ring: Compulsory	
Following Curricula				ory
		n, 7 semester): Specialisation Green Technolog		•
	Bioprocess Engineering: Core Qualification: Co		. ,	
	Energy and Environmental Engineering: Core (	Qualification: Compulsory		
	Green Technologies: Energy, Water, Climate: 0	Core Qualification: Compulsory		
	Logistics and Mobility: Specialisation Traffic Pla	anning and Systems: Elective Compulsory		
	Technomathematics: Specialisation III. Engine			
	Process Engineering: Core Qualification: Comp			
	Engineering and Management - Major in Logist	ics and Mobility: Specialisation Traffic Planning	and Systems: El	ective Compulsory

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

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

Module M0757: Bioch	emistry and Microbiology			
Courses				
Title Biochemistry (L0351) Biochemistry (L0728) Microbiology (L0881) Microbiology (L0888)		Typ Lecture Project-/problem-based Learning Lecture Project-/problem-based Learning	Hrs/wk 2 1 2	CP 2 1 2
Module Responsible	Prof. Johannes Gescher	Troject /problem basea zeaming		-
Admission Requirements	None			
-	none			
Knowledge				
Educational Objectives	After taking part successfully, students have reached the followi	ing learning results		
Professional Competence				
Knowledge	At the end of this module the students can:			
	- explain the methods of biological and biochemical research to	determine the properties of biom	nolecules	
	- 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 dis	scussions in teams		
	- to divide a complex task into subtasks, solve these and to pres	sent the combined results		
Autonomy	The students are able to present the results of their subtasks in	a written report		
Workload in Hours	Independent Study Time 96, Study Time in Lecture 84		<u> </u>	
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): Sp	pecialisation Bioprocess Engineeri	ing: Compulso	ry
Following Curricula	Bioprocess Engineering: Core Qualification: Compulsory			
	Green Technologies: Energy, Water, Climate: Specialisation Bior	esource Technology: Elective Cor	mpulsory	
	Orientation Studies: Core Qualification: Elective Compulsory			
	Technomathematics: Specialisation III. Engineering Science: Elec	ctive Compulsory		

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

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

Course L0881: Microbiology				
Тур	Lecture			
Hrs/wk	2			
СР	2			
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28			
Lecturer	Prof. Johannes Gescher			
Language	DE			
Cycle	SoSe			
Content	The procaryotic cell     evolution			
	taxonomy and specific properties of Archaea, Bacteria, and viruses			
	structure and properties of the cell			
	• growth			
	2. Metabolism			
	fermentation and anaerobic respiration			
	methanogenesis and the anaerobic food chain			
	degradation of polymers			
	chemolithotrophy			
	3. Microorganisms in relation to the environment			
	chemotaxis and motility			
	Elemental cycle of carbon, nitrogen and sulfur			
	biofilms			
	<ul><li>symbiotic relationships</li><li>extremophiles</li></ul>			
	biotechnology			
	- blockmology			
Literature				
Elecrature	• Allgemeine Mikrobiologie, 8. Aufl., 2007, Fuchs, G. (Hrsg.), Thieme Verlag (54,95 €)			
	• <b>Mikrobiologie</b> , 13 Aufl., 2013, Madigan, M., Martinko, J. M., Stahl, D. A., Clark, D. P. (Hrsg.), ehemals "Brock", Pearson Verlag (89,95 €)			
	Taschenlehrbuch Biologie Mikrobiologie, 2008, Munk, K. (Hrsg.), Thieme Verlag			
	• <b>Grundlagen der Mikrobiologie</b> , 4. Aufl., 2010, Cypionka, H., Springer Verlag (29,95 €), http://www.grundlagen-der-mikrobiologie.icbm.de/			

Course L0888: Microbiology			
Тур	Project-/problem-based Learning		
Hrs/wk	1		
СР	1		
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14		
Lecturer	Prof. Johannes Gescher		
Language	DE		
Cycle	SoSe		
Content	1. The procaryotic cell		
	• evolution		
	taxonomy and specific properties of Archaea, Bacteria, and viruses		
	structure and properties of the cell		
	• growth		
	2. Metabolism		
	fermentation and anaerobic respiration		
	methanogenesis and the anaerobic food chain		
	degradation of polymers		
	chemolithotrophy		
	3. Microorganisms in relation to the environment		
	chemotaxis and motility		
	Elemental cycle of carbon, nitrogen and sulfur		
	biofilms		
	symbiotic relationships		
	• extremophiles		
	biotechnology		
Literature			
	• Allgemeine Mikrobiologie, 8. Aufl., 2007, Fuchs, G. (Hrsg.), Thieme Verlag (54,95 €)		
	• <b>Mikrobiologie</b> , 13 Aufl., 2013, Madigan, M., Martinko, J. M., Stahl, D. A., Clark, D. P. (Hrsg.), ehemals "Brock", Pearson Verlag (89,95 €)		
	Taschenlehrbuch Biologie Mikrobiologie, 2008, Munk, K. (Hrsg.), Thieme Verlag		
	• <b>Grundlagen der Mikrobiologie</b> , 4. Aufl., 2010, Cypionka, H., Springer Verlag (29,95 €), http://www.grundlagen-der-mikrobiologie.icbm.de/		

Module M0544: Phase	Equilibria Thermodynamics			
Courses				
Title		Тур	Hrs/wk	СР
Phase Equilibria Thermodynamics (	L0114)	Lecture	2	2
Phase Equilibria Thermodynamics (		Recitation Section (small)	1	2
Phase Equilibria Thermodynamics (		Recitation Section (large)	1	2
Module Responsible	Prof. Irina Smirnova			
Admission Requirements	None			
-		size Land II		
Recommended Previous	Mathematics, Physical Chemistry, Thermodynan	nics I and II		
Knowledge				
Educational Objectives	After taking part successfully, students have rea	iched the following learning results		
Professional Competence				
Knowledge	. Charling from the year, basing of therman	dunamina the students leave the mathemati		ovilo a the averagely en averig
		dynamics, the students learn the mathemati	cai toois to desc	Tibe thermodynamic
	equilibria.	and by the miving of seven and leave		antitoticale doscriba
		enced by the mixing of compounds and learn	i concepts to qu	lantitatively describe
	these properties.	and the state of t	and collected and are	
		equilibria can be described mathematically		-
		kist in equilibrium. Furthermore the fundamen		
		xamples relevant for different kinds of proc	esses are snowi	and the necessary
	knowledge for plotting and interpreting th	ne equilibria are taught.		
Skills				
		are able to identify the correct equation for	the determination	on of the equilibrium
	state and know how to simplify these equ			
	<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 they
	are able to solve the resulting mathemati	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 well as
	model parameters in literature sources.			
	<ul> <li>Beside pure compound properties the stu</li> </ul>	dents are capable of describing the properties	of mixtures.	
	<ul> <li>The students know how to visualize phase</li> </ul>	e equilibria graphically and they know how to	interpret the occ	urring phenomena.
	<ul> <li>Based on their knowledge, the student</li> </ul>	ts are able to understand fundamental cor	cepts that are	the basis for many
	separation and reaction processes in cher	mical engineering.		
Personal Competence				
•	The students are able to work in small groups,	to solve the corresponding problems and to	present them or	aly to the tutors and
Social competence	other students	to solve the corresponding problems and to	present them of	ary to the tators and
Autonomy	other students			
Autonomy	<ul> <li>The students are able to find necessary ir</li> </ul>	nformation self-reliantly in literature sources a	nd to judge their	quality.
	During the semester the students are	able to check their learning progress conti	nuously in exer	cises. Based on this
	knowledge the students can adept their le	earning process.		
	·			
Workload in Hours	Independent Study Time 124, Study Time in Lec	ture 56		
Credit points	6			
Course achievement	None			
Examination	Written exam			
	120 minutes; theoretical questions and calculati	ons		
scale	120 minutes, theoretical questions and calculati	0113		
	Conoral Engineering Science (Samuel	7 competer): Specialization Process Form	nai Commilee	
=	General Engineering Science (German program,			
Following Curricula	General Engineering Science (German program,			-
	General Engineering Science (German program,	/ semester): Specialisation Green Technologi	es, Focus Renew	able Energy: Elective
	Compulsory		_	
	General Engineering Science (German program,	7 semester): Specialisation Green Technologi	es, Focus Renew	able Energy: Elective
	Compulsory			
	Bioprocess Engineering: Core Qualification: Com	pulsory		
	Green Technologies: Energy, Water, Climate: Sp	ecialisation Bioresource Technology: Elective	Compulsory	
	Green Technologies: Energy, Water, Climate: Sp	ecialisation Energy Systems: Elective Compul-	sory	
	Process Engineering: Core Qualification: Compul	sory		
	·			

Course L0114: Phase Equilib	ria Thermodynamics
Тур	Lecture
Hrs/wk	2
СР	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Prof. Irina Smirnova
Language	DE
Cycle	SoSe
Content	
	1. Introduction: Applications of thermodynamics of mixtures 2. Thermodynamic equations in multi-component systems: Fundamental equations, chemical potential, fugacity 3. Phase equilibria of pure substances: thermodynamic equilibrium, vapor pressure, Gibbs' phase rule 4. Equations of state: virial equations, van-der-Waals equation, generalized equations of state 5. Mixing properties: ideal and real mixtures, excess properties, partial molar properties 6. Vapor-liquid-equilibria: binary systems, azeotropes, equilibrium condition 7. Gas-liquid-equilibria: equilibrium condition, Henry-coefficient 8. G <sup>E</sup> -Models: Hildebrand-model, Flory-Huggins-model, Wilson-model, UNIQUAC, UNIFAC 9. Liquid-liquid-equilibria: equilibrium condition, phase equilibria in binary and ternary systems 10. Solid-liquid-equilibria: equilibrium condition, binary systems 11. Chemical reactions: reaction coordinate, mass action law, influence of pressure and temperature 12. Osmotic pressure
Literature	<ul> <li>Jürgen Gmehling, Bärbel Kolbe: Thermodynamik. VCH 1992</li> <li>J.M. Prausnitz, R.N. Lichtenthaler, E.G. de Azevedo: Molecular Thermodynamics of Fluid-Phase Equilibria, 3rd ed. Prentice Hall, 1999.</li> <li>J.W. Tester, M. Modell: Thermodynamics and its Applications. 3 <sup>rd</sup> ed. Prentice Hall, 1997.J.P. O´Connell, J.M. Haile: Thermodynamics. Cambridge University Press, 2005.</li> </ul>

Course L0140: Phase Equilibria Thermodynamics			
Тур	ecitation Section (small)		
Hrs/wk			
СР	2		
Workload in Hours	Independent Study Time 46, Study Time in Lecture 14		
Lecturer	Prof. Irina Smirnova		
Language	DE		
Cycle	SoSe		
Content	1. Introduction: Applications of thermodynamics of mixtures 2. Thermodynamic equations in multi-component systems: Fundamental equations, chemical potential, fugacity 3. Phase equilibria of pure substances: thermodynamic equilibrium, vapor pressure, Gibbs' phase rule 4. Equations of state: virial equations, van-der-Waals equation, generalized equations of state 5. Mixing properties: ideal and real mixtures, excess properties, partial molar properties 6. Vapor-liquid-equilibria: binary systems, azeotropes, equilibrium condition 7. Gas-liquid-equilibria: equilibrium condition, Henry-coefficient 8. GE-Models: Hildebrand-model, Flory-Huggins-model, Wilson-model, UNIQUAC, UNIFAC 9. Liquid-liquid-equilibria: equilibrium condition, phase equilibria in binary and ternary systems 10. Solid-liquid-equilibria: equilibrium condition, binary systems 11. Chemical reactions: reaction coordinate, mass action law, influence of pressure and temperature 12. Osmotic pressure  The students work on tasks in small groups and present their results in front of all students.		
	<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			
СР	2		
Workload in Hours	Independent Study Time 46, Study Time in Lecture 14		
Lecturer	Prof. Irina Smirnova		
Language	DE		
Cycle	SoSe		
Content	<ol> <li>Introduction: Applications of thermodynamics of mixtures</li> <li>Thermodynamic equations in multi-component systems: Fundamental equations, chemical potential, fugacity</li> <li>Phase equilibria of pure substances: thermodynamic equilibrium, vapor pressure, Gibbs' phase rule</li> <li>Equations of state: virial equations, van-der-Waals equation, generalized equations of state</li> <li>Mixing properties: ideal and real mixtures, excess properties, partial molar properties</li> <li>Vapor-liquid-equilibria: binary systems, azeotropes, equilibrium condition</li> <li>Gas-liquid-equilibria: equilibrium condition, Henry-coefficient</li> <li>G<sup>E</sup>-Models: Hildebrand-model, Flory-Huggins-model, Wilson-model, UNIQUAC, UNIFAC</li> <li>Liquid-liquid-equilibria: equilibrium condition, phase equilibria in binary and ternary systems</li> <li>Solid-liquid-equilibria: equilibrium condition, binary systems</li> <li>Chemical reactions: reaction coordinate, mass action law, influence of pressure and temperature</li> <li>Osmotic pressure</li> </ol>		
Literature	<ul> <li>Jürgen Gmehling, Bärbel Kolbe: Thermodynamik. VCH 1992</li> <li>J.M. Prausnitz, R.N. Lichtenthaler, E.G. de Azevedo: Molecular Thermodynamics of Fluid-Phase Equilibria, 3rd ed. Prentice Hall, 1999.</li> <li>J.W. Tester, M. Modell: Thermodynamics and its Applications. 3<sup>rd</sup> ed. Prentice Hall, 1997.J.P. O'Connell, J.M. Haile: Thermodynamics. Cambridge University Press, 2005.</li> </ul>		

Module M0938: Biopr	ocess Engineering - Fundamentals	3		
Courses				
Title		Тур	Hrs/wk	СР
Bioprocess Engineering - Fundame	ntals (L0841)	Lecture	2	3
Bioprocess Engineering- Fundamer	itals (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			
Recommended Previous	none, module "organic chemistry", module "funda	mentals for process engineering"		
Knowledge				
<b>Educational Objectives</b>	After taking part successfully, students have reach	ned the following learning results		
<b>Professional Competence</b>				
Knowledge	Students are able to describe the basic concepts	of bioprocess engineering. They are able to	classify differen	t types of kinetics for
	enzymes and microorganisms, as well as to di	fferentiate different types of inhibition. T	he parameters	of stoichiometry and
	rheology can be named and mass transport pro	ocesses in bioreactors can be explained.	The students ar	e capable to explain
	fundamental bioprocess management, sterilization	n technology and downstream processing in	n detail.	
Skille	After successful completion of this module, studer	ats should be able to		
SKIIIS	Successial completion of this module, studer	its should be able to		
	<ul> <li>describe different kinetic approaches for gr</li> </ul>	owth and substrate-uptake and to calculate	the correspondi	ng parameters
	<ul> <li>predict qualitatively the influence of ener</li> </ul>	gy generation, regeneration of redox equ	ivalents and gro	wth inhibition on the
	fermentation process			
	<ul> <li>analyze bioprocesses on basis of stoichiom</li> </ul>	etry and to set up / solve metabolic flux eq	uations	
	<ul> <li>distinguish between scale-up criteria for dif</li> </ul>	fferent bioreactors and bioprocesses (anae	robic, aerobic as	well as microaerobic)
	to compare them as well as to apply them t	to current biotechnical problem		
	propose solutions to complicated biotechno	ological problems and to deduce the corresp	onding models	
	to explore new knowledge resources and to	apply the newly gained contents		
	identify scientific problems with concrete in			
	to document and discuss their procedures a			
Personal Competence				
•	After completion of this module participants shou	ld be able to debate technical questions in	small teams to e	enhance the ability to
Social Competence	take position to their own opinions and increase the			
Autonomy	After completion of this module participants will be	be able to solve a technical problem in a te	eam independent	ly by organizing their
	workflow and to present their results in a plenum			
Workload in Hours	Independent Study Time 96, Study Time in Lectur	0.84		
		E 04		
Credit points		Description		
Course achievement	Yes 5 % Subject theoretical an			
	practical work			
Examination	Written exam			
Examination duration and				
scale	30 11111			
36416				
-	General Engineering Science (German program, 7	· ·		
Following Curricula		- · · · · · · · · · · · · · · · · · · ·	neering: Compuls	ory
	Bioprocess Engineering: Core Qualification: Comp	•		
	Green Technologies: Energy, Water, Climate: Spec			
	Biomedical Engineering: Specialisation Artificial O		ory	
	Biomedical Engineering: Specialisation Implants a			
	Biomedical Engineering: Specialisation Medical Te	chnology and Control Theory: Elective Com	pulsory	
	Biomedical Engineering: Specialisation Manageme	ent and Business Administration: Elective C	ompulsory	
	Technomathematics: Specialisation III. Engineerin			
	Process Engineering: Core Qualification: Compulso	pry		

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

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

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

Module 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				
Admission Requirements	None			
Recommended Previous	Contents of the previous modules mathematics I-II	I, physical chemistry, technical thermody	namics I+II as w	ell as computational
Knowledge	methods for engineers.			
Educational Objectives	After taking part successfully, students have reache	ed the following learning results		
Professional Competence				
Knowledge	The students are able to explain basic concepts of			
	thermodynamical and kinetical processes. The stu	dents have a strong ability to outline pa	rts of isotherma	l and non-isothermal
	ideal reactors and to describe their properties.			
Skills	After successful completion of the module, students	s are able to:		
	- apply different computational methods to dimension	on isothermal and non-isothermal ideal re	actors,	
	- determine and compute stable operation points for these reactors ,			
	- conduct experiments on a lab-scale pilot plants and document these according to scientific guidelines.			
Personal Competence				
Social Competence	After successful completition of the lab-course the	students have a strong ability to organiz	e themselfes in s	small groups to solve
	issues in chemical reaction engineering. The stude	ents can discuss their subject related kn	owledge among	each other and with
	their teachers.			
Autonomy	The students are able to obtain further information	ation and assess their relevance autor	nomously. Stude	nts can apply their
	knowldege discretely to plan, prepare and conduct	experiments.		
Workload in Hours	Independent Study Time 96, Study Time in Lecture	84		
Credit points	6			
Course achievement	, ,	Description		
	Yes None Subject theoretical and			
	practical work			
	Written exam			
Examination duration and	120 min			
scale	0 15 : : : : : : : : : : : : : : : : : :			
-	General Engineering Science (German program, 7 s			ory
Following Curricula	General Engineering Science (German program, 7 s			manula a m
	General Engineering Science (German program, 7 s		engineering: Cor	приіѕогу
	Bioprocess Engineering: Core Qualification: Compul: Chemical and Bioprocess Engineering: Core Qualific	•		
	Green Technologies: Energy, Water, Climate: Specia		Compulsory	
	Process Engineering: Core Qualification: Compulsor	**	Compaisory	
	Trocess Engineering, core Qualification, compulsory	,		

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

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

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

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

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

## Literature

lecture notes Raimund Horn

skript Frerich Keil

Books:

- M. Baerns, A. Behr, A. Brehm, J. Gmehling, H. Hofmann, U. Onken, A. Renken, Technische Chemie, Wiley-VCH
- G. Emig, E. Klemm, Technische Chemie, Springer
- A. Behr, D. W. Agar, J. Jörissen, Einführung in die Technische Chemie
- E. Müller-Erlwein, Chemische Reaktionstechnik 2012, 2. Auflage, Teubner Verlag
- J. Hagen, Chemiereaktoren: Auslegung und Simulation, 2004, Wiley-VCH
- H. S. Fogler, Elements of Chemical Reaction Engineering, Prentice Hall B
- H. S. Fogler, Essentials of Chemical Reaction Engineering, Prentice Hall
- O. Levenspiel, Chemical Reaction Engineering, John Wiley & Sons, 1998
- L. D. Schmidt, The Engineering of Chemical Reactions, Oxford Univ. Press, 2009
- J. B. Butt, Reaction Kinetics and Reactor Design, 2000, Marcel Dekker
- R. Aris, Elementary Chemical Reactor Analysis, Dover Pubn. Inc., 2000
- M. E. Davis, R. J. Davis, Fundamentals of Chemical Reaction Engineering, McGraw Hill
- G. F. Froment, K. B. Bischoff, J. De Wilde, Chemical Reactor Analysis and Design, John Wiley & Sons, 2010
- A. Jess, P. Wasserscheid, Chemical Technology An Integrated Textbook, WILEY-VCH

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

enthalpy, calorimeter, heat of reaction, standard heat of formation, Hess law, heat capacity, Kirchhoff law, standard heat of reaction, pressure dependence of the heat of reaction, second law of thermodynamics, reversible and irreversible processes, entropy, Clausius inequality, free energy, Gibbs Energy, chemical potential, chemical equilibrium, activity, van't Hoff law, calculation of chemical equilibrium, principle of Le Chatelier and Braun, equilibrium calculations in multiple reaction systems, Lagrange Multipliers)

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

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

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

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

## Literatur

lecture notes Raimund Horn

skript Frerich Keil

Books:

- M. Baerns, A. Behr, A. Brehm, J. Gmehling, H. Hofmann, U. Onken, A. Renken, Technische Chemie, Wiley-VCH
- G. Emig, E. Klemm, Technische Chemie, Springer
- A. Behr, D. W. Agar, J. Jörissen, Einführung in die Technische Chemie
- E. Müller-Erlwein, Chemische Reaktionstechnik 2012, 2. Auflage, Teubner Verlag
- J. Hagen, Chemiereaktoren: Auslegung und Simulation, 2004, Wiley-VCH
- H. S. Fogler, Elements of Chemical Reaction Engineering, Prentice Hall B
- $\hbox{H. S. Fogler, Essentials of Chemical Reaction Engineering, Prentice Hall}\\$
- O. Levenspiel, Chemical Reaction Engineering, John Wiley & Sons, 1998
- L. D. Schmidt, The Engineering of Chemical Reactions, Oxford Univ. Press, 2009
- J. B. Butt, Reaction Kinetics and Reactor Design, 2000, Marcel Dekker
- R. Aris, Elementary Chemical Reactor Analysis, Dover Pubn. Inc., 2000
- M. E. Davis, R. J. Davis, Fundamentals of Chemical Reaction Engineering, McGraw Hill
- G. F. Froment, K. B. Bischoff, J. De Wilde, Chemical Reactor Analysis and Design, John Wiley & Sons, 2010
- A. Jess, P. Wasserscheid, Chemical Technology An Integrated Textbook, WILEY-VCH

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

Module M1275: Enviro	onmental Techi	nology				
Courses						
Title	Title			Тур	Hrs/wk	СР
Practical Exercise Environmental To				Practical Course	1	1
Environmental Technologie (L0326	1			Lecture	2	2
Module Responsible		itt				
Admission Requirements			and letter and			
Recommended Previous  Knowledge	Fundamentals of Inorg	ganic/organic chemistry a	na biology			
Educational Objectives	After taking part succ	ossfully students have re	aschod the followi	na loarnina roculte		
Professional Competence	Arter taking part succ	essiully, students have re	acried the followi	ing learning results		
	With the completion of	of this modul the students	obtain profound	knowledge of environme	ntal technology Th	nev are able to describe
omeuge		nicals in the environmen	•	-		-
		em to related methods.	3			, ,
CL III						
SKIIIS		propose appropriate ma	-	-		•
	determine geochemical parameters and to assess the potential of pollutants to migrate and transform. The students are able to work out well founded opinions on how Environmental Technology contributes to sustainable development, and they can present					
	and defend these opinions in front of and against the group.					
		-				
Personal Competence						
Social Competence	The students are able to discuss the various technical and scientific tasks, both subject-specific and multidisciplinary. They are able to develop different approaches to the task as a group as well as to discuss their theoretical or practical implementation.					
	to develop different a	pproacnes to the task as	a group as well as	s to discuss their theoreti	cai or practical im	piementation.
Autonomy	Students can indepen	Students can independently exploit sources about of the subject, acquire the particular knowledge and transfer it to new problems.				
Workload in Hours	Independent Study Ti	me 48, Study Time in Lec	ture 42			
Credit points						
Course achievement	Compulsory Bonus	Form	Description			
	Yes None	Subject theoretical	and			
		practical work				
Examination						
Examination duration and	1 hour					
scale						
Assignment for the	3 3	Science (German program		•	-	
Following Curricula		Science (German program ng: Core Qualification: Ele		-	neering: Elective (	compulsory
		ental Engineering: Core Q				
		Core Qualification: Electiv		pa.50. y		
		quamication Electri				

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

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

Courses				
Title		Тур	Hrs/wk	СР
Bioprocess Engineering - Advanced		Lecture	2	4
Bioprocess Engineering - Advanced		Recitation Section (small)	2	2
Module Responsible				
Admission Requirements				
Recommended Previous	Content of module "Biochemisty and Microbiology"			
Knowledge	Content of module "Biochemical Engineering I"			
<b>Educational Objectives</b>	After taking part successfully, students have reache	ed the following learning results		
Professional Competence				
Knowledge	After successful completion of this module, students	s should be able		
	- explain the microbial, energetic and engineering p	principles of fermentation process,		
	- explain different kinetic approaches for cell grodevelopment,	owth, substrate uptake and product for	mation and app	ly them for proces
	- understand and quantify transport phenomena in	bioreactor and consider them for bioproce	ss scale-up	
	- identify specific scientific problems and solutions f	for different types of fermentation process	es	
Skills	After successful completion of this module, students	s should be able to		
	- to identify scientific questions or possible practica and animal cells) and to formulate solutions ,	l problems for concrete industrial applicati	ons (eg cultivatio	on of microorganism
	- to assess the application of scale-up criteria for different types of bioreactors and processes and to apply these criterian problems (anaerobic , aerobic or microaerobic bioprocesses),			
	- to formulate questions for the analysis and optimiz	zation of real biotechnological production	processes approp	oriate solutions,
	- to describe the effects of the energy generation behavior of microorganisms and to the total fermen		its , and the gro	wth inhibition of th
	- to establish material balance and fermentation approaches,	equations and solve them to determine	the kinetic par	ameters of differer
	- to select process control strategies (batch , fedevaluate them.	-batch ,or continuous culture) appropriat	ely and to calcu	late basic types an
Personal Competence Social Competence	After completion of this module participants should be able to debate technical questions in small teams to enhance the ability take position to their own opinions and increase their capacity for teamwork.			
Autonomy	After completion of this module participants are able to acquire new sources of knowledge and apply their knowledge to previously unknown issues and to present these.			
Workload in Hours	Independent Study Time 124, Study Time in Lecture	e 56		
Credit points				
Course achievement				
Examination Examination duration and				
scale				
Assignment for the	General Engineering Science (German program, 7 s	emester): Specialisation Bioprocess Engine	eering: Compulso	ory
Fallauring Cumiaula				
Following Curricula				
Following Curricula	Green Technologies: Energy, Water, Climate: Specia	•	Compulsory	

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

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

Module M0546: Therr	mal Separation Processes			
Courses				
Title		Тур	Hrs/wk	СР
Thermal Separation Processes (L01	118)	Lecture	2	2
Thermal Separation Processes (L01	119)	Recitation Section (small)	2	2
Thermal Separation Processes (L01	141)	Recitation Section (large)	1	1
Separation Processes (L1159)	In	Practical Course	1	1
Module Responsible				
Admission Requirements				
Knowledge	Recommended requirements: Thermodynamics III			
Educational Objectives	After taking part successfully, students have reach	ned the following learning results		
<b>Professional Competence</b>				
Knowledge	The students can distinguish and describ	different tunes of severetion processes	a auch an distilla	tion systemation and
	adsorption     The students develop an understanding for energy demand of a process, the possibilitie     They have good knowledge of designing me	r the course of concentration during a se es of energy saving, and the selection of s	paration process, eparation systems	the estimation of the
Personal Competence Social Competence Autonomy	Using the gained knowledge the students of close the associated energy and material bit. The students can use different graphical theoretical stages required They can select and design a basic type disadvantages of the process The students are capable to obtain indepentables) They can calculate continuous and discontinethes the students are able to prove their theorethes. The students are able to discuss the theorethes to discuss the theorethes the students are capable of linking their gained knowledge the students are capable of linking their gained knowledge the students. Other lectures such as thermost.  The students can work technical assignmenthes the students are able to carry out practical them. They are able to discuss their results.	alances methods for the designing of a separati of thermal separation process for a give indently the needed material properties from the separation processes tical knowledge in the experimental lab we etical background and the content of the separation of the sep	on process and of the case based on om appropriate so ork.  experimental work as and use it togetle engineering.  The deed results in the the afunctional divisite port.	define the amount of the advantages and purces (diagrams and switch the teachers in their for the solution of utorial to of labor between seess their quality
Workload in Hours	Independent Study Time 96, Study Time in Lecture	≘ 84		
Credit points				
Course achievement				
Examination				
Examination duration and scale	120 minutes; theoretical questions and calculation	is		
Assignment for the		semester): Specialisation Green Technolo	gies, Focus Renew	able Energy: Elective
Following Curricula				
	General Engineering Science (German program	, 7 semester): Specialisation Green Tec	chnologies, Focus	Renewable Energy:
	Compulsory			
	General Engineering Science (German program, 7			ory
	General Engineering Science (German program, 7			mpulson
	General Engineering Science (German program, 7 Bioprocess Engineering: Core Qualification: Compu		iverigirieering: Cor	πραισυτή
	Chemical and Bioprocess Engineering: Core Qualification.			
	Energy and Environmental Engineering: Core Quali	• •		
	Green Technologies: Energy, Water, Climate: Spec	cialisation Energy Systems: Elective Comp	ulsory	
	Green Technologies: Energy, Water, Climate: Spec	cialisation Bioresource Technology: Electiv	e Compulsory	
	Process Engineering: Core Qualification: Compulso	ory		

Course L0118: Thermal Sepa	ration Processes
Тур	Lecture
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Prof. Irina Smirnova
Language	DE
Cycle	WiSe
Content	<ul> <li>Introduction in the thermal process engineering and to the main features of separation processes</li> <li>Simple equilibrium processes, several steps processes</li> <li>Distillation of binary mixtures, enthalpy-concentration diagrams</li> <li>Extractive and azeotrope distillation, water vapor distillation, stepwise distillation</li> <li>Extraction: separation ternary systems, ternary diagram</li> <li>Multiphase separation including complex mixtures</li> <li>Designing of separation devices without discrete stages</li> <li>Drying</li> <li>Chromatographic separation processes</li> <li>Membrane separation</li> <li>Energy demand of separation processes</li> <li>Advance overview of separation processes</li> <li>Selection of separation processes</li> </ul>
Literature	<ul> <li>G. Brunner: Skriptum Thermische Verfahrenstechnik</li> <li>J. King: Separation Processes, McGraw-Hill, 2. Aufl. 1980</li> <li>Sattler: Thermische Trennverfahren, VCH, Weinheim 1995</li> <li>J.D. Seader, E.J. Henley: Separation Process Principles, Wiley, New York, 1998.</li> <li>Mersmann: Thermische Verfahrenstechnik, Springer, 1980</li> <li>Grassmann, Widmer, Sinn: Einführung in die Thermische Verfahrenstechnik, 3. Aufl., Walter de Gruyter, Berlin 1997</li> <li>Brunner, G.: Gas extraction. An introduction to fundamentals of supercritical fluids and the application to separation processes. Steinkopff, Darmstadt; Springer, New York; 1994. ISBN 3-7985-0944-1; ISBN 0-387-91477-3.</li> <li>R. Goedecke (Hrsg.): Fluid-Verfahrenstechnik, Wiley-VCH Verlag, Weinheim, 2006.</li> <li>Perry"s Chemical Engineers" Handbook, R.H. Perry, D.W. Green, J.O. Maloney (Hrsg.), 6th ed., McGraw-Hill, New York 1984 Ullmann"s Enzyklopädie der Technischen Chemie</li> </ul>

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

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

Course L1159: Separation Processes		
Тур	Practical Course	
Hrs/wk	1	
СР	1	
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14	
Lecturer	Prof. Irina Smirnova	
Language	DE/EN	
Cycle	WiSe	
Content	The students work on eight different experiments in this practical course. For every one of the eight experiments, a colloquium takes place in which the students explain and discuss the theoretical background and its translation into practice with staff and fellow students.	
	The students work small groups with a high degree of division of labor. For every experiment, the students write a report. They receive instructions in terms of scientific writing as well as feedback on their own reports and level of scientific writing so they can increase their capabilities in this area.	
	Topics of the practical course:  Introduction in the thermal process engineering and to the main features of separation processes Simple equilibrium processes, several steps processes Distillation of binary mixtures, enthalpy-concentration diagrams Extractive and azeotrope distillation, water vapor distillation, stepwise distillation Extraction: separation ternary systems, ternary diagram Multiphase separation including complex mixtures Designing of separation devices without discrete stages Drying Chromatographic separation processes Membrane separation Energy demand of separation processes Advance overview of separation processes Selection of separation processes	
Literature	<ul> <li>G. Brunner: Skriptum Thermische Verfahrenstechnik</li> <li>J. King: Separation Processes, McGraw-Hill, 2. Aufl. 1980</li> <li>Sattler: Thermische Trennverfahren, VCH, Weinheim 1995</li> <li>J.D. Seader, E.J. Henley: Separation Process Principles, Wiley, New York, 1998.</li> <li>Mersmann: Thermische Verfahrenstechnik, Springer, 1980</li> <li>Grassmann, Widmer, Sinn: Einführung in die Thermische Verfahrenstechnik, 3. Aufl., Walter de Gruyter, Berlin 1997</li> <li>Brunner, G.: Gas extraction. An introduction to fundamentals of supercritical fluids and the application to separation processes. Steinkopff, Darmstadt; Springer, New York; 1994. ISBN 3-7985-0944-1; ISBN 0-387-91477-3.</li> <li>R. Goedecke (Hrsg.): Fluid-Verfahrenstechnik, Wiley-VCH Verlag, Weinheim, 2006.</li> <li>Perry"s Chemical Engineers" Handbook, R.H. Perry, D.W. Green, J.O. Maloney (Hrsg.), 6th ed., McGraw-Hill, New York 1984 Ullmann"s Enzyklopädie der Technischen Chemie</li> </ul>	

Module M1274: Envir	onmental Technology			
Courses				
<b>Title</b> Case studies project assessment (Lenvironmental Assessment (Loseo)		Typ Recitation Section (small) Lecture	Hrs/wk 1 2	<b>CP</b> 1 2
	Prof. Martin Kaltschmitt			
Admission Requirements	None			
Recommended Previous				
Knowledge	and mentals of morganic, organic enemistry and storogy			
Educational Objectives	After taking part successfully, students have reached the follow	wing learning results		
Professional Competence				
	With the completion of this module the students acquire in-depth knowledge of important cause-effect chains of potential environmental problems which might occur from production processes, projects or construction measures. They have knowledge about the methodological diversity and are competent in dealing with different methods and instruments to assess environmental impacts. Besides the students are able to estimate the complexity of these environmental processes as well as uncertainties and difficulties with their measurement.  The students are able to select a suitable method for the respective case from the variety of assessment methods. Thereby they can develop suitable solutions for managing and mitigating environmental problems in a business context. They are able to carry out Life Cycle Impact Assessments independently and can apply the software programs OpenLCA and the database Ecolovent.			
Personal Competence	After finishing the course the students have the competence to critically judge research results or other publications on environmental impacts.			
Social Competence	The students are able to discuss the various technical and scie to develop jointly different solutions and to discuss their th topics, the students receive insights into the multi-layered iss. Their sensitivity and consciousness towards these subjects a social responsibilities in their role as engineers.	eoretical or practical implement ues of the environment protecti	ntation. Due to the on and the conce	he selected lecture ept of sustainability.
Autonomy	The students learn to research, process and present a scier scientific work. They can solve an environmental problem in a			
Workload in Hours	Independent Study Time 48, Study Time in Lecture 42			
Credit points	3			
Course achievement	None			
Examination	Written exam			
Examination duration and	1 hour written exam			
scale				
Assignment for the			-	
Following Curricula			ng: Elective Comp	oulsory
	Bioprocess Engineering: Core Qualification: Elective Compulsor			
	Energy and Environmental Engineering: Core Qualification: Cor	mpulsory		
	Process Engineering: Core Qualification: Elective Compulsory			

Course L1054: Case studies	project assessment
Тур	Recitation Section (small)
Hrs/wk	1
СР	1
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14
Lecturer	Prof. Martin Kaltschmitt, Weitere Mitarbeiter
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 L0860: Environmenta	Il 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)

Module M0538: Heat	and Mass Transfer			
Courses				
Title		Тур	Hrs/wk	СР
Heat and Mass Transfer (L0101)		Lecture	2	2
Heat and Mass Transfer (L0102)		Recitation Section (small)	1	2
Heat and Mass Transfer (L1868)		Recitation Section (large)	1	2
Module Responsible	Prof. Irina Smirnova			
Admission Requirements	None			
Recommended Previous	Basic knowledge: Technical Thermodynamics			
Knowledge				
Educational Objectives	After taking part successfully, students have reached th	e following learning results		
Professional Competence				
Knowledge	<ul> <li>The students are capable of explaining qualitative</li> </ul>	a and determining quantitative heat	transfer in proces	dural annaratus (e. g
	heat exchanger, chemical reactors).	and determining quantitative near	transier in proced	iurar apparatus (e. g.
	They are capable of distinguish and characterize	different kinds of heat transfer med	hanisms namely h	eat conduction, heat
	transfer and thermal radiation.		,	,
	The students have the ability to explain the p	hysical basis for mass transfer in	detail and to de	scribe mass transfer
	qualitative and quantitative by using suitable mas	ss transfer theories.		
	They are able to depict the analogy between hear	- and mass transfer and to describe	complex linked pr	ocesses in detail.
Skills				
SKIIIS	The students are able to set reasonable system	boundaries for a given transport pr	oblem by using th	ne gained knowledge
	and to balance the corresponding energy and ma	ss flow, respectively.		
	They are capable to solve specific heat transfer	problems (e.g. heated chemical rea	ctors, temperatur	e alteration in fluids)
	and to calculate the corresponding heat flows.			
	Using dimensionless quantities, the students can	execute scaling up of technical proc	esses or apparatu	s.
	<ul> <li>They are able to distinguish between diffusion, contact</li> </ul>	onvective mass transition and mass	transfer. They car	n use this knowledge
	for the description and design of apparatus (e.g. e	extraction column, rectification colu	nn).	
	<ul> <li>In this context, the students are capable to choos</li> </ul>	*	neat and mass exc	changer for a specific
	application considering their advantages and disa			
	In addition, they can calculate both, steady-state			
	The students are capable to connect their kr			
	particular the courses thermodynamics, fluid m	echanics and chemical process en	gineering) to solv	e concrete technical
	problems.			
Barraral Carractoria				
Personal Competence				
Social Competence	<ul> <li>The students are capable to work on subject-spe</li> </ul>	cific challenges in teams and to pre	esent the results of	rally in a reasonable
	manner to tutors and other students.			
Autonomy	The students are able to find and evaluate necess	ary information from suitable source	es	
	They are able to prove their level of knowledge	e during the course with accompa	nying procedure of	continuously (clicker-
	system, exam-like assignments) and on this basis	they can control their learning proc	esses.	•
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56			
Credit points	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 seme	ster): Specialisation Green Technolo	gies: Compulsory	
Following Curricula	General Engineering Science (German program, 7 seme	ster): Specialisation Bioprocess Engi	neering: Compulso	ory
	General Engineering Science (German program, 7 seme	ster): Specialisation Process Enginee	ering: Compulsory	
	General Engineering Science (German program, 7 seme	ster): Specialisation Chemical and B	oengineering: Cor	npulsory
	Bioprocess Engineering: Core Qualification: Compulsory			
	Chemical and Bioprocess Engineering: Core Qualification	: Compulsory		
	Energy and Environmental Engineering: Core Qualification	on: Compulsory		
	Green Technologies: Energy, Water, Climate: Core Quali	fication: Compulsory		
	Technomathematics: Specialisation III. Engineering Scien	nce: Elective Compulsory		
	Process Engineering: Core Qualification: Compulsory			
<del>-</del>				

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

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

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

Module M0670: Partio	cle Technology	and Solids Proce	ss Engineering		
Courses					
Title			Тур	Hrs/wk	СР
Particle Technology I (L0434)			Lecture	2	3
Particle Technology I (L0435)			Recitation Section (small)	1	1
Particle Technology I (L0440)			Practical Course	2	2
Module Responsible	Prof. Stefan Heinrich	1			
Admission Requirements	None				
Recommended Previous	keine				
Knowledge					
<b>Educational Objectives</b>	After taking part successfully, students have reached the following learning results				
<b>Professional Competence</b>					
Knowledge	After successful completion of the module students are able to				
	<ul> <li>name and explain processes and unit-operations of solids process engineering,</li> </ul>				
	characterize particles, particle distributions and to discuss their bulk properties				
Skills	Students are able to				
	choose and design apparatuses and processes for solids processing according to the desired solids properties of the produ				
	asses solids with respect to their behavior in solids processing steps				
	document their work scientifically.				
	- document the	an work scientifically.			
Personal Competence					
Social Competence	The students are able to discuss scientific topics orally with other students or scientific personal and to develop solutions				
technical-scientific issues in a group.					
Autonomy	Students are able to analyze and solve questions regarding solid particles independently.				
	Independent Study Time 110, Study Time in Lecture 70				
Credit points	6				
Course achievement		Form	Description	` - 10 0 "	
	Yes None	Written elaboration	sechs Berichte (pro Versuch ein Bericht)	a 5-10 Seiten	
Examination					
Examination duration and	90 minutes				
scale					
Assignment for the	General Engineering Science (German program, 7 semester): Specialisation Green Technologies, Focus Water and Environment				
Following Curricula	Engineering: Elective Compulsory				
	General Engineering Science (German program, 7 semester): Specialisation Bioprocess Engineering: Compulsory				
	General Engineering Science (German program, 7 semester): Specialisation Process Engineering: Compulsory				
	General Engineering Science (German program, 7 semester): Specialisation Chemical and Bioengineering: Compulsory				
	Bioprocess Engineering: Core Qualification: Compulsory				
	Chemical and Bioprocess Engineering: Core Qualification: Compulsory				
	Energy and Environmental Engineering: Core Qualification: Elective Compulsory				
	Green Technologies: Energy, Water, Climate: Specialisation Water: Elective Compulsory				
	Process Engineering: Core Qualification: Compulsory				

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

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

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

Module M0539: Proce	ss and Plant Engineering I				
Courses					
Title Process and Plant Engineering I (LC Process and Plant Engineering I (LC			<b>p</b> cture citation Section (large)	Hrs/wk 2 1	<b>CP</b> 4 1
Process and Plant Engineering I (L1	214)	Re	citation Section (small)	1	1
Module Responsible	Prof. Mirko Skiborowski				
Admission Requirements	None				
Recommended Previous	unit operation of thermal an dmechanical sep	paration processes			
Knowledge	chemical reactor eingineering				
<b>Educational Objectives</b>	After taking part successfully, students have	reached the following le	earning results		
<b>Professional Competence</b>					
Knowledge	students can:				
1	classify and formulate blobal balance equation	ons of chemical process	es		
	specify linear component equations of comple	lex chemical processes			
	explain linear regression and data reconcillia	tion problems			
	explain pfd-diagrams				
Skills	students are capable of				
	- formulation of mass and energy balance eq	uations and estimation	of product streams		
	- estimation of component streams of chemic	cal plants using linear c	omponent balance mode	els	
	- solution of data reconcilliation tasks				
	- conduction of process synthesis				
	- economic evaluation of processes and the e	estimation of production	costs		
Personal Competence					
Social Competence					
Autonomy					
Workload in Hours	Independent Study Time 124, Study Time in	Lecture 56			
Credit points	6 Compulsory Bonus Form	Description			
Course achievement	Yes 10 % Subject theoretical	•			
	practical work				
Examination	Written exam				
Examination duration and	120 Min. lectures notes and books				
scale					
Assignment for the	General Engineering Science (German progra				ry
Following Curricula	General Engineering Science (German progra				anulcon.
	General Engineering Science (German progra Bioprocess Engineering: Core Qualification: C		iiisation Chemical and Bi	oengineering: Com	ipuisury
	Chemical and Bioprocess Engineering: Core C		rv		
	Green Technologies: Energy, Water, Climate:			e Compulsory	
	Process Engineering: Core Qualification: Com	npulsory			

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

Decision levels Experimental process development Reactor synthesis Synthesis of separation processes (process alternatives and criteria for selection) Integration of reaction systems/separation systems (interactions, recycle streams) 4. Process safety 5. Cost estimation of production plants Production costs, capital costs, economic evaluation Literature S.D. Barnicki, J.R. Fair, Ind. End. Chem., 29(1990), S. 421, Ind. End. Chem., 31(1992), S. 1679 H. Becker, S. Godorr, H. Kreis, Chemical Engineering, January 2001, S. 68-74 Behr, W. Ebbers, N. Wiese, Chem. -Ing.-Tech. 72(2000)Nr. 10, S.1157 E. Blass, Entwicklung verfahrenstechnischer Prozesse, Springer-Verlag, 2. Auflage 1997 M. H. Bauer, J. Stichlmair, Chem.-Ing.-Tech., 68(1996), Nr. 8, 911-916 R. Dittmeyer, W. Keim, G. Kreysa, A. Oberholz, Chemische Technik. Prozesse und Produkte, Band 2, Neue Technologien, 5. Auflage, Wiley-VCH GmbH&Co.KGaA, Weinheim, 2004 J.M. Douglas, Conceptual Design of Chemical Processes, Mc Graw-Hill, NY, 1988 G. Fieg, Inz. Chem. Proc., 5(1979), S.15-19 G. Fieg, G. Wozny, L. Jeromin, Chem. Eng. Technol. 17(1994),5, 301-306 G. Fieg, Heat and Mass Transfer 32(1996), S. 205-213 G. Fieg, Chem. Eng. Processing, Vol. 41/2(2001), S. 123-133 U.H. Felcht, Chemie eine reife Industrie oder weiterhin Innovationsmotor, Universitätsbuchhandlung Blazek und Bergamann, J.P. van Gigch, Systems Design, Modeling and Metamodeling, Plenum Press, New York, 1991 T.F. Edgar, D.M. Himmelblau, L.S. Lasdon, Optimization of Chemical Processes, McGraw-Hill, 2001 G. Gruhn, Vorlesungsmanuskript "Prozess- und Anlagentechnik, TU Hamburg-Harburg D. Hairston, Chemical Engineering, October 2001, S. 31-37 J.L.A. Koolen, Design of Simple and Robust Process Plants, Wiley-VCH, Weinheim, 2002 J. Krekel, G. Siekmann, Chem. -Ing.-Tech. 57(1985)Nr. 6, S. 511 K. Machej, G. Fieg, J. Wojcik, Inz. Chem. Proc., 2(1981), S.815-824 S. Meier, G. Kaibel, Chem. -Ing.-Tech. 62(1990)Nr. 13, S.169 J. Mittelstraß, Chem. -Ing.-Tech. 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, Chem.-Ing.-Tech. 61 (1989), Nr. 2, S. 104-112 G. Kaibel, Chem. Eng. Technol., 10(1987), Nr. 2, S. 92-98 H.J. Lang, Chem. Eng. 54(10),117, 1947 H.J. Lang, Chem. Eng. 55(6), 112, 1948 F. Lestak, C. Collins, Chemical Engineering, July 1997, S. 72-76

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

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

## **Specialization Electrical Engineering**

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

## Graduates will have

- 1 ) A firm grounding in mathematics, physics, electrical engineering, and computer science
- 2) A basic knowledge of systems theory, control systems, and electrical power and energy or measurement technology
- 3) In-depth knowledge of engineering science areas, especially their specialization area (electrical engineering materials and components, semiconductor technology, communications engineering, electromagnetig theory). They will, in particular, have the methodological skills required for applying their knowledge to the solution of technical problems, taking technical, economic and societal requirements into account.

Module M0708: Electi	rical Engineering III: Circuit Theory and Transients		
Courses			
Title Circuit Theory (L0566) Circuit Theory (L0567)	Typ         Hrs/wk         CP           Lecture         3         4           Recitation Section (small)         2         2		
Module Responsible	Prof. Alexander Kölpin		
•	None		
	Electrical Engineering I and II, Mathematics I and II		
Knowledge			
Educational Objectives	After taking part successfully, students have reached the following learning results		
Professional Competence			
Knowledge	Students are able to explain the basic methods for calculating electrical circuits. They know the Fourier series analysis of linear networks driven by periodic signals. They know the methods for transient analysis of linear networks in time and in frequency domain, and they are able to explain the frequency behaviour and the synthesis of passive two-terminal-circuits.		
Skills	The students are able to calculate currents and voltages in linear networks by means of basic methods, also when driven by periodic signals. They are able to calculate transients in electrical circuits in time and frequency domain and are able to explain the respective transient behaviour. They are able to analyse and to synthesize the frequency behaviour of passive two-terminal-circuits.		
Personal Competence Social Competence	Students work on exercise tasks in small guided groups. They are encouraged to present and discuss their results within the group.		
Autonomy	The students are able to find out the required methods for solving the given practice problems. Possibilities are given to test their knowledge during the lectures continuously by means of short-time tests. This allows them to control independently their educational objectives. They can link their gained knowledge to other courses like Electrical Engineering I and Mathematics I.		
Workload in Hours	Independent Study Time 110, Study Time in Lecture 70		
Credit points	6		
Course achievement			
Examination			
Examination duration and			
scale			
Assignment for the	General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Mechatronics:		
Following Curricula	Compulsory		
	General Engineering Science (German program, 7 semester): Specialisation Electrical Engineering: Compulsory		
	Electrical Engineering: Core Qualification: Compulsory		
	Engineering Science: Specialisation Electrical Engineering: Compulsory		
	General Engineering Science (English program, 7 semester): Specialisation Mechanical Engineering, Focus Mechatronics: Compulsory		
	Computational Science and Engineering: Specialisation II. Mathematics & Engineering Science: Elective Compulsory		
	Mechatronics: Core Qualification: Compulsory		
	Technomathematics: Specialisation III. Engineering Science: Elective Compulsory		

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

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

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Courses		H	CD.
Title Computer Engineering (L0321)	<b>Typ</b> Lecture	Hrs/wk 3	<b>CP</b> 4
Computer Engineering (L0324)	Recitation Section (small)	1	2
Module Responsible	Prof. Heiko Falk		
Admission Requirements	None		
Recommended Previous	Basic knowledge in electrical engineering		
Knowledge	After taking north an according to the state of the fallowing leave in a results		
Educational Objectives Professional Competence	After taking part successfully, students have reached the following learning results		
•	This module deals with the foundations of the functionality of computing systems. It cove programming down to gates. The module includes the following topics:  • Introduction	rs the layers fror	n the assembly-lev
	<ul> <li>Combinational logic: Gates, Boolean algebra, Boolean functions, hardware synthesis, of 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</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-</li> </ul>	pipelining	
Skills	The students perceive computer systems from the architect's perspective, i.e., they identify composition of computer systems. The students can analyze, how highly specific and individe collection of few and simple components. They are able to distinguish between and to exptoday's computing systems - from gates and circuits up to complete processors.  After successful completion of the module, the students are able to judge the interdepent system and the software executed on it. In particular, they shall understand the consequent on the hardware-centric abstraction layers from the assembly language down to gates. This the impact that these low abstraction levels have on an entire system's performance and to	ual computers ca lain the different dencies between ces that the exec way, they will be	n be built based or abstraction layers a physical comput ution of software h enabled to evalua
Personal Competence Social Competence	Students are able to solve similar problems alone or in a group and to present the results ac	cordingly.	
Autonomy	Students are able to acquire new knowledge from specific literature and to associate this knowledge	owledge with othe	r classes.
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56		
Credit points	6		
Course achievement			
Evamination	Yes 10 % Excercises Written exam		
	90 minutes, contents of course and labs		
scale	50 minutes, contents of course and lass		
Assignment for the	General Engineering Science (German program, 7 semester): Specialisation Computer Science	ce: Compulsory	
	General Engineering Science (German program, 7 semester): Specialisation Process Enginee General Engineering Science (German program, 7 semester): Specialisation Mechanic Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Eng Engineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Eng Engineering Sciences: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Eng and Production: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Compulsory	al Engineering, Food neering, Food Engineering, Focus The cal Engineering, Focus Food Engineering, Foo	cus Aircraft System neoretical Mechanic Focus Materials Product Developme us Energy System
	General Engineering Science (German program, 7 semester): Specialisation Naval Architectus General Engineering Science (German program, 7 semester): Specialisation Biomedical Engineerial Engineering Science (German program, 7 semester): Specialisation Bioprocess Engin General Engineering Science (German program, 7 semester): Specialisation Electrical Engine General Engineering Science (German program, 7 semester): Specialisation Green Technological Engineering Science (German program, 7 semester): Specialisation Green Technological Engineering Science (German program, 7 semester): Specialisation Green Technological Engineering Science (German program, 7 semester): Specialisation Green Technological Engineering Science (German program, 7 semester): Specialisation Green Technological Engineering Science (German program, 7 semester): Specialisation Green Technological Engineering Science (German program, 7 semester): Specialisation Green Technological Engineering Science (German program, 7 semester): Specialisation Green Technological Engineering Science (German program, 7 semester): Specialisation Green Technological Engineering Science (German program, 7 semester): Specialisation Green Technological Engineering Science (German program, 7 semester): Specialisation Green Technological Engineering Science (German program, 7 semester): Specialisation Green Technological Engineering Science (German program, 7 semester): Specialisation Green Technological Engineering Science (German program, 7 semester): Specialisation Green Technological Engineering Science (German program, 7 semester): Specialisation Green Technological Engineering Science (German program, 7 semester): Specialisation Green Technological Engineering Science (German program, 7 semester): Specialisation Green Technological Engineering Science (German program, 7 semester): Specialisation Green Technological Engineering Science (German program, 7 semester): Specialisation Green Technological Engineering Science (German program, 7 semester): Specialisatio	neering: Compulsoneering: Compulsoneering: Compulsonering: Compulson	pry y

Technomathematics: Specialisation II. Informatics: Elective Compulsory

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

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

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

Module M0567: Theor	retical Electrical Engineering I: T	ime-Independent Fields		
Courses				
Title Theoretical Electrical Engineering I Theoretical Electrical Engineering I		<b>Typ</b> Lecture Recitation Section (small)	Hrs/wk 3 2	<b>CP</b> 5
	Prof. Christian Schuster	,	<del>-</del>	
Admission Requirements				
-	Basic principles of electrical engineering and ac	Ivanced mathematics		
Knowledge				
Educational Objectives	After taking part successfully, students have re	ached the following learning results		
Professional Competence				
Knowledge	Students can explain the fundamental formula: They can explicate the principal behavior of sources. They can describe the properties of fields. The students are aware of applications these.	electrostatic, magnetostatic, and current complex electromagnetic fields by means	density fields with of superposition of	regard to respective f solutions for simple
Skills	Students can apply Maxwell's Equations in integral notation in order to solve highly symmetrical, time-independent, electromagnetic field problems. Furthermore, they are capable of applying a variety of methods that require solving Maxwell's Equations for more general problems. The students can assess the principal effects of given time-independent sources of fields and analyze these quantitatively. They can deduce meaningful quantities for the characterization of electrostatic, magnetostatic, and electrical flow fields (capacitances, inductances, resistances, etc.) from given fields and dimension them for practical applications.			
Personal Competence Social Competence	Students are able to work together on subject related tasks in small groups. They are able to present their results effectively (e.g. during exercise sessions).			
Autonomy	Students are capable to gather necessary information from provided references and relate this information to the lecture. They are able to continually reflect their knowledge by means of activities that accompany the lecture, such as short oral quizzes during the lectures and exercises that are related to the exam. Based on respective feedback, students are expected to adjust their individual learning process. They are able to draw connections between their knowledge obtained in this lecture and the content of other lectures (e.g. Electrical Engineering I, Linear Algebra, and Analysis).			
Workload in Hours	Independent Study Time 110, Study Time in Le	cture 70		
Credit points				
Course achievement				
Examination	Written exam			
Examination duration and scale	90-150 minutes			
Assignment for the Following Curricula	General Engineering Science (German program Electrical Engineering: Core Qualification: Comp Computational Science and Engineering: Special Technomathematics: Specialisation III. Enginee	oulsory Ilisation II. Mathematics & Engineering Scie		

Course L0180: Theoretical El	ectrical Engineering I: Time-Independent Fields
Тур	Lecture
Hrs/wk	3
СР	5
Workload in Hours	Independent Study Time 108, Study Time in Lecture 42
Lecturer	Prof. Christian Schuster
Language	DE
Cycle	SoSe
Content	- Maxwell's Equations in integral and differential notation
	- Boundary conditions
	- Laws of conservation for energy and charge
	- Classification of electromagnetic field properties
	- Integral characteristics of time-independent fields (R, L, C)
	- Generic approaches to solving Poisson's Equation
	- Electrostatic fields and specific methods of solving
	- Magnetostatic fields and specific methods of solving
	- Fields of electrical current density and specific methods of solving
	- Action of force within time-independent fields
	- Numerical methods for solving time-independent problems
	The practical application of numerical methods will be trained within specifically prepared lectures in an interactive manner using small MATLAB programs.
Literature	- G. Lehner, "Elektromagnetische Feldtheorie: Für Ingenieure und Physiker", Springer (2010)
	- H. Henke, "Elektromagnetische Felder: Theorie und Anwendung", Springer (2011)
	- W. Nolting, "Grundkurs Theoretische Physik 3: Elektrodynamik", Springer (2011)
	- D. Griffiths, "Introduction to Electrodynamics", Pearson (2012)
	- J. Edminister, " Schaum's Outline of Electromagnetics", Mcgraw-Hill (2013)
	- Richard Feynman, "Feynman Lectures on Physics: Volume 2", Basic Books (2011)

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

Module M0748: Materials in Electrical Engineering				
Courses				
Title		Тур	Hrs/wk	СР
Electrotechnical Experiments (L072	14)	Lecture	1	1
Materials in Electrical Engineering	(L0685)	Lecture	2	3
Materials in Electrical Engineering	(Problem Solving Course) (L0687)	Recitation Section (small)	2	2
Module Responsible	Prof. Manfred Eich			
Admission Requirements	None			
Recommended Previous	Highschool level physics and mathematics			
Knowledge				
<b>Educational Objectives</b>	After taking part successfully, students have reach	ed the following learning results		
<b>Professional Competence</b>				
Knowledge	Students can explain the composition and the structural properties of materials used in electrical engineering. Students can explicate the relevance of mechanical, electrical, thermal, dielectric, magnetic and chemical properties of materials in view of their applications in electrical engineering.			
Skills	Students can identify appropriate descriptive models and apply them mathematically. They can derive approximative solutions and judge factors influential on the performance of materials in electrical engineering applications.			
Personal Competence				
Social Competence	Students can jointly solve subject related problems in groups. They can present their results effectively within the framework of the problem solving course.			
Autonomy	Students are capable to extract relevant information from the provided references and to relate this information to the content of the lecture. They can reflect their acquired level of expertise with the help of lecture accompanying measures such as exam typical exam questions. Students are able to connect their knowledge with that acquired from other lectures.			
Workload in Hours	Independent Study Time 110, Study Time in Lectur	re 70		
Credit points	6			
Course achievement	None			
Examination	Written exam			
Examination duration and	60 minutes			
scale				
Assignment for the	General Engineering Science (German program, 7	semester): Specialisation Electrical Eng	ineering: Compulso	ry
Following Curricula				
_	Orientation Studies: Core Qualification: Elective Co	ompulsory		

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

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

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

Module M0854: Mathe	ematics IV			
Courses				
Title		Тур	Hrs/wk	СР
Differential Equations 2 (Partial Diff Differential Equations 2 (Partial Diff		Lecture Recitation Section (sm	2 all) 1	1
Differential Equations 2 (Partial Diff		Recitation Section (large	•	1
Complex Functions (L1038)		Lecture	2	1
Complex Functions (L1041)		Recitation Section (sm		1
Complex Functions (L1042)	D (A ) 7	Recitation Section (larg	ge) 1	1
Module Responsible	Prof. Anusch Taraz			
Admission Requirements  Recommended Previous	None  Mathematics 1 - III			
Knowledge	Mathematics 1 - III			
Educational Objectives	After taking part successfully, students have reached the	ne following learning results		
Professional Competence	7.			
Knowledge				
	Students can name the basic concepts in Mather     Students can alieura be size because the same at the same			
	<ul> <li>Students can discuss logical connections between the help of examples.</li> </ul>	en these concepts. They are c	apable of illustrating th	ese connections with
	They know proof strategies and can reproduce the strategies are strate	nem		
	mey allow proof strategies and carrieproduce a			
Skills				
	Students can model problems in Mathematics I'  appelle of solving them by applying actabilished		s studied in this course	. Moreover, they are
	<ul> <li>capable of solving them by applying established</li> <li>Students are able to discover and verify further l</li> </ul>		concents studied in the	COURSE
	For a given problem, the students can develop			
	results.			,
Personal Competence				
Social Competence	Charles to a sold a to a sold to sold			
	<ul> <li>Students are able to work together in teams. The</li> <li>In doing so, they can communicate new concept</li> </ul>			-
	design examples to check and deepen the under		en cooperating pareners	. Moreover, ency cum
	,	, , , , , , , , , , , , , , , , , , ,		
Autonomy	. Chudonte ore conchie of sheeting their understand	nding of complex concepts on	their own They can an	acifu anan succeiona
	<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> </ul>			
	Students have developed sufficient persistence to be able to work for longer periods in a goal-oriented manner on hard			
	problems.	J		
Workload in Hours	Independent Study Time 68, Study Time in Lecture 112			
Credit points	6			
Course achievement	None			
Examination	Written exam			
Examination duration and	60 min (Complex Functions) + 60 min (Differential Equa	ations 2)		
Scale Assignment for the	Congral Engineering Science (Corman program 7 com	octor). Specialisation Floatrical	Engineering, Compulsor	,
Following Curricula	General Engineering Science (German program, 7 seme General Engineering Science (German program, 7	•		
. cc.mig carricula	Compulsory			1 1 2 2 1 1 CONTROL OF THE STATE OF THE STAT
	General Engineering Science (German program, 7 seme	ester): Specialisation Naval Arcl	nitecture: Compulsory	
	General Engineering Science (German program, 7 sem	ester): Specialisation Mechanic	al Engineering, Focus Th	neoretical Mechanical
	Engineering: Elective Compulsory			
	Computer Science: Specialisation Computational Mathe	matics: Elective Compulsory		
	Electrical Engineering: Core Qualification: Compulsory	etor), Coocielisation 51tui. 15	inginoprine: Carrelle	
	General Engineering Science (English program, 7 seme General Engineering Science (English program, 7	•		
	Compulsory	oeester). Openialisation Mei	amear Engineering,	. Seas Mechadonics.
	General Engineering Science (English program, 7 seme	ester): Specialisation Mechanica	al Engineering, Focus Th	neoretical Mechanical
	Engineering: Compulsory		- <del>-</del>	
	Computational Science and Engineering: Specialisation	II. Mathematics & Engineering	Science: Elective Compu	ulsory
	Mechanical Engineering: Specialisation Mechatronics: C	ompulsory		
	Mechanical Engineering: Specialisation Theoretical Mec	hanical Engineering: Elective C	ompulsory	
	Mechatronics: Core Qualification: Compulsory			
	Naval Architecture: Core Qualification: Compulsory	nontany Course Care Child's - 5	lactive Commissions	
	Theoretical Mechanical Engineering: Technical Compler	nentary Course Core Studies: E	lective Compulsory	

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

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

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

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

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

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

Courses				
Title		Тур	Hrs/wk	СР
Electrical Machines and Actuators (	(L0293)	Lecture	3	4
Electrical Machines and Actuators (	(L0294)	Recitation Section (large)	2	2
Module Responsible	Prof. Thorsten Kern			
Admission Requirements	None			
Recommended Previous	Basics of mathematics, in particular complexe n	umbers, integrals, differentials		
Knowledge	Basics of electrical engineering and mechanical	engineering		
Educational Objectives	After taking part successfully, students have rea	ached the following learning results		
Professional Competence				
Knowledge	Students can to draw and explain the basic prin	ciples of electric and magnetic fields.		
	They can describe the function of the stand characteristic curves. For typically used drives the from the power grid to the driven engine.			
Skills	Students are able to calculate two-dimensional this they apply the usual methods of the design	- ·	rromagnetic circ	uits with air gap. Fo
	They can calulate the operational performance and characteristic curves. They apply the usual		cteristic data an	d selected quantities
Personal Competence				
Social Competence				
Autonomy		ectric and magnatic fields for applications. Th	nev are able to a	nalyse independently
	the operational performance of electric machin and characteristic curves.	es from the charactersitic data and theycan	calculate therec	of selected quantities
Workload in Hours	Independent Study Time 110, Study Time in Lec	ture 70		
Credit points	6			
Course achievement				
Examination	Subject theoretical and practical work			
Examination duration and		of design files		
scale				
Assignment for the	General Engineering Science (German program,	7 semester): Specialisation Electrical Engine	ering: Elective Co	mpulsory
Following Curricula	General Engineering Science (German progra Compulsory	m, 7 semester): Specialisation Mechanical	Engineering, Foo	
	General Engineering Science (German progr	am, 7 semester): Specialisation Mechanica	al Engineering,	cus Energy Systems
	Compulsory			Focus Mechatronics
	Compulsory General Engineering Science (German program			Focus Mechatronics
	Compulsory General Engineering Science (German program, Engineering: Elective Compulsory	7 semester): Specialisation Mechanical Engi		Focus Mechatronics
	Compulsory General Engineering Science (German program, Engineering: Elective Compulsory Digital Mechanical Engineering: Core Qualification	7 semester): Specialisation Mechanical Engi		Focus Mechatronics
	Compulsory General Engineering Science (German program, Engineering: Elective Compulsory Digital Mechanical Engineering: Core Qualification Electrical Engineering: Core Qualification: Elective	7 semester): Specialisation Mechanical Engi on: Compulsory ve Compulsory		Focus Mechatronics
	Compulsory General Engineering Science (German program Engineering: Elective Compulsory Digital Mechanical Engineering: Core Qualification Electrical Engineering: Core Qualification: Electi Energy and Environmental Engineering: Core Qualification	7 semester): Specialisation Mechanical Engion: Compulsory ve Compulsory ualification: Compulsory	neering, Focus Ti	cus Energy Systems Focus Mechatronics neoretical Mechanica
	Compulsory General Engineering Science (German program, Engineering: Elective Compulsory Digital Mechanical Engineering: Core Qualification Electrical Engineering: Core Qualification: Electi Energy and Environmental Engineering: Core Qu General Engineering Science (English program,	7 semester): Specialisation Mechanical Engi on: Compulsory we Compulsory ualification: Compulsory 7 semester): Specialisation Mechanical Engine	neering, Focus Tl	cus Energy Systems Focus Mechatronics neoretical Mechanica
	Compulsory General Engineering Science (German program Engineering: Elective Compulsory Digital Mechanical Engineering: Core Qualification Electrical Engineering: Core Qualification: Electi Energy and Environmental Engineering: Core Qualification	7 semester): Specialisation Mechanical Enginon: Compulsory ve Compulsory valification: Compulsory 7 semester): Specialisation Mechanical Enginecialisation Energy Technology: Elective Com	neering, Focus Tl	cus Energy Systems Focus Mechatronics neoretical Mechanica
	Compulsory General Engineering Science (German program, Engineering: Elective Compulsory Digital Mechanical Engineering: Core Qualificatic Electrical Engineering: Core Qualification: Electic Energy and Environmental Engineering: Core Qualification: General Engineering Science (English program, Green Technologies: Energy, Water, Climate: Sp	7 semester): Specialisation Mechanical Enginon: Compulsory we Compulsory ualification: Compulsory 7 semester): Specialisation Mechanical Enginericalisation Energy Technology: Elective Com g Science: Elective Compulsory	neering, Focus Tl	cus Energy Systems Focus Mechatronics neoretical Mechanica
	Compulsory General Engineering Science (German program, Engineering: Elective Compulsory Digital Mechanical Engineering: Core Qualificatic Electrical Engineering: Core Qualification: Electic Energy and Environmental Engineering: Core Qu General Engineering Science (English program, Green Technologies: Energy, Water, Climate: Sp Logistics and Mobility: Specialisation Engineerin	7 semester): Specialisation Mechanical Enginers: Compulsory ve Compulsory ualification: Compulsory 7 semester): Specialisation Mechanical Enginericalisation Energy Technology: Elective Com g Science: Elective Compulsory uning and Systems: Elective Compulsory	neering, Focus Tl eering: Elective C apulsory	cus Energy Systems Focus Mechatronics neoretical Mechanica
	Compulsory General Engineering Science (German program Engineering: Elective Compulsory Digital Mechanical Engineering: Core Qualificatio Electrical Engineering: Core Qualification: Electi Energy and Environmental Engineering: Core Qu General Engineering Science (English program, Green Technologies: Energy, Water, Climate: Sp Logistics and Mobility: Specialisation Engineerin Logistics and Mobility: Specialisation Traffic Plan	7 semester): Specialisation Mechanical Enginers: Compulsory ve Compulsory valification: Compulsory 7 semester): Specialisation Mechanical Enginericalisation Energy Technology: Elective Compulsory valing and Systems: Elective Compulsory Management and Processes: Elective Compulsory	neering, Focus Tl eering: Elective C apulsory	cus Energy Systems Focus Mechatronics neoretical Mechanica
	Compulsory General Engineering Science (German program Engineering: Elective Compulsory Digital Mechanical Engineering: Core Qualification: Elective Electrical Engineering: Core Qualification: Electi Energy and Environmental Engineering: Core Qualification: Electi Energy and Environmental Engineering: Core Qualification: Electi Energy and Environmental Engineering: Core Qualification: Elective Energy and Environmental Engineering: Core Qualification Engineering Science (English program, Green Technologies: Energy, Water, Climate: Sp. Logistics and Mobility: Specialisation Traffic Plar Logistics and Mobility: Specialisation Production	7 semester): Specialisation Mechanical Enginers: Compulsory ve Compulsory valification: Compulsory 7 semester): Specialisation Mechanical Enginericalisation Energy Technology: Elective Compulsory valing and Systems: Elective Compulsory Management and Processes: Elective Compulsory	neering, Focus Tl eering: Elective C apulsory	cus Energy Systems Focus Mechatronics neoretical Mechanica
	Compulsory General Engineering Science (German program Engineering: Elective Compulsory Digital Mechanical Engineering: Core Qualification: Elective Electrical Engineering: Core Qualification: Elective Energy and Environmental Engineering: Core Qualification: Elective Engineering: Engineering: Core Qualification: Elective Engineering: Engineering: Elective Engineering: Electi	7 semester): Specialisation Mechanical Enginers: Compulsory ve Compulsory ualification: Compulsory 7 semester): Specialisation Mechanical Enginerations Energy Technology: Elective Compulsory g Science: Elective Compulsory uning and Systems: Elective Compulsory Management and Processes: Elective Compulsory	neering, Focus Tl eering: Elective C apulsory	cus Energy Systems Focus Mechatronics neoretical Mechanica

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

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

Module M1340: Introd	luction to Waveguides, Antennas, and	l Electromagnetic Compat	ibility		
Courses					
itle		Тур	Hrs/wk	СР	
ntroduction to Waveguides, Antenr	as, and Electromagnetic Compatibility (L1669)	Lecture	3	4	
ntroduction to Waveguides, Antenr	as, and Electromagnetic Compatibility (L1877)	Recitation Section (small)	2	2	
Module Responsible	Prof. Christian Schuster				
Admission Requirements	None				
<b>Recommended Previous</b>	Basic principles of physics and electrical engineering				
Knowledge					
<b>Educational Objectives</b>	After taking part successfully, students have reached the	ne following learning results			
Professional Competence					
Knowledge	Students can explain the basic principles, relationship	s, and methods for the design of wa	veguides and ar	ntennas as well as	
	Electromagnetic Compatibility. Specific topics are:				
	- Fundamental properties and phenomena of electrical	circuits			
	- Steady-state sinusoidal analysis of electrical circuits				
	- Fundamental properties and phenomena of electroma				
	- Steady-state sinusoidal description of electromagnetic	fields and waves			
	- Useful microwave network parameters				
	- Transmission lines and basic results from transmission				
	- Plane wave propagation, superposition, reflection and refraction				
	- General theory of waveguides	iaa			
	- Most important types of waveguides and their properties				
	- Radiation and basic antenna parameters  Most important types of antennas and their proporties				
	- Most important types of antennas and their properties				
	- Numerical techniques and CAD tools for waveguide ar	id antenna design			
	- Fundamentals of Electromagnetic Compatibility				
- Coupling mechanisms and countermeasures					
	- Shielding, grounding, filtering				
	- Standards and regulations				
	- EMC measurement techniques				
Skills	Students know how to apply various methods and mod	dels for characterization and choice of	waveguides and	d antennas. They a	
	able to assess and qualify their basic electromagne	etic properties. They can apply resu	lts and strategi	es from the field	
	Electromagnetic Compatibilty to the development of ele	ectrical components and systems.			
Personal Competence					
Social Competence	Students are able to work together on subject related	tasks in small groups. They are able	to present their	results effectively	
	English (e.g. during small group exercises).				
Autonomy	Students are capable to gather information from sub	oject related, professional publication	s and relate tha	at information to the	
	context of the lecture. They are able to make a conne	ction between their knowledge obtain	ed in this lectur	e with the content	
	other lectures (e.g. theory of electromagnetic fields, fu	indamentals of electrical engineering	physics). They	can discuss technic	
	problems and physical effects in English.				
Workload in Hours	Independent Study Time 110, Study Time in Lecture 70				
	6				
Course achievement	None				
	Oral exam				
Examination duration and	45 min				
scale					
Assignment for the	General Engineering Science (German program, 7 seme	ester): Specialisation Flectrical Engine	erina: Elective Co	mpulsory	
Following Curricula	Electrical Engineering: Core Qualification: Elective Com				
rollowing curricula	Aircraft Systems Engineering: Core Qualification: Electiv				

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

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

Module M1235: Electi	rical Power Systems I: Introduction to	Electrical Power Systems	5	
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	Prof. Christian Becker			
Admission Requirements				
	Fundamentals of Electrical Engineering			
Knowledge				
<b>Educational Objectives</b>	After taking part successfully, students have reached the	e following learning results		
<b>Professional Competence</b>				
Knowledge	Students are able to give an overview of conventional ar	nd modern electric power systems. $ $	They can explain i	n detail and criticall
	evaluate technologies of electric power generation, tran	smission, storage, and distribution a	s well as integrati	on of equipment into
	electric power systems.			
Skills	With completion of this module the students are able	e to apply the acquired skills in ar	onlications of the	design integration
Skiiis	development of electric power systems and to assess th		pheadons of the	design, meegration
Personal Competence				
Social Competence	The students can participate in specialized and interdisc	iplinary discussions, advance ideas a	ind represent thei	r own work results i
	front of others.			
Autonomy	Students can independently tap knowledge of the emph	asis of the lectures.		
Workload in Hours	Independent Study Time 110, Study Time in Lecture 70			
Credit points	6			
Course achievement	None			
Examination	Written exam			
Examination duration and	90 - 150 minutes			
scale				
Assignment for the	General Engineering Science (German program, 7 seme	ster): Specialisation Electrical Engine	ering: Elective Co	mpulsory
Following Curricula	General Engineering Science (German program, 7 seme	ster): Specialisation Green Technolog	jies, Focus Renew	able Energy: Electiv
	Compulsory			
	Data Science: Core Qualification: Elective Compulsory			
	Electrical Engineering: Core Qualification: Elective Comp	ulsory		
	Energy Systems: Specialisation Energy Systems: Elective	e Compulsory		
	Engineering Science: Specialisation Electrical Engineerin	g: Elective Compulsory		
	Green Technologies: Energy, Water, Climate: Specialisat	ion Energy Systems: Elective Compu	Isory	
	Computer Science in Engineering: Specialisation II. Math		tive Compulsory	
	Integrated Building Technology: Core Qualification: Com	pulsory		
	Renewable Energies: Core Qualification: Compulsory			
	Theoretical Mechanical Engineering: Specialisation Energ	gy Systems: Elective Compulsory		

Course L1670: Electrical Pow	er Systems I: Introduction to Electrical Power Systems	
Тур	Lecture	
Hrs/wk	3	
СР	4	
Workload in Hours	Independent Study Time 78, Study Time in Lecture 42	
Lecturer	Prof. Christian Becker	
Language	DE	
Cycle	WiSe	
Content	fundamentals and current development trends in electric power engineering	
	tasks and history of electric power systems	
	symmetric three-phase systems	
	fundamentals and modelling of eletric power systems	
	o lines	
	• transformers	
	synchronous machines	
	induction machines	
	loads and compensation	
	grid structures and substations	
	fundamentals of energy conversion	
	electro-mechanical energy conversion	
	• thermodynamics	
	power station technology	
	<ul> <li>renewable energy conversion systems</li> </ul>	
	steady-state network calculation	
	network modelling	
	load flow calculation	
	o (n-1)-criterion	
	symmetric failure calculations, short-circuit power	
	control in networks and power stations	
	grid protection	
	• grid planning	
	power economy fundamentals	
Literature	K. Heuck, KD. Dettmann, D. Schulz: "Elektrische Energieversorgung", Vieweg + Teubner, 9. Auflage, 2013	
Literature	na redect, to D. Detarram, D. Serialz. Elektrische Energieversorgang , vieweg i redoner, J. Adriage, 2015	
	A. J. Schwab: "Elektroenergiesysteme", Springer, 5. Auflage, 2017	
	R. Flosdorff: "Elektrische Energieverteilung" Vieweg + Teubner, 9. Auflage, 2008	

Course L16/1: Electrical Pow	er Systems I: Introduction to Electrical Power Systems	
Тур	Recitation Section (small)	
Hrs/wk		
СР		
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> <li>tasks and history of electric power systems</li> <li>symmetric three-phase systems</li> <li>fundamentals and modelling of eletric power systems         <ul> <li>lines</li> <li>transformers</li> <li>synchronous machines</li> <li>induction machines</li> <li>loads and compensation</li> <li>grid structures and substations</li> </ul> </li> <li>fundamentals of energy conversion         <ul> <li>electro-mechanical energy conversion</li> <li>thermodynamics</li> <li>power station technology</li> <li>renewable energy conversion systems</li> </ul> </li> <li>steady-state network calculation         <ul> <li>network modelling</li> <li>load flow calculation</li> <li>(n-1)-criterion</li> </ul> </li> <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	

Module M0783: Meas	urements: Meth	ods 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 Schlae	efer				
Admission Requirements	None					
Recommended Previous	principles of mathema	atics				
Knowledge	principles of electrical	engineering				
Educational Objectives	After taking part succe	essfully, students	have reached the following	ng learning results		
Professional Competence						
	aspects of probability describe measured sig	theory and errors	s, and explain the process	the acquisition and processing of stochastic signals. St	cudents know meth	ods to digitalize and
Personal Competence Social Competence	The students solve pro	oblems in small g	roups.			
Autonomy	The students can refle	ect their knowledg	ge and discuss and evalua	ite their results.		
Workload in Hours	Independent Study Tir	me 110, Study Tir	ne in Lecture 70			
Credit points	6					
Course achievement	Compulsory Bonus Yes 10 %	Form Excercises	Description			
Examination	Written exam					
Examination duration and						
scale						
	General Engineering S	Science (German	program, 7 semester). Sn	ecialisation Electrical Engine	eering: Elective Co	mpulsory
Following Curricula	Electrical Engineering		-	colanisation Electrical Eligini	ccg. Licetive Col	
i onoming carricula			ctrical Engineering: Electi	ve Compulsory		
		•	ualification: Elective Com			
			Engineering Science: Elec			
	recinioniamenialics.	Specialisation III.	Linging entity octenice. Elec	.cive compuisory		

Course L0781: EE Experimen	Course L0781: EE Experimental Lab			
Тур	Practical Course			
Hrs/wk	2			
СР	2			
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28			
Lecturer	Prof. Alexander Schlaefer, Prof. Herbert Werner, Dozenten des SD E, Prof. Christian Becker, Prof. Heiko Falk, Prof. Bernd-Christian			
	Renner, 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	s: Methods and Data Processing
Тур	Lecture
Hrs/wk	2
СР	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Prof. Alexander Schlaefer
Language	DE
Cycle	WiSe
Content	introduction, systems and errors in metrology, probability theory, measuring stochastic signals, describing measurements,
	acquisition of analog signals, applied metrology
Literature	Puente León, Kiencke: Messtechnik, Springer 2012
	Lerch: Elektrische Messtechnik, Springer 2012
	Weitere Literatur wird in der Veranstaltung bekanntgegeben.

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

Module M0568: Theor	etical Electrical Engineering II: Tim	e-Dependent Fields			
Courses					
Title		Тур	Hrs/wk	СР	
Theoretical Electrical Engineering II	: Time-Dependent Fields (L0182)	Lecture	3	5	
Theoretical Electrical Engineering II	: Time-Dependent Fields (L0183)	Recitation Section (small)	2	1	
Module Responsible	Prof. Christian Schuster				
Admission Requirements	None				
Recommended Previous	Electrical Engineering I, Electrical Engineering II, Th	eoretical Electrical Engineering I			
Knowledge	Mathematics I, Mathematics II, Mathematics III, Mat	hematics IV			
Educational Objectives	After taking part successfully, students have reache	ed the following learning results			
Professional Competence					
	Students are able to explain fundamental formulas, relations, and methods related to the theory of time-dependent electromagnetic fields. They can assess the principal behavior and characteristics of quasistationary and fully dynamic fields with regard to respective sources. They can describe the properties of complex electromagnetic fields by means of superposition of solutions for simple fields. The students are aware of applications for the theory of time-dependent electromagnetic fields and are able to explicate these.				
	Students are able to apply a variety of procedures in order to solve the diffusion and the wave equation for general time-depender field problems. They can assess the principal effects of given time-dependent sources of fields and analyze these quantitatively. They can deduce meaningful quantities for the characterization of fully dynamic fields (wave impedance, skin depth, Poynting vector, radiation resistance, etc.) from given fields and interpret them with regard to practical applications.				
· ·	Students are able to work together on subject related tasks in small groups. They are able to present their results effectively (e.g. during exercise sessions).				
Autonomy	Students are capable to gather necessary information from provided references and relate this information to the lecture. They are able to continually reflect their knowledge by means of activities that accompany the lecture, such as short oral quizzes during the lectures and exercises that are related to the exam. Based on respective feedback, students are expected to adjust their individua learning process. They are able to draw connections between acquired knowledge and ongoing research at the Hamburg University of Technology (TUHH), e.g. in the area of high frequency engineering and optics.				
Workload in Hours	Independent Study Time 110, Study Time in Lecture	70			
	Independent Study Time 110, Study Time in Lecture	5.70			
	6 None				
Course achievement					
	Written exam 90-150 minutes				
	an-Ton minniez				
scale Assignment for the	Conoral Engineering Science (Correspondence 7	omostor), Enocialisation Floatrical Facility	oring, Commula	.,	
•	General Engineering Science (German program, 7 s Electrical Engineering: Core Qualification: Compulso	- · ·	ering: compulsor	у	
-		•			
	Engineering Science: Specialisation Electrical Engineering: Compulsory				
J	Engineering Science: Specialisation Mechatronics: F				
	Engineering Science: Specialisation Mechatronics: Engineering Science: Specialisation Mechatronics: E				

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

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

Module M0675: Introd	duction to Communications and Rar	ndom Processes		
Courses				
Title		Тур	Hrs/wk	СР
Introduction to Communications an	d Random Processes (L0442)	Lecture	3	4
Introduction to Communications an		Recitation Section (large)	1	1
Introduction to Communications an	·	Recitation Section (small)	1	1
Module Responsible				
Admission Requirements	None			
Recommended Previous	Mathematics 1-3			
Knowledge	Signals and Systems			
-	After taking part successfully, students have reache	ed the following learning results		
Professional Competence				
Knowledge	The students know and understand the fundament	-		-
	the individual building blocks using knowledge of s		-	
	aware of the essential resources and evaluation cr	iteria of information transmission and a	e able to design	and evaluate a basic
	communications system.			
	The students are familiar with the contents of lectu	re and tutorials. They can explain and ap	ply them to new p	roblems.
Skills	The students are able to design and evaluate a	basic communications system. In partic	cular, they can e	stimate the required
	resources in terms of bandwidth and power. They	·	-	·
	system such as bandwidth efficiency or bit error rat	·		
Personal Competence	System such as summan emissing of six error rate and to decide for a suitable datismission medical.			
Social Competence	The students can jointly solve specific problems.			
Autonomy	The students are able to acquire relevant information from appropriate literature sources. They can control their level of			
	knowledge during the lecture period by solving tuto	rial problems, software tools, clicker syst	em.	
Workload in Hours	Independent Study Time 110, Study Time in Lecture	e 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 s	emester): Specialisation Electrical Engine	eering: Compulsor	y
Following Curricula	Data Science: Core Qualification: Elective Compulso	pry		
	Data Science: Specialisation I. Mathematics/Compu	ter Science: Elective Compulsory		
	Electrical Engineering: Core Qualification: Compulso	pry		
	Computer Science in Engineering: Core Qualification: Compulsory			
	Technomathematics: Specialisation III. Engineering	Science: Elective Compulsory		

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

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

## ■ Delta modulation

- Fundamentals of information theory and coding
  - o Definitions of information: Self-information, entropy
  - Binary entropy function
  - Source coding theorem
  - Source coding: Huffman code
  - Mutual information and channel capacity
  - Channel capacity of the AWGN channel and the binary input AWGN channel
  - Channel coding theorem
  - Principles of channel coding: Code rate and data rate, Hamming distance, minimum Hamming distance, error detection and error correction
  - Examples for channel codes: Block codes and convolutional codes, repetition code, single parity check code,
     Hamming code, Turbo codes
- Combinatorics
  - · Variation with and without repetition
  - o Combination with and without repetition
  - · Permutation. Permutation of multisets
  - Word error probabilities of linear block codes
- · Baseband transmission
  - Pulse shaping: Non-return to zero (NRZ) rectangular pulses, Manchester pulses, raised-cosine pulses, square-root raised-cosine pulses, Gaussian pulses
  - Transmit signal energy, average energy per symbol
  - o Power spectral density (psd) of baseband signals
  - Definitions of signal bandwidth
  - Bandwidth efficiency
  - Intersymbol interference (ISI)
  - First and second Nyquist criterion
  - Eye patterns
  - · Receive filter design: Matched filter
  - o Matched-filter receiver and correlation receiver
  - · Square-root Nyquist pulse shaping
  - Discrete-time AWGN channel model
- Maximum a posteriori probability (MAP) and maximum likelihood (ML) detection
- Bit error probability in AWGN channels for binary antipodal and on-off signaling
- Band-pass transmission via carrier modulation
  - Amplitude modulation, frequency modulation, phase modulation
  - Linear digital modulation methods: On-off keying (OOK), phase-shift keying (PSK), amplitude shift keying (ASK), quadrature amplitude shift keying (QAM)

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

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

Module M0760: Electr	onic Devices					
Courses						
Title				Тур	Hrs/wk	СР
Electronic Devices (L0720)				Lecture	3	4
Electronic Devices (L0721)	Project-/problem-based Learning 2 2					2
Module Responsible	Prof. Hoc Khiem Trieu					
Admission Requirements	None					
Recommended Previous Knowledge				ate materials, basics in solid-stat		ent contents
Educational Objectives	After taking part succes	ssfully, students have r	eached the followi	ng learning results		
Professional Competence	riter taking part sacces	solution, students have t	caerrea erre romonni	ng rearring results		
Knowledge						
J						
	Students are able					
	<ul> <li>to represent the</li> </ul>	basics of semiconducto	or physics,			
	to explain the op	erating principle of imp	ortant semicondu	ctor devices,		
	<ul> <li>to outline device</li> </ul>	characteristics and eq	uivalent circuits as	well as to explain their derivation	on and	
	<ul> <li>to discuss the lin</li> </ul>	nitation of device mode	ıls.			
Skills						
Skills						
	Students are capable					
	<ul> <li>to apply devices</li> </ul>	in basic circuits,				
	to realize the phy	ysical context and to so	olve complex probl	ems by oneself		
Barrard Committee						
Personal Competence Social Competence	Students are able to nr	enare and perform the	ir lah evneriments	in team work as well as to prese	ant and discus	the results in fron
Sucial Competence	of audience.	epare and perioriii the	п нав ехрепппениз	in team work as well as to prese	ent and discus	s the results in from
Autonomy	Students are capable to	acquire knowledge ba	sed on literature i	n order to prepare their experime	ents.	
Workload in Hours	Independent Study Tim					
Credit points	6					
Course achievement		Form	Description			
	Yes 10 %	Subject theoretical	andStudierenden	erarbeiten in Kleingruppen Wis	sen zu einem	bestimmten Thema
		practical work	demonstriere	n dieses in Form eines Ve	ersuches mit	Präsentation und
				Darüber hinaus betreut jede C	Gruppe eine Ü	Übungsaufgabe, die
			inhaltlich zu	dem jeweiligen Versuch gehört.		
Examination	Written exam					
Examination duration and scale	120 min					
Assignment for the	General Engineering Sc	ience (German program	n 7 samastar). Sn	ecialisation Electrical Engineerin	a: Compulsor	
Following Curricula	Electrical Engineering:			celansation Electrical Engineerin	g. Compuisory	
. cc.mig carricula	Engineering Science: Sp	· ·		pulsory		
				cialisation Electrical Engineering	: Compulsorv	
				& Engineering Science: Elective		
	·	<u> </u>				

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

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

Module M0777: Semi	conductor Circuit Design			
Courses				
Title		Тур	Hrs/wk	СР
Semiconductor Circuit Design (L0763)		Lecture	3	4
Semiconductor Circuit Design (L08)		Recitation Section (small)	1	2
Module Responsible				
Admission Requirements	None			
Recommended Previous  Knowledge	Fundamentals of electrical engineering			
Knowledge	Basics of physics, especially semiconductor physics			
<b>Educational Objectives</b>	After taking part successfully, students have reache	ed the following learning results		
<b>Professional Competence</b>				
Knowledge	<ul> <li>Students are able to explain the functionality</li> </ul>	of different MOS devices in electronic circ	uits.	
	Students are able to explain how analog circular			
	<ul> <li>Students are able to explain the functionality</li> </ul>	of fundamental operational amplifiers and	d their specificati	ions.
	Students know the fundamental digital logic of the students know the s	circuits and can discuss their advantages	and disadvantag	es.
	Students have knowledge about memory circ	uits and can explain their functionality an	d specifications.	
	Students know the appropriate fields for the i	use of bipolar transistors.		
Skills				
SKIIIS	<ul> <li>Students can calculate the specifications of d</li> </ul>	ifferent MOS devices and can define the p	arameters of ele	ctronic circuits.
	<ul> <li>Students are able to develop different logic c</li> </ul>	ircuits and can design different types of lo	gic circuits.	
	<ul> <li>Students can use MOS devices, operational a</li> </ul>	mplifiers and bipolar transistors for specifi	ic applications.	
Personal Competence				
Social Competence	<ul> <li>Students are able work efficiently in heteroge</li> </ul>	eneous teams.		
	<ul> <li>Students working together in small groups ca</li> </ul>	in solve problems and answer professiona	I questions.	
Autonomy	<ul> <li>Students are able to assess their level of kno</li> </ul>	wledge.		
Workload in Hours	Independent Study Time 124, Study Time in Lecture	2 56		
Credit points				
Course achievement				
Examination	Written exam			
Examination duration and	120 min			
Scale Assignment for the	General Engineering Science (German program, 7 s	emester): Specialisation Flectrical Engineer	ering: Compulsor	W.
Following Curricula	General Engineering Science (German program, 7 Si		-	
	Compulsory	, semester, specialisation recitation	g,eeg,	. ocus i recriati omes
	Data Science: Core Qualification: Elective Compulso	ry		
	Electrical Engineering: Core Qualification: Compulso	ory		
	Engineering Science: Specialisation Electrical Engine	eering: Compulsory		
	Engineering Science: Specialisation Mechatronics: C			
	General Engineering Science (English program, 7 se			
	General Engineering Science (English program, 7 se			
	Computer Science in Engineering: Specialisation II. I		ive Compulsory	
	Mechanical Engineering: Specialisation Mechatronic Mechatronics: Core Qualification: Compulsory	s. Compulsory		
	Technomathematics: Specialisation III. Engineering	Science: Elective Compulsory		
	recimentationality. Specialisation III. Engineering	Science. Elective Compulsory		

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

Course L0864: Semiconductor Circuit Design		
Тур	Recitation Section (small)	
Hrs/wk	1	
СР	2	
Workload in Hours	Independent Study Time 46, Study Time in Lecture 14	
Lecturer	Prof. Matthias Kuhl, Weitere Mitarbeiter	
Language	DE	
Cycle	SoSe	
Content	<ul> <li>Basic circuits and characteristic curves of bipolar transistors</li> <li>Basic circuits and characteristic curves of MOS transistors for amplifiers</li> <li>Realization and dimensioning of operational amplifiers</li> <li>Realization of logic functions</li> <li>Basic circuits with MOS transistors for combinational and sequential logic</li> <li>Memory circuits</li> <li>Circuits for analog-to-digital and digital-to-analog converters</li> <li>Design of exemplary circuits</li> </ul>	
Literature	U. Tietze und Ch. Schenk, E. Gamm, Halbleiterschaltungstechnik, Springer Verlag, 14. Auflage, 2012, ISBN 3540428496  R. J. Baker, CMOS - Circuit Design, Layout and Simulation, J. Wiley & Sons Inc., 3. Auflage, 2011, ISBN: 047170055S  H. Göbel, Einführung in die Halbleiter-Schaltungstechnik, Berlin, Heidelberg Springer-Verlag Berlin Heidelberg, 2011, ISBN: 9783642208874 ISBN: 9783642208867  URL: http://site.ebrary.com/lib/alltitles/docDetail.action?docID=10499499  URL: http://dx.doi.org/10.1007/978-3-642-20887-4  URL: http://ebooks.ciando.com/book/index.cfm/bok_id/319955  URL: http://www.ciando.com/img/bo	

Module M0734: Electr	ical Engineering Project Laborato	ory		
Courses				
Title Electrical Engineering Project Labor	ratory (L0640)	<b>Typ</b> Project-/problem-based Learning	Hrs/wk	<b>CP</b> 6
Module Responsible	Prof. Christian Becker			
Admission Requirements	None			
Recommended Previous	Electrical Engineering I, Electrical Engineering II			
Knowledge				
-	After taking part successfully, students have rea	ched the following learning results		
Professional Competence				
Knowledge	Students are able to give a summary of the respective relationships. They are capable of detechnical language. They can explain the typical	escribing and communicating relevant problem	ns and question	ns using appropriate
Skills	The students can transfer their fundamental knowledge on electrical engineering to the process of solving practical problems.  They identify and overcome typical problems during the realization of projects in the context of electrical engineering. Students are able to develop, compare, and choose conceptual solutions for non-standardized problems.			
Personal Competence				
_	Students are able to cooperate in small, mixed-subject groups in order to independently derive solutions to given problems in the context of electrical engineering. They are able to effectively present and explain their results alone or in groups in front of a qualified audience. Students have the ability to develop alternative approaches to an electrical engineering problem independently or in groups and discuss advantages as well as drawbacks.			
Autonomy	Students are capable of independently solving electrical engineering problems using provided literature. They are able to fill gaps in as well as extent their knowledge using the literature and other sources provided by the supervisor. Furthermore, they can meaningfully extend given problems and pragmatically solve them by means of corresponding solutions and concepts.			
Workload in Hours	Independent Study Time 68, Study Time in Lectu	ire 112		
Credit points	6			
Course achievement	None			
Examination	Subject theoretical and practical work			
Examination duration and scale	based on task + presentation			
Assignment for the	General Engineering Science (German program,	7 semester): Specialisation Electrical Engineer	ng: Compulsory	
Following Curricula	Electrical Engineering: Core Qualification: Compu	ulsory		
	Engineering Science: Specialisation Electrical Engineering	gineering: Compulsory		
	Engineering Science: Specialisation Electrical Engineering	gineering: Elective Compulsory		
	Technomathematics: Specialisation III. Engineeri	ng Science: Elective Compulsory		

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

## **Specialization Green Technologies**

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

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

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

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

Module M1497: Meas	urement Techn	ology for VT	/ BVT		
Courses					
Title			Тур	Hrs/wk	СР
Practical Course Measurement Technology (L2270)		Practical Course	2	2	
Measurement Technology (L2268)			Lecture	2	2
Physical Fundamentals of Measurer		)	Lecture	2	2
Module Responsible	Prof. Alexander Penn				
Admission Requirements	None				
Recommended Previous	1	gical skills, integra	al- and differential calculus, basic physical conc	epts such as tempera	ture, mass, velocity,
Knowledge	etc				
Educational Objectives	After taking part succ	essfully, students	have reached the following learning results		
Professional Competence					
·	Physical basics: kine	ematics and dyna	mics (theory of motion), rotation of rigid bo	dies, energy and mo	mentum, electricity,
_	-		emperature and heat, ideal gas.		,
	1		measurement uncertainty, basics of sensor te		nciples, temperature
	measurement, pressu	ire measurement,	level measurement, flow measurement. Usage of	or Matiab Scripts.	
	Practical course: Pres	sure drop in piping	g, calorimetry, image data acquisition, flow mea	surement, concentrati	on measurement and
	mass transfer, capaci	tive measurement	s of solid concentrations, spectroscopy, error ca	lculation, chromatogra	phy
Skille	Literature research	catogorication of t	hematical topics, analysis of an experimental to	est stand proparation	of tost protocol first
SKIIIS			evant laboratory measurement technology, pre		
	calculations.	iatiab, asc of fer	evalue laboratory measurement teenhology, pro	eparation of a test p	otocoi, excedion of
Personal Competence					
Social Competence	Arrangement and division of work in practical training and learning groups, assessment of own level of knowledge, work on the				
	· ·		Itation with persons responsible for teaching	, presentation of the	preparation of the
	experiment, tolerance	e of frustration			
Autonomy	Time management of	f the workload, inc	dependent development of the thematic basics,	personal responsibilit	y for the provision of
	protective equipmen	t and work cloth	ing, practice of presentation in front of a gr	roup, active participa	tion in the lectures,
	formulation of enquir	ies/detailed questi	ons by using clicker.		
Wanda ad la Harra	In demandant Charles T	06 Study Tim	a in Lankous Od		
Workload in Hours	Independent Study Ti	me 96, Study Time	e in Lecture 84		
0.00.1 po		Farms	Description		
Course achievement	No 20 %	Form Excercises	Description Popup-Quizzes währen der Vorlesun	a	
Examination			. Spap Quizzes warren der vortesdir	9	
Examination duration and	120 min				
scale					
Assignment for the	General Engineering	Science (German r	program, 7 semester): Specialisation Process End	nineering: Compulsory	
Following Curricula			program, 7 semester): Specialisation Process Eng		
			program, 7 semester): Specialisation Bioprocess		ory
	General Engineering	Science (German p	program, 7 semester): Specialisation Green Tech	nologies: Compulsory	
	Bioprocess Engineering	ng: Core Qualificat	ion: Compulsory		
	General Engineering	Science (English p	rogram, 7 semester): Specialisation Process Eng	ineering: Compulsory	
	Green Technologies:	Energy, Water, Cli	mate: Core Qualification: Compulsory		
	Orientation Studies: 0	Core Qualification:	Elective Compulsory		
	Process Engineering:	Core Qualification	: Compulsory		

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

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

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

Module M0536: Funda	amentals of Fluid Mechanics			
Courses				
Title		Тур	Hrs/wk	СР
Fundamentals of Fluid Mechanics (	L0091)	Lecture	2	4
Fluid Mechanics for Process Engine	ering (L0092)	Recitation Section (large)	2	2
Module Responsible	Prof. Michael Schlüter			
Admission Requirements	None			
Recommended Previous	Mathematics I+II+III			
Knowledge	Technical Mechanics I+II			
	Technical Thermodynamics I+II			
	Working with force balances			
	Simplification and solving of partial diffe	erential equations		
	Integration			
<b>Educational Objectives</b>	After taking part successfully, students have re	eached the following learning results		
<b>Professional Competence</b>				
Knowledge	Students are able to:			
	explain the difference between different	types of flow		
		ns of the Reynolds Transport-Theorem in proc	ess engineering	
	<ul> <li>explain simplifications of the Continuity-</li> </ul>	and Navier-Stokes-Equation by using physica	l boundary condit	ions
Skills	The students are able to			
S.i.i.s				
	describe and model incompressible flow			
	<ul> <li>reduce the governing equations of fluid</li> <li>notice the dependency between theory</li> </ul>	mechanics by simplifications to archive quant	itative solutions e	.g. by integration
	, , ,	and technical applications al applications in fields of process engineering	ı	
Personal Competence				
Social Competence	The students			
		subject related, professional publications and	relate that inforr	nation to the context
	of the lecture and			
	able to work together on subject related tasks in small groups. They are able to present their results effectively in English  (a.g. division arrall group everyions).			
	<ul><li>(e.g. during small group exercises)</li><li>are able to work out solutions for exercises by themselves, to discuss the solutions orally and to present the results.</li></ul>			
			any and to presen	e tire results.
Autonomy	The students are able to			
	search further literature for each topic and to expand their knowledge with this literature,			
	<ul> <li>work on their exercises by their own and</li> </ul>	d to evaluate their actual knowledge with the f	eedback.	
Workload in Hours	Independent Study Time 124, Study Time in Le	ecture 56		
Credit points		3344.0 50		
Course achievement		Description		
	Yes 5 % Midterm			
	Written exam			
Examination duration and	3 hours			
scale				
Assignment for the Following Curricula				an/
i Showing Curricula	General Engineering Science (German progran General Engineering Science (German progran			J. y
	Bioprocess Engineering: Core Qualification: Co		,puisory	
	Energy and Environmental Engineering: Core C			
	Green Technologies: Energy, Water, Climate: C	Core Qualification: Compulsory		
	Logistics and Mobility: Specialisation Traffic Pla	anning and Systems: Elective Compulsory		
	Technomathematics: Specialisation III. Enginee			
	Process Engineering: Core Qualification: Comp		16	
	Engineering and Management - Major in Logist	ics and Mobility: Specialisation Traffic Planning	g and Systems: El	ective Compulsory

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

se 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 SoSe
Content	In the exercise-lecture the topics from the main lecture are discussed intensively and transferred into application. For that, th students receive example tasks for download. The students solve these problems based on the lecture material eithe independently or in small groups. The solution is discussed with the students under scientific supervision and parts of the solution are presented on the chalk board. At the end of each exercise-lecture, the correct solution is presented on the chalk board. Paralle to the exercise-lecture tutorials are held where the student solve exam questions under a set time-frame in small groups and discuss the solutions afterwards.
Literature	<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 Strömunger 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+ Teubne Verlag / GWV Fachverlage GmbH, Wiesbaden, 2009</li> <li>Schade, H.; Kunz, E.: Strömungslehre. Verlag de Gruyter, Berlin, New York, 2007</li> <li>Truckenbrodt, E.: Fluidmechanik 1: Grundlagen und elementare Strömungsvorgänge dichtebeständiger Fluide. Springer Verlag, Berlin, Heidelberg, 2008</li> <li>Schlichting, H.: Grenzschicht-Theorie. Springer-Verlag, Berlin, 2006</li> <li>van Dyke, M.: An Album of Fluid Motion. The Parabolic Press, Stanford California, 1882.</li> <li>White, F.: Fluid Mechanics, Mcgraw-Hill, ISBN-10: 0071311211, ISBN-13: 978-0071311212, 2011</li> </ol>

Module M0686: Sanita	ary Engineering I			
Courses				
Title Wastewater Disposal (L0276) Wastewater Disposal (L0278) Drinking Water Supply (L0306) Drinking Water Supply (L0308)		Typ  Lecture  Recitation Section (large)  Lecture  Recitation Section (large)	Hrs/wk 2 1 2 1	CP 2 1 1 2
Module Responsible	Prof. Ralf Otterpohl			
Admission Requirements	None			
Recommended Previous Knowledge	Basic knowledge on Chemistry and Biology Hydraulics of pipe systems and open channels Basic knowledge on water management: water o Basic knowledge on Environmental Legislation: F			
<b>Educational Objectives</b>	After taking part successfully, students have reached the	ne following learning results		
Professional Competence Knowledge				
Skills	The students are able to apply the relevant standards and guidelines for the design and operation of urban water infrastructures independently. Their expertise comprises expert skills to design drinking water supply and urban drainage systems as well as the associated treatment facilities. Besides the acquirement of technical skills the students are able to address and solve biochemical problems in the filed of drinking water and wastewater treatment. The students are also able to develop ideas of their own to improve the existing water related infrastructures, systems and concepts.			
Personal Competence Social Competence	Social skills are not targeted in this module.			
Autonomy	Students are able to form concepts on their own to optimize urban water infrastructure processes. Therefore they can acquire appropriate knowledge when being given some clues or information with regard to the approach to problems (preparation and follow-up of the exercises).			
Workload in Hours	Independent Study Time 96, Study Time in Lecture 84		-	
Credit points	6			
Course achievement	None			
Examination	Written exam			
Examination duration and	120 min			
•	General Engineering Science (German program, 7 semi General Engineering Science (German program, 7 semi Civil- and Environmental Engineering: Core Qualificatio Civil- and Environmental Engineering: Core Qualificatio General Engineering Science (English program, 7 seme Green Technologies: Energy, Water, Climate: Core Qua	ester): Specialisation Green Technologi n: Compulsory n: Compulsory ster): Specialisation Civil Engineering:	es: Compulsory	,

Course L0276: Wastewater D	isposal
Тур	Lecture
Hrs/wk	2
СР	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Prof. Ralf Otterpohl
Language	DE
Cycle	SoSe SoSe
Content	This lecture focusses on urban drainage and wastewater treatment.
	Urban Drainage
	Design of urban drainage systems (combined and separate sewer systems)
	Special structures
	Rainwater management
	Wastewater treatement
	<ul> <li>Mechanical treatment (Screens, Grit chamber, Preliminary Sedimentation, Secondary Settlement Tanks, Membrane Filtration)</li> </ul>
	Biological Treatment (aerobic, anaerobic, anoxic)
	Special Wastewater Treatment Processes (Ozonation, Adsorption)
Literature	Die hier aufgeführte Literatur ist in der Bibliothek der TUHH verfügbar.
	The literature listed below is available in the library of the TUHH.
	• Taschenbuch der Stadtentwässerung : mit 10 Tafeln und 67 Tabellen, Imhoff, K., & . (2009). (31., verbesserte Aufl.). München: Oldenbourg Industrieverl.
	Abwasser : Technik und Kontrolle. Neitzel, Volkmar, and Weinheim [u.a.]: Wiley-VCH, 1998.
	<ul> <li>Kommunale Kläranlagen: Bemessung, Erweiterung, Optimierung, Betrieb und Kosten, (2009). Günthert, F. Wolfgang: (3., völlig neu bearb. Aufl.). Renningen: expert-Verl.</li> </ul>
	• Water and wastewater technology Hammer, M. J. 1., & . (2012). (7. ed., internat. ed.). Boston [u.a.]: Pearson Education International.
	• Water and wastewater engineering : design principles and practice: Davis, M. L. 1. (2011) New York, NY: McGraw-Hill.
	Biological wastewater treatment: (2011). C. P. Leslie Grady, Jr. (3. ed.). London, Boca Raton, Fla. [u.a.]: IWA Publ.

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

Course L0306: Drinking Water	er Supply
Тур	Lecture
Hrs/wk	2
СР	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	ourse L0308: Drinking Water Supply	
Тур	Recitation Section (large)	
Hrs/wk	1	
СР	2	
Workload in Hours	Independent Study Time 46, Study Time in Lecture 14	
Lecturer	Dr. Klaus Johannsen, Prof. Mathias Ernst	
Language	DE	
Cycle	SoSe	
Content	See interlocking course	
Literature	See interlocking course	

Module M1712: Green	n Technologies II			
Courses				
<b>Title</b> Practical Exercise Environmental Technology (L1387) Pollutant analysis (L2996)		<b>Typ</b> Practical Course Lecture	<b>Hrs/wk</b> 1 2	<b>CP</b> 1 3
Environmental Technologie (L0326		Lecture	2	2
	Dr. Marvin Scherzinger			
Admission Requirements				
Recommended Previous Knowledge	Fundamentals of inorganic/organic chemistry and biolog	y.		
Educational Objectives	After taking part successfully, students have reached th	e 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.  Additional students acquire in-depth knowledge of important cause-effect chains of potential environmental problems which might occur from production processes, projects or construction measures. They have knowledge about the methodological diversity and are competent in dealing with different methods and instruments to assess environmental impacts. Besides the students are able			
Skills	to estimate the complexity of these environmental processes as well as uncertainties and difficulties with their measurement.  Students are able to propose appropriate management and mitigation measures for environmental problems. They are able to determine geochemical parameters and to assess the potential of pollutants to migrate and transform. The students are able to work out well founded opinions on how Environmental Technology contributes to sustainable development, and they can present and defend these opinions in front of and against the group.  The students are able to select a suitable method for the respective case from the variety of assessment methods. Thereby they can develop suitable solutions for managing and mitigating environmental problems in a business context. They are able to carry out Life Cycle Impact Assessments independently and can apply the software programs OpenLCA and the database Ecolinvent. After finishing the course the students have the competence to critically judge research results or other publications or environmental impacts.			
Personal Competence				
Social Competence				
Autonomy	concept of sustainability. Their sensitivity and consciousness towards these subjects are raised and which helps to raise their awareness of their future social responsibilities in their role as engineers.  The students learn to research, process and present a scientific topic independently. They are able to carry out independent scientific work. They can solve an environmental problem in a business context and are able to judge results of other publications.			
Workload in Hours	Independent Study Time 110, Study Time in Lecture 70			
Credit points	6			
Course achievement	None	None		
Examination	Written exam			
Examination duration and scale	120 min			
Assignment for the		•	ologies: Compulsory	
Following Curricula	Green Technologies: Energy, Water, Climate: Core Quali	tication: 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. Marvin Scherzinger	
Language	DE	
Cycle	SoSe	
Content	The practical course Environmental Engineering currently consists of 5 experiments, which deal with the different focal points of	
	environmental engineering in the areas of air, water, soil, energy and noise. The following experiments are carried out for this	
	purpose:	
	biological degradation of artificial materials,	
	fine dust measurement in the air,	
	water analysis,	
	noise emission measurement,	
	photovoltaic energy	
	Within the lab course students discuss the various technical and scientific tasks, both subject-specific and multidisciplinary. They	
	discuss different approaches to the task as well as it's theoretical or practical implementation.	
Literature	Folien der Einführungsveranstaltung	

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

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

Module M0538: Heat	and Mass Transfer			
Courses				
Title		Тур	Hrs/wk	СР
Heat and Mass Transfer (L0101)		Lecture	2	2
Heat and Mass Transfer (L0102)		Recitation Section (small)	1	2
Heat and Mass Transfer (L1868)		Recitation Section (large)	1	2
Module Responsible	Prof. Irina Smirnova			
Admission Requirements	None			
Recommended Previous Knowledge	Basic knowledge: Technical Thermodynamics			
Educational Objectives	After taking part successfully, students have reached the	following learning results		
Professional Competence				
Knowledge Skills	The students are able to set reasonable system by	different kinds of heat transfer med nysical basis for mass transfer in s transfer theories. and mass transfer and to describe noundaries for a given transport pr	hanisms namely h detail and to de complex linked pi	eat conduction, heat scribe mass transfer rocesses in detail.
	<ul> <li>and to balance the corresponding energy and mas</li> <li>They are capable to solve specific heat transfer pand to calculate the corresponding heat flows.</li> <li>Using dimensionless quantities, the students can earlier they are able to distinguish between diffusion, cofor the description and design of apparatus (e.g. earlier this context, the students are capable to choose application considering their advantages and disacent in addition, they can calculate both, steady-state at the students are capable to connect their known particular the courses thermodynamics, fluid meaning problems.</li> </ul>	execute scaling up of technical proc nvective mass transition and mass straction column, rectification colur e and design fundamental types of dvantages, respectively. and non-steady-state processes in powledge obtained in this course	esses or apparatu transfer. They can mn). heat and mass exc procedural apparat with knowlegde	s.  n use this knowledge  changer for a specific  us.  of other courses (In
Personal Competence Social Competence	The students are capable to work on subject-spec manner to tutors and other students.	ific challenges in teams and to pre	esent the results o	rally in a reasonable
Autonomy	The students are able to find and evaluate necess They are able to prove their level of knowledge system, exam-like assignments) and on this basis	during the course with accompa	nying procedure o	continuously (clicker-
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 semes	ter): Specialisation Green Technolo	gies: Compulsory	
Following Curricula	General Engineering Science (German program, 7 semes	ter): Specialisation Bioprocess Engi	neering: Compulso	ory
	General Engineering Science (German program, 7 semes	ter): Specialisation Process Enginee	ering: Compulsory	
	General Engineering Science (German program, 7 semes	ter): Specialisation Chemical and B	ioengineering: Cor	npulsory
	Bioprocess Engineering: Core Qualification: Compulsory			
	Chemical and Bioprocess Engineering: Core Qualification	: Compulsory		
	Energy and Environmental Engineering: Core Qualificatio	n: Compulsory		
	Green Technologies: Energy, Water, Climate: Core Qualif	ication: Compulsory		
	Technomathematics: Specialisation III. Engineering Scien	ce: Elective Compulsory		
	Process Engineering: Core Qualification: Compulsory			

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

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

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

Module M1714: Conve	entional Energy Systems and Energy In	dustry		
Courses				
Title Power Industry (L0316) Energy markets and energy trading (L2744) Fossil Energy Systems (L2745)		Typ Lecture Lecture Lecture	Hrs/wk 1 2 2	CP 1 2 2
Fossil Energy Systems (L2746)	Prof. Martin Kaltschmitt	Recitation Section (large)	1	1
Module Responsible  Admission Requirements	None			
Recommended Previous				
Knowledge	none			
	After taking part successfully, students have reached the	following learning results		
Professional Competence				
	Upon completion of this module, students will be able to provide an overview of characteristics of energy systems. They can explain the issues that arise. Furthermore, they are able to explain knowledge of energy production, energy distribution and energy trade in this context, taking into account contexts bordering on other disciplines. The students can explain this knowledge, which is applicable to almost all energy systems, in particular detail for conventional energy systems and take a critical stance on them. Furthermore, they can explain the environmental impact of using conventional energy systems. They also have an overview of reserves and resources as well as global and national market volumes. This also includes the legal framework, which should especially take into account the mitigation of climate change.  Students are able to apply methodologies for determining energy demand or energy supply to different types of energy systems. Furthermore, they can evaluate energy systems technically, ecologically and economically as well as systemically and are also able to design them under certain given conditions. They are able to select the regulations necessary for this in a subject-specific manner, especially by means of non-standard solutions to a problem.  Students are able to orally explain issues from the subject area and approaches to dealing with them and to classify them in the respective context.			
·	The students are able to analyze suitable technical altoriteria under sustainability aspects.  Students can independently exploit sources , acquire the questions.			_
Workload in Hours	Independent Study Time 96, Study Time in Lecture 84			
Credit points Course achievement				
Examination duration and				
scale				
Assignment for the Following Curricula	General Engineering Science (German program, 7 semest General Engineering Science (German program, 7 semest Green Technologies: Energy, Water, Climate: Core Qualifi	ter): Specialisation Green Techno		

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

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

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

Course L2746: Fossil Energy	Systems
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	The goal of this exercise is to present and discuss the different fossil energy systems in their entirety. This includes the petroleum, natural gas, hard coal, lignite and nuclear energy systems. In each case, the formation processes, the exploration technologies, the exploration processes, the extraction technologies, the further processing processes and the corresponding utilization are presented. In addition, the respective markets and their development, the existing reserves and resources, and the environmental effects associated with extraction and utilization are discussed. A total system approach is pursued, which includes a presentation of the entire energy system including the given interdependencies and (geo)political dependencies. The current changes in these energy systems for Germany and internationally, and those that are expected to occur in the coming years, are also discussed. In addition, the respective reserve and resource availability is illuminated.
Literature	Unterlagen des Übung

Module M1715: Renev	wable Energies				
Courses					
Title		Ту	γp	Hrs/wk	СР
Renewable Energies I (L2740)		Le	cture	2	2
Renewable Energies I (L2742)		Re	citation Section (large)	1	1
Renewable Energies II (L2741)			cture	2	2
Renewable Energies II (L2743)		Re	citation Section (large)	1	1
	Prof. Martin Kaltschmitt				
Admission Requirements					
Recommended Previous	none				
Knowledge					
	After taking part successfully, students have re	eached the following l	earning results		
Professional Competence					
Knowledge	Upon completion of this module, students will				
	will be able to explain the issues that arise in				
	energy distribution and energy trading in this	context, taking into a	ccount contexts bordering	g on specific disc	iplines. The students
	can explain this knowledge in detail for such				
	environmental impact of using renewable ene	ergy systems and have	re an overview of the eco	nomic classificati	on of the respective
	options.				
Skills	Students are able to apply methodologies for o	determining energy d	emand or energy supply t	o different types	of renewable energy
	systems. Furthermore, they can evaluate such				
	and also design them under certain given cond				
	manner, especially by means of non-standard				in a subject specific
	mainer, especially by means or non-standard	sorucions to a prosici			
	Students are able to orally explain issues from	n the subject area an	d approaches to dealing	with them and to	classify them in the $ \\$
	respective context.				
Personal Competence					
Social Competence	Students are able to investigate suitable tech	nical alternatives an	d ultimately evaluate the	m based on tech	nical, economic and
Boolar competence	ecological criteria - and thus from a sustainabil		a diamately evaluate the	basea on teen	mean, economic and
	ecological chieffa and thus home sustainus.	ney perspective.			
Autonomy	Students will be able to independently access:	sources about the field	d acquire knowledge and	I transform it to a	ddroee now ieeuoe
Autonomy	Students will be able to independently access:	sources about the her	a, acquire knowledge and	i transionin it to a	duress riew issues.
Workload in Hours	Independent Study Time 96, Study Time in Lec	ture 84			
Credit points		itale 04			
Course achievement					
Examination	Written exam				
Examination duration and	90 min				
scale					
Assignment for the	General Engineering Science (German program	n, 7 semester): Specia	alisation Green Technolog	ies: Compulsory	
Following Curricula					
	Civil- and Environmental Engineering: Specialis		-		
	Civil- and Environmental Engineering: Specialis	9	. ,	,	
	Civil- and Environmental Engineering: Specialis				
	Chemical and Bioprocess Engineering: Specialis			,	
	Green Technologies: Energy, Water, Climate: C	_			
	Process Engineering: Core Qualification: Comp	-			
	The state of the s				

Course L2740: Renewable En	ergies 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 Energies 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	
	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	nergies 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	Unterlagen der Vorlesung

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

## **Focus Renewable Energy**

Module M1693: Comp	outer Science fo	or Engineers - Pro	gramming	Concepts, Data Hand	dling & Com	munication
Courses						
Title				Тур	Hrs/wk	СР
Computer Science for Engineers - P	Programming Concepts, I	Data Handling & Communica	tion (L2689)	Lecture	3	3
Computer Science for Engineers - P	Programming Concepts, I	Data Handling & Communica	tion (L2690)	Recitation Section (small)	2	3
Module Responsible	Prof. Sibylle Fröschle					
Admission Requirements	None					
<b>Recommended Previous</b>						
Knowledge						
<b>Educational Objectives</b>	After taking part succ	essfully, students have re	ached the follow	ing learning results		
<b>Professional Competence</b>						
Knowledge						
Skills						
Personal Competence						
Social Competence						
Autonomy						
	Independent Study Ti	me 110, Study Time in Le	cture 70			
		,,				
Course achievement	1	Form	Description			
	No 10 %	Attestation	Testate find	en semesterbegleitend statt.		
Examination	Written exam					
Examination duration and	120 min					
scale						
Assignment for the	General Engineering	Science (German progr	ram, 7 semeste	r): Specialisation Mechanica	l Engineering, F	ocus Biomechanics:
Following Curricula	Compulsory					
				pecialisation Process Engineer		
				pecialisation Biomedical Engin		
		Science (German program	, / semester): Sp	pecialisation Green Technologi	les, Focus Renew	able Energy: Elective
	Compulsory	Science (German progra	m 7 semester	: Specialisation Mechanical I	Engineering Foc	us Energy Systems:
		Science (German progre	iii, 7 Seillestei,	. Specialisation Mechanical	Linging ering, 100	us Ellergy Systems.
		Compulsory  General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Aircraft Systems			us Aircraft Systems	
	Engineering: Compuls			•		
	General Engineering	Science (German prog	ram, 7 semest	er): Specialisation Mechanic	al Engineering,	Focus Materials in
	Engineering Sciences	: Compulsory				
	General Engineering	Science (German progr	ram, 7 semeste	er): Specialisation Mechanica	l Engineering, F	ocus Mechatronics:
	Compulsory					
			i, 7 semester): S	pecialisation Mechanical Engir	neering, Focus Th	eoretical Mechanical
	Engineering: Compuls					
			n, / semester): S	Specialisation Mechanical Eng	ineering, Focus P	roduct Development
	and Production: Elect		7 comostor). Si	pecialisation Electrical Enginee	oring: Elective Co	mpulsory
				pecialisation Green Technologi		
	Compulsory	Science (German program	, / Scilicatory. Sp	recialisation of een recimologi	ies, i ocus iteliew	able Energy. Elective
		ng: Core Qualification: Cor	npulsory			
	Electrical Engineering	g: Core Qualification: Comp	oulsory			
	Energy and Environm	ental Engineering: Core Q	ualification: Com	pulsory		
	General Engineering	Science (English program,	7 semester): Sp	ecialisation Process Engineeri	ng: Elective Comp	oulsory
	General Engineering	Science (English progra	m, 7 semester	: Specialisation Energy and	Enviromental E	ngineering: Elective
	Compulsory					
				rgy Systems: Elective Compul	sory	
		: Core Qualification: Comp	-			
		: Specialisation Informatio	n Technology: C	ompulsory		
		ualification: Compulsory				
		Core Qualification: Compu		Specialisation Information Tea	hnology: Commit	son
	Engineering and Man	ayement - Major in Logisti	cs and Modility:	Specialisation Information Tec	imology: Compul	SUI ý

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

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

Module M0544: Phase	Equilibria Thermodynamics			
Courses				
Title		Тур	Hrs/wk	СР
Phase Equilibria Thermodynamics (	L0114)	Lecture	2	2
Phase Equilibria Thermodynamics (		Recitation Section (small)	1	2
Phase Equilibria Thermodynamics (		Recitation Section (large)	1	2
Module Responsible	Prof. Irina Smirnova			
•				
Admission Requirements	None			
Recommended Previous	Mathematics, Physical Chemistry, Thermodynan	nics I and II		
Knowledge				
Educational Objectives	After taking part successfully, students have rea	ached the following learning results		
Professional Competence				
Knowledge				
		dynamics, the students learn the mathemati	cal tools to desc	cribe thermodynamic
	equilibria.			
		enced by the mixing of compounds and learn	n concepts to qu	iantitatively describe
	these properties.			
		e equilibria can be described mathematically		-
		xist in equilibrium. Furthermore the fundamen		
	<ul> <li>For different phase equilibria, several e</li> </ul>	xamples relevant for different kinds of proc	esses are show	n and the necessary
	knowledge for plotting and interpreting the	ne equilibria are taught.		
Skills				
Skills	Applying their knowledge, the students	are able to identify the correct equation for	the determination	on of the equilibrium
	state and know how to simplify these equ	ations meaningfully.		
	The students know models which can be	used to determine the properties of the syst	em in the equili	brium state and they
	are able to solve the resulting mathemati	ical relations.		
		self-reliantly find necessary physico-chemica	I properties of c	ompounds as well as
	model parameters in literature sources.	, , , , , , , , , , , , , , , , , , , ,		,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,
	•	idents are capable of describing the properties	of mixtures	
		e equilibria graphically and they know how to		urring phenomena
		ts are able to understand fundamental cor		
	<u> </u>		icepts that are	the basis for many
	separation and reaction processes in che	mical engineering.		
Personal Competence				
Social Competence	The students are able to work in small groups,	to solve the corresponding problems and to $% \left\{ \left\{ \left( $	present them or	aly to the tutors and
	other students			
Autonomy				
	·	nformation self-reliantly in literature sources a		
	<ul> <li>During the semester the students are</li> </ul>	able to check their learning progress conti	nuously in exer	cises. Based on this
	knowledge the students can adept their l	earning process.		
Workload in Hours	Independent Study Time 124, Study Time in Lec	cture 56		
Credit points	6			
Course achievement	None			
Examination	Written exam			
Examination duration and	120 minutes; theoretical questions and calculati	ions		
scale				
	General Engineering Science (German program,	7 semester): Specialisation Process Engineeri	na: Compulsory	
Following Curricula	General Engineering Science (German program,			orv
. onowing curricula				-
	General Engineering Science (German program,	, i semester). Specialisation Green Technologi	es, i ocus Kenew	able Lifergy, Elective
	Compulsory	Zaamaatan). Caratistissa Carati	Fa C	able Ferror FL 11
	General Engineering Science (German program,	/ sernester): Specialisation Green Technologi	es, rocus Renew	able Energy: Elective
	Compulsory			
	Bioprocess Engineering: Core Qualification: Com	npulsory		
	Green Technologies: Energy, Water, Climate: Sp	ecialisation Bioresource Technology: Elective	Compulsory	
	Green Technologies: Energy, Water, Climate: Sp	ecialisation Energy Systems: Elective Compul	sory	
	Process Engineering: Core Qualification: Compu	lsory		
	· · · · · · · · · · · · · · · · · · ·			

Course L0114: Phase Equilib	ria Thermodynamics
Тур	Lecture
Hrs/wk	2
СР	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Prof. Irina Smirnova
Language	DE
Cycle	SoSe
Content	
	1. Introduction: Applications of thermodynamics of mixtures 2. Thermodynamic equations in multi-component systems: Fundamental equations, chemical potential, fugacity 3. Phase equilibria of pure substances: thermodynamic equilibrium, vapor pressure, Gibbs' phase rule 4. Equations of state: virial equations, van-der-Waals equation, generalized equations of state 5. Mixing properties: ideal and real mixtures, excess properties, partial molar properties 6. Vapor-liquid-equilibria: binary systems, azeotropes, equilibrium condition 7. Gas-liquid-equilibria: equilibrium condition, Henry-coefficient 8. G <sup>E</sup> -Models: Hildebrand-model, Flory-Huggins-model, Wilson-model, UNIQUAC, UNIFAC 9. Liquid-equilibria: equilibrium condition, phase equilibria in binary and ternary systems 10. Solid-liquid-equilibria: equilibrium condition, binary systems 11. Chemical reactions: reaction coordinate, mass action law, influence of pressure and temperature 12. Osmotic pressure
Literature	<ul> <li>Jürgen Gmehling, Bärbel Kolbe: Thermodynamik. VCH 1992</li> <li>J.M. Prausnitz, R.N. Lichtenthaler, E.G. de Azevedo: Molecular Thermodynamics of Fluid-Phase Equilibria, 3rd ed. Prentice Hall, 1999.</li> <li>J.W. Tester, M. Modell: Thermodynamics and its Applications. 3 rd ed. Prentice Hall, 1997.J.P. O´Connell, J.M. Haile: Thermodynamics. Cambridge University Press, 2005.</li> </ul>

Course L0140: Phase 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
Literature	1. Introduction: Applications of thermodynamics of mixtures 2. Thermodynamic equations in multi-component systems: Fundamental equations, chemical potential, fugacity 3. Phase equilibria of pure substances: thermodynamic equilibrium, vapor pressure, Gibbs' phase rule 4. Equations of state: virial equations, van-der-Waals equation, generalized equations of state 5. Mixing properties: ideal and real mixtures, excess properties, partial molar properties 6. Vapor-liquid-equilibria: binary systems, azeotropes, equilibrium condition 7. Gas-liquid-equilibria: equilibrium condition, Henry-coefficient 8. GE-Models: Hildebrand-model, Flory-Huggins-model, Wilson-model, UNIQUAC, UNIFAC 9. Liquid-liquid-equilibria: equilibrium condition, phase equilibria in binary and ternary systems 10. Solid-liquid-equilibria: equilibrium condition, binary systems 11. Chemical reactions: reaction coordinate, mass action law, influence of pressure and temperature 12. Osmotic pressure  The students work on tasks in small groups and present their results in front of all students.  • Jürgen Gmehling, Bärbel Kolbe: Thermodynamik. VCH 1992  • J.M. Prausnitz, R.N. Lichtenthaler, E.G. de Azevedo: Molecular Thermodynamics of Fluid-Phase Equilibria, 3rd ed. Prentice
	Hall, 1999.  • J.W. Tester, M. Modell: Thermodynamics and its Applications. 3 <sup>rd</sup> ed. Prentice Hall, 1997.J.P. O´Connell, J.M. Haile: Thermodynamics. Cambridge University Press, 2005.

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

Module M0546: Therr	mal Separation Processes			
Courses				
Title		Тур	Hrs/wk	СР
Thermal Separation Processes (L01	118)	Lecture	2	2
Thermal Separation Processes (L01		Recitation Section (small)	2	2
Thermal Separation Processes (L01 Separation Processes (L1159)	141)	Recitation Section (large) Practical Course	1 1	1
Module Responsible	Prof Irina Smirnova	Tractical Course	1	1
Admission Requirements				
-	Recommended requirements: Thermodynamics III			
Knowledge				
Educational Objectives	After taking part successfully, students have read	ned the following learning results		
Professional Competence		3 3		
Knowledge				
	The students can distinguish and describ adsorption The students develop an understanding fo energy demand of a process, the possibiliti They have good knowledge of designing me	r the course of concentration during a se es of energy saving, and the selection of s	paration process, eparation systems	the estimation of the
Personal Competence Social Competence Autonomy	Using the gained knowledge the students of close the associated energy and material be The students can use different graphical theoretical stages required They can select and design a basic type disadvantages of the process The students are capable to obtain indepediables) They can calculate continuous and discontient theoretables The students are able to prove their theoretables are the continuous and discontient theoretables are capable of linking their gained ket technical problems. Other lectures such as thermore the students are able to carry out practications. The students are able to carry out practications. The students are able to carry out practications. The students are able to discuss their results.	alances methods for the designing of a separat of thermal separation process for a give ndently the needed material properties fr nuous processes tical knowledge in the experimental lab we etical background and the content of the nowledge with the content of other lecture odynamics, fluid mechanics and chemical hts in small groups and present the combinal al lab work in small groups and organize and to document them scientifically in a ded information from suitable sources by	ion process and of en case based on or or appropriate so ork.  experimental work es and use it togetion end results in the togetion and as functional divisor eport.	the advantages and burces (diagrams and with the teachers in the for the solution of the utorial to the diagrams and the utorial to the session of the sessi
Workload in Hours	Independent Study Time 96, Study Time in Lectur	e 84		
Credit points		~ · ·		
Course achievement				
Examination				
Examination duration and	120 minutes; theoretical questions and calculation	ns		
scale Assignment for the		semester): Specialisation Green Technology	naies Focus Renov	rable Energy: Flective
Following Curricula		semester, specialisation dieen reciliote	g.cs, i ocus neilew	asic Lifergy. Liective
	General Engineering Science (German program	, 7 semester): Specialisation Green Te	chnologies, Focus	Renewable Energy:
	Compulsory			
	General Engineering Science (German program, 7	· · · · · · · · · · · · · · · · · · ·		ory
	General Engineering Science (German program, 7	- · ·		
	General Engineering Science (German program, 7 Bioprocess Engineering: Core Qualification: Comp		ioengineering: Cor	npulsory
	Chemical and Bioprocess Engineering: Core Qualification: Comp	·		
	Energy and Environmental Engineering: Core Qua	• •		
	Green Technologies: Energy, Water, Climate: Spec	cialisation Energy Systems: Elective Comp	ulsory	
	Green Technologies: Energy, Water, Climate: Spec		e Compulsory	
	Process Engineering: Core Qualification: Compulso	ory		

Course L0118: Thermal Sepa	ration Processes
Тур	Lecture
Hrs/wk	2
СР	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Prof. Irina Smirnova
Language	DE
Cycle	WiSe
Content	<ul> <li>Introduction in the thermal process engineering and to the main features of separation processes</li> <li>Simple equilibrium processes, several steps processes</li> <li>Distillation of binary mixtures, enthalpy-concentration diagrams</li> <li>Extractive and azeotrope distillation, water vapor distillation, stepwise distillation</li> <li>Extraction: separation ternary systems, ternary diagram</li> <li>Multiphase separation including complex mixtures</li> <li>Designing of separation devices without discrete stages</li> <li>Drying</li> <li>Chromatographic separation processes</li> <li>Membrane separation</li> <li>Energy demand of separation processes</li> <li>Advance overview of separation processes</li> <li>Selection of separation processes</li> </ul>
Literature	<ul> <li>G. Brunner: Skriptum Thermische Verfahrenstechnik</li> <li>J. King: Separation Processes, McGraw-Hill, 2. Aufl. 1980</li> <li>Sattler: Thermische Trennverfahren, VCH, Weinheim 1995</li> <li>J.D. Seader, E.J. Henley: Separation Process Principles, Wiley, New York, 1998.</li> <li>Mersmann: Thermische Verfahrenstechnik, Springer, 1980</li> <li>Grassmann, Widmer, Sinn: Einführung in die Thermische Verfahrenstechnik, 3. Aufl., Walter de Gruyter, Berlin 1997</li> <li>Brunner, G.: Gas extraction. An introduction to fundamentals of supercritical fluids and the application to separation processes. Steinkopff, Darmstadt; Springer, New York; 1994. ISBN 3-7985-0944-1; ISBN 0-387-91477-3.</li> <li>R. Goedecke (Hrsg.): Fluid-Verfahrenstechnik, Wiley-VCH Verlag, Weinheim, 2006.</li> <li>Perry"s Chemical Engineers" Handbook, R.H. Perry, D.W. Green, J.O. Maloney (Hrsg.), 6th ed., McGraw-Hill, New York 1984 Ullmann"s Enzyklopädie der Technischen Chemie</li> </ul>

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

Course L0141: Thermal Sepa	ration Processes
Тур	Recitation Section (large)
Hrs/wk	1
СР	1
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14
Lecturer	Prof. Irina Smirnova
Language	DE
Cycle	WiSe
Content	
Literature	<ul> <li>G. Brunner: Skriptum Thermische Verfahrenstechnik</li> <li>J. King: Separation Processes, McGraw-Hill, 2. Aufl. 1980</li> <li>Sattler: Thermische Trennverfahren, VCH, Weinheim 1995</li> <li>J.D. Seader, E.J. Henley: Separation Process Principles, Wiley, New York, 1998.</li> <li>Mersmann: Thermische Verfahrenstechnik, Springer, 1980</li> <li>Grassmann, Widmer, Sinn: Einführung in die Thermische Verfahrenstechnik, 3. Aufl., Walter de Gruyter, Berlin 1997</li> <li>Brunner, G.: Gas extraction. An introduction to fundamentals of supercritical fluids and the application to separation processes. Steinkopff, Darmstadt; Springer, New York; 1994. ISBN 3-7985-0944-1; ISBN 0-387-91477-3.</li> <li>R. Goedecke (Hrsg.): Fluid-Verfahrenstechnik, Wiley-VCH Verlag, Weinheim, 2006.</li> <li>Perry"s Chemical Engineers" Handbook, R.H. Perry, D.W. Green, J.O. Maloney (Hrsg.), 6th ed., McGraw-Hill, New York 1984 Ullmann"s Enzyklopädie der Technischen Chemie</li> </ul>

Course L1159: Separation Pr	ocesses
Тур	Practical Course
Hrs/wk	1
СР	1
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14
Lecturer	Prof. Irina Smirnova
Language	DE/EN
Cycle	WiSe
Content	The students work on eight different experiments in this practical course. For every one of the eight experiments, a colloquium takes place in which the students explain and discuss the theoretical background and its translation into practice with staff and fellow students.
	The students work small groups with a high degree of division of labor. For every experiment, the students write a report. They receive instructions in terms of scientific writing as well as feedback on their own reports and level of scientific writing so they can increase their capabilities in this area.
	Topics of the practical course:  Introduction in the thermal process engineering and to the main features of separation processes  Simple equilibrium processes, several steps processes  Distillation of binary mixtures, enthalpy-concentration diagrams  Extractive and azeotrope distillation, water vapor distillation, stepwise distillation  Extraction: separation ternary systems, ternary diagram  Multiphase separation including complex mixtures  Designing of separation devices without discrete stages  Drying  Chromatographic separation processes  Membrane separation  Energy demand of separation processes  Advance overview of separation processes  Selection of separation processes
Literature	<ul> <li>G. Brunner: Skriptum Thermische Verfahrenstechnik</li> <li>J. King: Separation Processes, McGraw-Hill, 2. Aufl. 1980</li> <li>Sattler: Thermische Trennverfahren, VCH, Weinheim 1995</li> <li>J.D. Seader, E.J. Henley: Separation Process Principles, Wiley, New York, 1998.</li> <li>Mersmann: Thermische Verfahrenstechnik, Springer, 1980</li> <li>Grassmann, Widmer, Sinn: Einführung in die Thermische Verfahrenstechnik, 3. Aufl., Walter de Gruyter, Berlin 1997</li> <li>Brunner, G.: Gas extraction. An introduction to fundamentals of supercritical fluids and the application to separation processes. Steinkopff, Darmstadt; Springer, New York; 1994. ISBN 3-7985-0944-1; ISBN 0-387-91477-3.</li> <li>R. Goedecke (Hrsg.): Fluid-Verfahrenstechnik, Wiley-VCH Verlag, Weinheim, 2006.</li> <li>Perry"s Chemical Engineers" Handbook, R.H. Perry, D.W. Green, J.O. Maloney (Hrsg.), 6th ed., McGraw-Hill, New York 1984 Ullmann"s Enzyklopädie der Technischen Chemie</li> </ul>

Module M1235: Electr	rical Power Systems I: Introduction to	Electrical Power Systems	3	
Courses				
· · · · · · · · · · · · · · · · · · ·	ction to Electrical Power Systems (L1670) ction to Electrical Power Systems (L1671)	<b>Typ</b> Lecture Recitation Section (small)	Hrs/wk 3 2	<b>CP</b> 4 2
Module Responsible	Prof. Christian Becker			
Admission Requirements	None			
Recommended Previous Knowledge	Fundamentals of Electrical Engineering			
Educational Objectives	After taking part successfully, students have reached the	e following learning results		
Professional Competence				
	Students are able to give an overview of conventional are evaluate technologies of electric power generation, tran electric power systems.  With completion of this module the students are able	smission, storage, and distribution as	s well as integration	on of equipment into
Personal Competence Social Competence	development of electric power systems and to assess th  The students can participate in specialized and interdisc front of others.		nd represent thei	r own work results in
Autonomy	Students can independently tap knowledge of the emph	asis of the lectures.		
Workload in Hours	Independent Study Time 110, Study Time in Lecture 70			
Credit points	6			
Course achievement	None			
Examination	Written exam			
Examination duration and	90 - 150 minutes			
scale				
Assignment for the	General Engineering Science (German program, 7 seme	ster): Specialisation Electrical Engine	ering: Elective Co	mpulsory
	Compulsory Data Science: Core Qualification: Elective Compulsory Electrical Engineering: Core Qualification: Elective Comp Energy Systems: Specialisation Energy Systems: Elective Engineering Science: Specialisation Electrical Engineerin Green Technologies: Energy, Water, Climate: Specialisat Computer Science in Engineering: Specialisation II. Math Integrated Building Technology: Core Qualification: Com	e Compulsory g: Elective Compulsory ion Energy Systems: Elective Compu ematics & Engineering Science: Elect	-	
	Renewable Energies: Core Qualification: Compulsory  Theoretical Mechanical Engineering: Specialisation Energials	av Systems: Flactive Compulsory		
	Theoretical Mechanical Engineering: Specialisation Energ	gy Systems: Elective Compulsory		

Course L1670: Electrical Pow	ver Systems I: Introduction to Electrical Power Systems
Тур	Lecture
Hrs/wk	3
СР	4
Workload in Hours	Independent Study Time 78, Study Time in Lecture 42
Lecturer	Prof. Christian Becker
Language	DE
Cycle	WiSe
Content	fundamentals and current development trends in electric power engineering     tasks and history of electric power systems     symmetric three-phase systems     fundamentals and modelling of eletric power systems         ilines             transformers             synchronous machines             induction machines             loads and compensation                 grid structures and substations      fundamentals of energy conversion                electro-mechanical energy conversion                 thermodynamics                 power station technology                 renewable energy conversion systems      steady-state network calculation
	<ul> <li>control in networks and power stations</li> <li>grid protection</li> <li>grid planning</li> </ul>
	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

Course L1671: Electrical Pow	er Systems I: Introduction to Electrical Power Systems
Тур	Recitation Section (small)
Hrs/wk	2
СР	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Prof. Christian Becker
Language	DE
Cycle	WiSe
Content	
	fundamentals and current development trends in electric power engineering
	tasks and history of electric power systems
	symmetric three-phase systems
	fundamentals and modelling of eletric power systems
	• lines
	• transformers
	synchronous machines
	induction machines
	<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>
	renewable energy conversion systems
	steady-state network calculation
	network modelling
	o load flow calculation
	• (n-1)-criterion
	symmetric failure calculations, short-circuit power
	control in networks and power stations
	grid protection
	grid planning
	power economy fundamentals
Literature	K. Heuck, KD. Dettmann, D. Schulz: "Elektrische Energieversorgung", Vieweg + Teubner, 9. Auflage, 2013
	A. J. Schwab: "Elektroenergiesysteme", Springer, 5. Auflage, 2017
	R. Flosdorff: "Elektrische Energieverteilung" Vieweg + Teubner, 9. Auflage, 2008

Module M0730: Comp	outer Engineering			
Courses				
Title		Тур	Hrs/wk	СР
Computer Engineering (L0321)		Lecture	3	4
Computer Engineering (L0324)		Recitation Section (small)	1	2
Module Responsible	Prof. Heiko Falk			
Admission Requirements	None			
Recommended Previous	Basic knowledge in electrical engineering			
Knowledge				
Educational Objectives	After taking part successfully, students have reached the foll	owing learning results		
Professional Competence				
Knowledge	This module deals with the foundations of the functionality	of computing systems. It covers	the layers fron	n the assembly-level
	programming down to gates. The module includes the follow	ing topics:		
	Introduction			
	Combinational logic: Gates, Boolean algebra, Boolean	functions hardware synthesis co	mhinational not	works
	Sequential logic: Flip-flops, automata, systematic hard		mbinational neti	WOLKS
	Technological foundations	ware design		
	Computer arithmetic: Integer addition, subtraction, mu	ultiplication and division		
	Basics of computer architecture: Programming models		pipelining	
	Memories: Memory hierarchies, SRAM, DRAM, caches			
	Input/output: I/O from the perspective of the CPU, prin	ciples of passing data, point-to-po	oint connections,	busses
Chille	The shudents never to sever they sustained from the events as the	a managastiva i a shavridantifir th	a internal struct	uura and the physical
SKIIIS	The students perceive computer systems from the architect's composition of computer systems. The students can analyze			
	collection of few and simple components. They are able to			
	today's computing systems - from gates and circuits up to co		iii tile dillerent	abstraction layers of
	today 5 compating systems from gates and effects up to co	implete processors.		
	After successful completion of the module, the students ar	e able to judge the interdepende	encies between	a physical computer
	system and the software executed on it. In particular, they s			
	on the hardware-centric abstraction layers from the assemble.			
	the impact that these low abstraction levels have on an entir	e system's performance and to pr	opose feasible o	options.
Personal Competence				
Social Competence	Students are able to solve similar problems alone or in a grou	up and to present the results acco	ordingly.	
Autonomo		areture and to acceptate this know	مطغم طغنيي مسلممان	r elegene
Autonomy	Students are able to acquire new knowledge from specific lite	erature and to associate this know	viedge with othe	r classes.
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56			
Credit points	6			
Course achievement	Compulsory Bonus Form Description			
	Yes 10 % Excercises			
Examination				
_	90 minutes, contents of course and labs			
scale				
Assignment for the		·		- acus Machahranias
Following Curricula	General Engineering Science (German program, 7 seme Compulsory	ster): Specialisation Mechanical	Engineering, i	ocus Mechatronics:
	General Engineering Science (German program, 7 semest	ter): Specialisation Mechanical E	ngineering Foo	us Aircraft Systems
	Engineering: Compulsory	tery. Specialisation mechanical E	ingineering, roc	as Aircraft Systems
	General Engineering Science (German program, 7 semester)	: Specialisation Mechanical Engin	eerina. Focus Th	eoretical Mechanical
	Engineering: Compulsory	,,	3,	
	General Engineering Science (German program, 7 sem	ester): Specialisation Mechanica	al Engineering,	Focus Materials in
	Engineering Sciences: Compulsory			
	General Engineering Science (German program, 7 semester	): Specialisation Mechanical Engi	neering, Focus P	roduct Development
	and Production: Compulsory			
	General Engineering Science (German program, 7 semest	er): Specialisation Mechanical E	ngineering, Foc	us Energy Systems:
	Compulsory			
	General Engineering Science (German program, 7 seme	ster): Specialisation Mechanical	Engineering, F	ocus Biomechanics:
	Compulsory  Conoral Engineering Science (Gorman program, 7 competer)	Specialization Flootrical Facilities	ring: Compuler -	,
	General Engineering Science (German program, 7 semester): General Engineering Science (German program, 7 semester):			
	Compulsory	. Specialisation of een Technologic	.s, i ocus nellew	ubic Energy. Elective
	Computer Science: Core Qualification: Compulsory			
	Data Science: Core Qualification: Elective Compulsory			
	Data Science: Specialisation I. Mathematics/Computer Science	e: Elective Compulsory		
	Electrical Engineering: Core Qualification: Compulsory			
	Computer Science in Engineering: Core Qualification: Compu	Isory		
	Integrated Building Technology: Core Qualification: Elective C	Compulsory		
	Technomathematics: Specialisation II. Informatics: Elective C	ompulsory		

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

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

## **Specialization Computer Science**

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

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

Module M0561: Discre	ete Algebraic Structures				
Courses					
Title		-	Тур	Hrs/wk	СР
Discrete Algebraic Structures (L016	54)	1	Lecture	2	3
Discrete Algebraic Structures (L016	55)	I	Recitation Section (small)	2	3
Module Responsible	Prof. Karl-Heinz Zimmermann				
Admission Requirements	None				
Recommended Previous	Mathematics from High School.				
Knowledge					
Educational Objectives	After taking part successfully, students have re	eached the following	g learning results		
Professional Competence					
Knowledge	The students know the important basics of dis	screte algebraic str	uctures including elementar	y combinatorial s	structures, monoids,
	groups, rings, fields, finite fields, and vector sp	aces. They also kno	ow specific structures like su	b sum-, and quo	tient structures and
	homomorphisms.				
Chille	Charles have a half he formed has a section of the	-1			
SKIIIS	Students are able to formalize and analyze bas	sic discrete algebrai	c structures.		
Personal Competence					
Social Competence	Students are able to solve specific problems al	lone or in a group a	nd to present the results acc	ordingly.	
4					
Autonomy	Students are able to acquire new knowledge from specific standard books and to associate the acquired knowledge to other .				
	classes.				
Workload in Hours	Independent Study Time 124, Study Time in Le	ecture 56			
Credit points		scture 50			
Course achievement					
Examination					
Examination duration and	120 min				
scale					
Assignment for the	General Engineering Science (German program	n, 7 semester): Spe	cialisation Computer Science	: Compulsory	
_	Computer Science: Core Qualification: Compuls			. ,	
	Data Science: Core Qualification: Compulsory				
	Computational Science and Engineering: Core	Qualification: Comp	oulsory		
	Orientation Studies: Core Qualification: Elective	e Compulsory			

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

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

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Courses		Hara-faula	CD.
Title Computer Engineering (L0321)	<b>Typ</b> Lecture	Hrs/wk 3	<b>CP</b> 4
Computer Engineering (L0324)	Recitation Section (small)	1	2
Module Responsible	Prof. Heiko Falk		
Admission Requirements	None		
Recommended Previous	Basic knowledge in electrical engineering		
Knowledge	After taking your groups the students have youghed the fallering leaving youth		
Educational Objectives Professional Competence	After taking part successfully, students have reached the following learning results		
•	This module deals with the foundations of the functionality of computing systems. It cover programming down to gates. The module includes the following topics:  • Introduction	s the layers fron	n the assembly-lev
	<ul> <li>Combinational logic: Gates, Boolean algebra, Boolean functions, hardware synthesis, co</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,</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-p</li> </ul>	pipelining	
Skills	The students perceive computer systems from the architect's perspective, i.e., they identify the internal structure and the physical 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 of today's computing systems - from gates and circuits up to complete processors.  After successful completion of the module, the students are able to judge the interdependencies between a physical computer system and the software executed on it. In particular, they shall understand the consequences that the execution of software had on the hardware-centric abstraction layers from the assembly language down to gates. This way, they will be enabled to evaluat the impact that these low abstraction levels have on an entire system's performance and to propose feasible options.		
Personal Competence Social Competence	Students are able to solve similar problems alone or in a group and to present the results according to the control of the con	ordingly.	
Autonomy	Students are able to acquire new knowledge from specific literature and to associate this knowledge.	wledge with othe	r classes.
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56		
Credit points	6		
Course achievement			
F	Yes 10 % Excercises		
	Written exam  90 minutes, contents of course and labs		
scale	30 minutes, contents of course and labs		
Assignment for the	General Engineering Science (German program, 7 semester): Specialisation Computer Science	e: Compulsory	
	General Engineering Science (German program, 7 semester): Specialisation Process Engineering General Engineering Science (German program, 7 semester): Specialisation Mechanical Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering Sciences: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineerial Engineering Science (German program, 7 semester): Specialisation Mechanical Engineerial Engineering Science (German program, 7 semester): Specialisation Mechanical Engineerial Engineering Science (German program, 7 semester): Specialisation Mechanical Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineerial Engineering Science (German program, 7 semester): Specialisation Mechanical Compulsory	I Engineering, I Engineering, Focus Th al Engineering, ineering, Focus F Engineering, Focus F	cus Aircraft System neoretical Mechanic Focus Materials Product Developme us Energy System
	Compulsory General Engineering Science (German program, 7 semester): Specialisation Naval Architectur General Engineering Science (German program, 7 semester): Specialisation Biomedical Engine General Engineering Science (German program, 7 semester): Specialisation Bioprocess Engine General Engineering Science (German program, 7 semester): Specialisation Electrical Enginee General Engineering Science (German program, 7 semester): Specialisation Green Technologi Compulsory	eering: Compulso eering: Compulso ering: Compulsory	pry y

Technomathematics: Specialisation II. Informatics: Elective Compulsory

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

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

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

Module M0852: Grapl	n Theory and Optimization			
Courses				
itle		Тур	Hrs/wk	СР
Graph Theory and Optimization (L1		Lecture	2	3
Graph Theory and Optimization (L1	1	Recitation Section (small)	2	3
Module Responsible	Prof. Anusch Taraz			
Admission Requirements	None			
Recommended Previous	Discrete Algebraic Structures			
Knowledge	Mathematics I			
Educational Objectives	After taking part successfully, students hav	e reached the following learning results		
Professional Competence				
Knowledge	Students can name the basic concept	ots in Graph Theory and Optimization. They are	able to explain the	em using appropriat
	examples.			
	Students can discuss logical connect	tions between these concepts. They are capabl	e of illustrating th	ese connections wit
	the help of examples.			
	They know proof strategies and can	reproduce them.		
Skills				
	'	raph Theory and Optimization with the help of	f the concepts st	udied in this course
		g them by applying established methods.		
		rify further logical connections between the conc		
		can develop and execute a suitable approach,	and are able to d	ritically evaluate th
	results.			
Personal Competence				
Social Competence	Students are able to work together in teams. They are capable to use mathematics as a common language.			
	• In doing so, they can communicate new concepts according to the needs of their cooperating partners. Moreover, they can			
	design examples to check and deepe	en the understanding of their peers.		
Autonomy	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.			
	• Students have developed sufficient persistence to be able to work for longer periods in a goal-oriented manner on hard			
	problems.			
Workload in Hours	Independent Study Time 124, Study Time in	n Lecture 56		
Credit points	6			
Course achievement	None			
Examination	Written exam			
Examination duration and	120 min			
scale				
Assignment for the	General Engineering Science (German prog	ram, 7 semester): Specialisation Computer Scien	ce: Compulsory	
Following Curricula	Computer Science: Core Qualification: Com			
	Data Science: Core Qualification: Compulso	ry		
	Logistics and Mobility: Specialisation Engine	eering Science: Elective Compulsory		
	Logistics and Mobility: Specialisation Traffic	Planning and Systems: Elective Compulsory		
	Logistics and Mobility: Specialisation Inform	nation Technology: Elective Compulsory		
	Technomathematics: Specialisation I. Mathe	ematics: Elective Compulsory		
		gistics and Mobility: Specialisation Traffic Plannin		
	Engineering and Management - Major in Lo	gistics and Mobility: Specialisation Information Te	chnology: Elective	e 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	Graphs, search algorithms for graphs, trees planar graphs shortest paths minimum spanning trees maximum flow and minimum cut theorems of Menger, König-Egervary, Hall NP-complete problems backtracking and heuristics linear programming duality integer linear programming
Literature	<ul> <li>M. Aigner: Diskrete Mathematik, Vieweg, 2004</li> <li>T. Cormen, Ch. Leiserson, R. Rivest, C. Stein: Algorithmen - Eine Einführung, Oldenbourg, 2013</li> <li>J. Matousek und J. Nesetril: Diskrete Mathematik, Springer, 2007</li> <li>A. Steger: Diskrete Strukturen (Band 1), Springer, 2001</li> <li>A. Taraz: Diskrete Mathematik, Birkhäuser, 2012</li> <li>V. Turau: Algorithmische Graphentheorie, Oldenbourg, 2009</li> <li>KH. Zimmermann: Diskrete Mathematik, BoD, 2006</li> </ul>

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

Module M0727: Stoch	astics			
Courses				
Title		Тур	Hrs/wk	СР
Stochastics (L0777)		Lecture	2	4
Stochastics (L0778)		Recitation Section (small)	2	2
Module Responsible	Prof. Matthias Schulte			
Admission Requirements	None			
Recommended Previous	Calculus			
Knowledge	Discrete algebraic structures (combinatorics)			
	Propositional logic			
	, ,			
Educational Objectives	After taking part successfully, students have reached	the following learning results		
Professional Competence				
Knowledge	Students can name the basic concepts in Stock	hastics. They are able to explain them u	sing appropriate e	examples.
	Students can discuss logical connections between			
	the help of examples.	.,		
	They know proof strategies and can reproduce	them.		
CL III				
Skills	Students can model problems from stochasti	cs with the help of the concepts studio	ed in this course	. Moreover, they are
	capable of solving them by applying establishe	ed methods.		
	<ul> <li>Students are able to discover and verify further</li> </ul>	er logical connections between the conce	pts studied in the	course.
	For a given problem, the students can devel	op and execute a suitable approach, a	nd are able to c	ritically evaluate the
	results.			
Personal Competence				
Social Competence				
	Students are able to work together (e.g. on the	eir regular home work) in heterogeneou	sly composed tea	ims (i.e., teams from
	different study programs and background know			
	In doing so, they can communicate new concern		perating partners	. Moreover, they can
	design examples to check and deepen the unc	lerstanding of their peers.		
Autonomy				
	Students are capable of checking their under		own. They can sp	ecify open questions
	precisely and know where to get help in solvin			
	<ul> <li>Students can put their knowledge in relation to</li> <li>Students have developed sufficient persisten</li> </ul>		ls in a goal orion	tod manner on hard
	problems.	ce to be able to work for longer period	is iii a goai-orieii	ted illaffiler off flatd
	F. 0516.1151			
	Independent Study Time 124, Study Time in Lecture	56		
Credit points				
Course achievement				
	Written exam			
Examination duration and	120 min			
scale	Conseq Francisco Colon (C	washan) Caratallashi G		
Assignment for the		mester): Specialisation Computer Science	e: Compulsory	
Following Curricula	Computer Science: Core Qualification: Compulsory  Data Science: Core Qualification: Compulsory			
	Computational Science and Engineering: Core Qualification:	cation: Compulsory		
	Logistics and Mobility: Specialisation Engineering Science			
	Logistics and Mobility: Specialisation Engineering Science Logistics and Mobility: Specialisation Information Tec			
	Theoretical Mechanical Engineering: Core Qualification			
	Engineering and Management - Major in Logistics and	, ,	hnology: Elective	Compulsorv
		,	3,	. ,

Course L0777: Stochastics	
Тур	Lecture
Hrs/wk	2
СР	4
Workload in Hours	Independent Study Time 92, Study Time in Lecture 28
Lecturer	Prof. Matthias Schulte
Language	DE/EN
Cycle	SoSe
Content	<ul> <li>Definitions of probability, conditional probability</li> <li>Random variables, dependencies, independence assumptions,</li> <li>Marginal and joint probabilities</li> <li>Distributions and density functions</li> <li>Characteristics: expected values, variance, standard deviation, moments</li> <li>Multivariate distributions</li> <li>Law of large numbers and central limit theorem</li> <li>Basic notions of stochastic processes</li> <li>Basic concepts of statistics (point estimators, confidence intervals, hypothesis testing)</li> </ul>
Literature	<ol> <li>Methoden der statistischen Inferenz, Likelihood und Bayes, Held, L., Spektrum 2008</li> <li>Stochastik für Informatiker, Dümbgen, L., Springer 2003</li> <li>Statistik: Der Weg zur Datenanalyse, Fahrmeir, L., Künstler R., Pigeot, I, Tutz, G., Springer 2010</li> <li>Stochastik, Georgii, HO., deGruyter, 2009</li> <li>Probability and Random Processes, Grimmett, G., Stirzaker, D., Oxford University Press, 2001</li> <li>Programmieren mit R, Ligges, U., Springer 2008</li> </ol>

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

Module M0624: Auton	nata Theory and Formal Languages			
Courses				
Title Automata Theory and Formal Langu Automata Theory and Formal Langu		Typ Lecture Recitation Section (small)	Hrs/wk 2 2	<b>CP</b> 4 2
Module Responsible		recitation Section (Small)		
Admission Requirements				
-	Participating students should be able to			
Knowledge	- specify algorithms for simple data structures (such	as, e.g., arrays) to solve computational p	roblems	
	- apply propositional logic and predicate logic for spe	cifying and understanding mathematical	proofs	
	- apply the knowledge and skills taught in the module	e Discrete Algebraic Structures		
Educational Objectives	After taking part successfully, students have reached	the following learning results		
Professional Competence				
Skills	solving decision problems. Students can show corn problems are hard to represent with propositional syntax, semantics, and decision problems for this resolving the predicate logic SAT decision problem. Stukinds of temporal logic, and identify their application automata and can identify relationships to logic and deterministic and nondeterministic finite automata formalism for which nondeterminism is more expresorblems require which expressivity, and, in addition problems w.r.t. other formalisms. They understand the for specifying systems and their properties. Students or grammars.  Students can apply propositional logic as well as preeproblems in order to derive propositional logic, pred which formalism is best suited for a particular application problems to specific formulas. Students can grammars from automata and vice versa. They can emptiness problem in case of infinite words.	logic, and therefore, the students can epresentation formalism. Students can also describe syntax, semantion areas. The participants of the course of formal grammars. The spectrum that and pushdown automata to Turing missive than determinism. They are also a students can transform decision problems to a manager of the course of the cour	motivate predica explain unification can decision se can define value to students can able to demons ms w.r.t. one for thms whereas of formalisms such prepresent them ate the application application and the control of the control o	ate logic, and define on and resolution for problems for various arious kinds of finite explain ranges from ats can name those trate which decision malism into decision thers are best suited in as logic, automata, as analyze application in. They can evaluate ion of algorithms for nistic ones, or derive
	emptiness problem in case of infinite words.			
Personal Competence				
Social Competence				
Autonomy				
Workload in Hours	Independent Study Time 124, Study Time in Lecture	56		
Credit points	6			
Course achievement				
Examination	Written exam			
Examination duration and scale	90 min			
Assignment for the	General Engineering Science (German program, 7 sei	mester): Specialisation Computer Science	e: Compulsory	
Following Curricula	Computer Science: Core Qualification: Compulsory			
	Data Science: Core Qualification: Compulsory			
	Engineering Science: Specialisation Mechatronics: Ele	ective Compulsory		
	General Engineering Science (English program, 7 sen	nester): Specialisation Mechatronics: Elec	tive Compulsory	
	Computational Science and Engineering: Core Qualification			
	Orientation Studies: Core Qualification: Elective Comp	•		
	Technomathematics: Specialisation II. Informatics: Ele	ective Compulsory		

Typ Lecture  Workload in Hours  Lecturer  Language  IN  Crottent  1. Propositional logic, Boolean algebra, propositional resolution, SAT-2KNF  2. Predicate logic, unification, predicate logic resolution  3. Temporal logics (LTL, CTL)  4. Deterministic finite automate, definition and construction  5. Regular languages, closure properties, word problem, string matching  6. Nondeterministic intellia automata.  Rabin-Scott transformation of nondesterministic into deterministic automata  7. Epsilon automata, minimization of automata, eliminal automaton (modulo renaming of states)  8. Myhill-Merode Theorem:  Correctness of tool which, in some cases, can be used to show that a finite automata provision of a lood which, in some cases, can be used to show that a finite automaton be expressive enough to solve a word problem for some given language  10. Regular expressions vs. finite automats. Equivalence classes of strings induced by automata provision of a tool which, in some cases, can be used to show that a finite automaton principally cannot be expressive enough to solve a word problem for some given language  10. Regular expressions vs. finite automats: Equivalence of formalisms, systematic transformation of representations, reductions  11. Pushdown automata and context-free grammars. Definition of pashdown automata, definition of context-free grammars, derivations, parse trees, ambiguities, pumping lemma for context-free grammars, transformation of formalisms (from pushdown automata to context-free grammars and back)  12. Chamsky normal form  13. CYK algorithm of deciding the word problem for context-free grammars  14. Deterministic pushdown automata: Application for parsing, LL(k) or LR(k) grammars and parsers vs. deterministic pushdown automata, compiler compiler  15. Regular grammars  16. Deterministic vs. nondeterministic pushdown automata representation of state transition systems, verification w.r.t. temporal logic specifications (in particular LTI)  21. LTL safety conditions and model checking with Buchi aut	Course L0332: Automata The	ory and Formal Languages			
Workland in boars  Letturer  The Matthias Minich  Language EN  Content  1. Propositional logic, Boolean algebra, propositional resolution, SAT-ZKNF  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, milminization of automata, climination of undurber ministic into deterministic automata  8. Myhill-Nerode Theorem:  Correctness of the minimization procedure, equivalence classes of strings induced by automata  9. Pumping Lemma for regular languages: provision of a lood which, in some cases, can be used to show that a finite automata principally cannot be expressive enough to solve a word problem for some given language  10. Regular expressions vs. Inflice automata: Equivalence of formalisms, systematic transformation of representations, reductions  11. Pushdown automata and context-free grammars: Definition of pushdown automata, definition of context-free grammars, derivations, parse trees, ambiguities, pumping lemma for context-free grammars, transformation of formalisms (from pushdown automata to context-free grammars and back)  12. Chomsky normal form  13. CYK algorithm for deciding the word problem for context-free grammis  14. Deterministic pushdown automata: Application for parsing, LL(k) or LR(k) grammars and parsers vs. deterministic pushdown automata, compiler compiler  16. Regular grammars  17. Outlook: Tuming machines and linear bounded automata vs. general and context-sensitive grammars  18. Chomsky hierarchy  19. Mealy- and Moore automata: Automata with output (wo accepting states), infinite state sequences, automata networks  20. Omega automata: Automata for infinite input words, Bloth automata, representation of state transition systems, verification w.r.t. temporal logic specifications (in particulu	Тур	Lecture			
Lecturer   Fiof. Matthias Minich	Hrs/wk	2			
Language EN Cycle Sose Content 1. Propositional logic, Boolean algebra, propositional resolution, SAT-ZKNF 2. Predicate logic, unflication, predicate logic resolution 3. Temporal Logics (LTL, CTL) 4. Deterministic finite automata, definition and construction 5. Regular languages, closure properties, word problem, string matching 6. Nondeterministic automata: Rabin-Scott transformation of nondeterministic into deterministic automata 7. Epsilon automata, minimization of automata, elimination of e-edges, uniqueness of the minimal automaton (modulo renaming of states) 8. Myhill-Nerode Theorem: Correctness of the minimization procedure, equivalence classes of strings induced by automata 9. Pumping Lemma for regular languages: provision of a tool whitch, in some cases, can be used to show that a finite automaton principally cannot be expressive enough to solve a word problem for some given language 10. Regular expressions vs. finite automata: Equivalence of formalisms, systematic transformation of representations, reductions 11. Pushdown automata and context-free grammars: Definition of pushdown automata and context-free grammars, derivations, parse trees, ambiguities, pumping lemma for context-free grammars, transformation of formalisms (from pushdown automata to context-free grammars and back) 12. Chomsky normal form 13. CYK algorithm for deciding the word problem for context-free grammars 14. Deterministic pushdown automata Application for parsing, LIK) or LIKIk) grammars and parsers vs. deterministic pushdown automata, compiler compiler 16. Regular grammars 17. Outook: Turing machines and linear bounded automata vs general and context-sensitive grammars 18. Chomsky hierarchy 19. Mealy- and Moore automata: Automata with output (wo accepting states), infinite state sequences, automata networks 20. Omega automata: Automata for infinite input words, Buchi automata, representation of state transition systems, verification w.r.t. temporal logic specifications (in particular LTL) 21. LT safety conditions and model check	СР	4			
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	Literature				
Logik für Informatiker Martin Kreuzer, Stefan Kühling, Pearson Studium, 2006     Grandlaus Theoreticals a Informatiki Confessor Worth Wish With With Windows Yorks a 2010.					
3. Grundkurs Theoretische Informatik, Gottfried Vossen, Kurt-Ulrich Witt, Vieweg-Verlag, 2010.					
4. Principles of Model Checking, Christel Baier, Joost-Pieter Katoen, The MIT Press, 2007		4. Principles of Model Checking, Christel Baler, Joost-Pieter Katoen, The MIT Press, 2007			

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

Module M0803: Embe	dded Systems			
Courses				
Title		Тур	Hrs/wk	СР
Embedded Systems (L0805)		Lecture	3	4
Embedded Systems (L0806)		Recitation Section (small)	1	2
Module Responsible	Prof. Heiko Falk			
Admission Requirements	None			
Recommended Previous	Computer Engineering			
Knowledge				
Educational Objectives	After taking part successfully, students have reached th	e following learning results		
Professional Competence				
Knowledge	Embedded systems can be defined as information processing systems embedded into enclosing products. This course teaches the foundations of such systems. In particular, it deals with an introduction into these systems (notions, common characteristics) and their specification languages (models of computation, hierarchical automata, specification of distributed systems, task graphs, specification of real-time applications, translations between different models).			
	Another part covers the hardware of embedded systems: Sonsors, A/D and D/A converters, real-time capable communication hardware, embedded processors, memories, energy dissipation, reconfigurable logic and actuators. The course also features an introduction into real-time operating systems, middleware and real-time scheduling. Finally, the implementation of embedded systems using hardware/software co-design (hardware/software partitioning, high-level transformations of specifications, energy-efficient realizations, compilers for embedded processors) is covered.			
Skills	After having attended the course, students shall be able to realize simple embedded systems. The students shall realize which relevant parts of technological competences to use in order to obtain a functional embedded systems. In particular, they shall be able to compare different models of computations and feasible techniques for system-level design. They shall be able to judge in which areas of embedded system design specific risks exist.			
Personal Competence				
Social Competence	Students are able to solve similar problems alone or in a	a group and to present the results acco	ordingly.	
Autonomy	Students are able to acquire new knowledge from speci	fic literature and to associate this know	vledge with other	· classes.
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56			
Credit points	6			
Course achievement	Compulsory Bonus Form Descri	ription		
	Yes 10 % Subject theoretical and			
	practical work			
Examination	Written exam			
Examination duration and scale	90 minutes, contents of course and labs			
Assignment for the	General Engineering Science (German program, 7 seme	ster): Specialisation Computer Science	: Compulsory	
Following Curricula	Computer Science: Specialisation Computer and Softwa	re Engineering: Elective Compulsory		
	Computer Science: Specialisation I. Computer and Softw	vare Engineering: Elective Compulsory		
	Electrical Engineering: Core Qualification: Elective Comp	•		
	Engineering Science: Specialisation Mechatronics: Electi			
	Aircraft Systems Engineering: Core Qualification: Electiv	, ,		
	General Engineering Science (English program, 7 semes	•	tive Compulsory	
	Computational Science and Engineering: Core Qualificat			
	Mechatronics: Specialisation System Design: Elective Co			
	Mechatronics: Specialisation Intelligent Systems and Ro	bolics: Elective Compulsory		
	Mechatronics: Core Qualification: Elective Compulsory Microelectronics and Microsystems: Specialisation Embe	edded Systems: Elective Compulsory		
	Pricroelectronics and Pricrosystems, Specialisation Embe	sauca Systems. Liective Compulsory		

Course L0805: Embedded Sy	stems
Тур	Lecture
Hrs/wk	3
СР	4
Workload in Hours	Independent Study Time 78, Study Time in Lecture 42
Lecturer	Prof. Heiko Falk
Language	EN
Cycle	SoSe
Content	<ul> <li>Introduction</li> <li>Specifications and Modeling</li> <li>Embedded/Cyber-Physical Systems Hardware</li> <li>System Software</li> <li>Evaluation and Validation</li> <li>Mapping of Applications to Execution Platforms</li> <li>Optimization</li> </ul>
Literature	<ul> <li>Peter Marwedel. Embedded System Design - Embedded Systems Foundations of Cyber-Physical Systems. 2 nd Edition, Springer, 2012., Springer, 2012.</li> </ul>

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

Module M0731: Funct	ional Programming			
Courses				
Title		Тур	Hrs/wk	СР
Functional Programming (L0624)		Lecture	2	2
Functional Programming (L0625)		Recitation Section (large)	2	2
Functional Programming (L0626)		Recitation Section (small)	2	2
Module Responsible	Prof. Sibylle Schupp			
Admission Requirements	None			
Recommended Previous	Discrete mathematics at high-school level			
Knowledge				
<b>Educational Objectives</b>	After taking part successfully, students have reached th	ne following learning results		
Professional Competence				
Knowledge	Students apply the principles, constructs, and simple 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 peer programming with varying peoprograms orally. They communicate in English.	ers. They explain problems and solution	ons to their pee	r. They defend their
Autonomy	In programming labs, students learn under supervisi exercises, they develop solutions individually and indep		the mechanics	of programming. In
Workload in Hours	Independent Study Time 96, Study Time in Lecture 84			
Credit points	6			
Course achievement		ription		
	Yes 15 % Excercises			
Examination				
Examination duration and	90 min			
scale				_
Assignment for the	General Engineering Science (German program, 7 seme	ester): Specialisation Computer Science	: Elective Comp	ulsory
Following Curricula	Computer Science: Core Qualification: Compulsory			
	Data Science: Core Qualification: Elective Compulsory	Science: Flective Commules of		
	Data Science: Specialisation I. Mathematics/Computer S			
	Engineering Science: Specialisation Mechatronics: Elect		bina Camerolla	
	General Engineering Science (English program, 7 seme		uve Compuisory	
	Computer Science in Engineering: Specialisation I. Com			
	Technomathematics: Specialisation II. Informatics: Elec	uve compuisory		

Typ 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
CP 2 Workload in Hours Independent Study Time 32, Study Time in Lecture 28  Lecturer Prof. Sibylle Schupp  Language EN  Cycle WiSe  Content
Workload in Hours Independent Study Time 32, Study Time in Lecture 28  Lecturer Prof. Sibylle Schupp  Language EN  Cycle WiSe  Content
Lecturer Prof. Sibylle Schupp  Language EN  Cycle WiSe  Content
Language EN  Cycle WiSe  Content
Cycle WiSe Content
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>

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.

Course L0626: Functional Programming	
Тур	Recitation Section (small)
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.

Module M1578: Semir	nars Computer Science			
Courses				
Title		Тур	Hrs/wk	СР
Introductory Seminar Computer Sci	ence I (L2362)	Seminar	2	3
Introductory Seminar Computer Sci	ence II (L2361)	Seminar	2	3
Module Responsible	Dozenten des SD E			
Admission Requirements	None			
Recommended Previous	Basic knowledge of Computer Science and Mathemat	ics at the Bachelor's level.		
Knowledge				
Educational Objectives	After taking part successfully, students have reached	the following learning results		
Professional Competence				
Knowledge	The students are able to			
	<ul> <li>explicate a specific topic in the field of Comput</li> </ul>	ter Science.		
	describe complex issues,			
	<ul> <li>present different views and evaluate in a critic</li> </ul>	al way.		
Skills	The students are able to			
	<ul> <li>familiarize in a specific topic of Computer Scien</li> </ul>	nce in limited time,		
	<ul> <li>realize a literature survey on the specific topic</li> </ul>	and cite in a correct way,		
	<ul> <li>elaborate a presentation and give a lecture to</li> </ul>			
	<ul> <li>sum up the presentation in 10-15 lines,</li> </ul>			
	<ul> <li>answer questions in the final discussion.</li> </ul>			
B				
Personal Competence	The shudents are able to			
30Ciai Competence	The students are able to			
	<ul> <li>elaborate and introduce a topic for a certain au</li> </ul>	udience,		
	<ul> <li>discuss the topic, content and structure of the</li> </ul>	presentation with the instructor,		
	<ul> <li>discuss certain aspects with the audience, and</li> </ul>			
	<ul> <li>as the lecturer listen and respond to questions</li> </ul>	from the audience.		
Autonomy	The students are able to			
	<ul> <li>define the task in question in an autonomous v</li> </ul>	vav		
	<ul> <li>develop the necessary knowledge,</li> </ul>			
	use appropriate work equipment, and			
	<ul> <li>guided by an instructor critically check the wor</li> </ul>	rking status.		
Workload in Hours	Independent Study Time 124, Study Time in Lecture	56		
Credit points		50		
Course achievement				
Examination				
Examination Examination duration and	x x			
examination duration and scale	^			
Assignment for the	Gonoral Engineering Science (Gorman program, 7 co.	mostor): Specialisation Computer S	cionco: Electivo Comp	ulsony
Following Curricula	General Engineering Science (German program, 7 ser Computer Science: Core Qualification: Compulsory	niester). Specialisation Computer S	cience, Elective Compi	uisui y
i onowing curricula	Data Science: Core Qualification: Compulsory			
	Data Science: Core Qualification: Compulsory			
	Computer Science in Engineering: Core Qualification:	Compulsory		
	p. 2. 2 2gdoming. core quantication.	preservy		

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	Dozenten des SD E	
Language	DE/EN	
Cycle	WiSe/SoSe	
Content		
Literature		

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

Module M0834: Comp	uternetworks and Internet Security			
Courses				
Title		Тур	Hrs/wk	СР
Computer Networks and Internet Se		Lecture	3	5
Computer Networks and Internet Se	•	Recitation Section (small)	1	1
Module Responsible	Prof. Andreas Timm-Giel			
Admission Requirements	None			
	Basics of Computer Science			
Knowledge				
Educational Objectives	After taking part successfully, students have reached the	following learning results		
Professional Competence				
Knowledge	Students are able to explain important and common Inte	ernet protocols in detail and classify	them, in order to	be able to analyse
	and develop networked systems in further studies and join	0.		
Skille	Students are able to analyse common Internet protocols	and avaluate the use of them in diffe	ront domains	
SKIIIS	Students are able to analyse common internet protocols	and evaluate the use of them in diffe	erent domains.	
Personal Competence				
Social Competence				
Autonomy	Students can select relevant parts out of high amount of	professional knowledge and can inde	ependently learn	and understand it.
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56			
Credit points	6			
Course achievement	None			
Examination	Written exam			
Examination duration and	120 min			
scale				
Assignment for the	General Engineering Science (German program, 7 semes	ter): Specialisation Computer Scienc	e: Elective Compu	ilsory
Following Curricula	Computer Science: Core Qualification: Compulsory			
	Data Science: Specialisation I. Mathematics/Computer Sc	ience: Elective Compulsory		
	Data Science: Core Qualification: Elective Compulsory			
	Electrical Engineering: Core Qualification: Elective Compu	ılsory		
	Engineering Science: Specialisation Electrical Engineering	g: Elective Compulsory		
	Engineering Science: Specialisation Mechatronics: Electiv			
	Engineering Science: Specialisation Mechatronics: Electiv			
	General Engineering Science (English program, 7 semest		ctive Compulsory	
	Computer Science in Engineering: Core Qualification: Cor	•		
	Technomathematics: Specialisation II. Informatics: Elective	ve Compulsory		

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

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

Module M0662: Nume	erical Mathematics I			
Courses				
Title		Тур	Hrs/wk	СР
Numerical Mathematics I (L0417)		Lecture	2	3
Numerical Mathematics I (L0418)		Recitation Section (small)	2	3
Module Responsible				
Admission Requirements	None			
Recommended Previous	Mathematik I + II for Engineering Students (german or en	glish) <b>or</b> Analysis & Linear Alg	ebra I + II for Te	chnomathematicians
Knowledge	basic MATLAB/Python knowledge			
Educational Objectives	After taling worth acceptability attendants have reached the fallow	na lagraina regulta		
	After taking part successfully, students have reached the follow	ng learning results		
Professional Competence	Students are able to			
Knowieuge	Students are able to			
	<ul> <li>name numerical methods for interpolation, integration, le</li> </ul>	east squares problems, eigenv	alue problems, n	onlinear root finding
	problems and to explain their core ideas,			
	repeat convergence statements for the numerical method			1 2
	explain aspects for the practical execution of numerical n	nethods with respect to compu	tational and stor	age complexitx.
Skille	Students are able to			
Skills	Students are able to			
	<ul> <li>implement, apply and compare numerical methods using</li> </ul>			
	justify the convergence behaviour of numerical methods		d solution algori	thm,
	<ul> <li>select and execute a suitable solution approach for a give</li> </ul>	n problem.		
Personal Competence				
Social Competence	Students are able to			
	work together in heterogeneously composed teams (i.e.,	toams from different study pro	arams and had	varound knowledge)
	explain theoretical foundations and support each other w			
	explain allowered foundations and support each other w	an praetical aspects regarding	and implementa	alon or algoritanis.
Autonomy	Students are capable			
	to assess whether the supporting theoretical and practical	l excercises are better solved	individually or in	a team,
	<ul> <li>to assess their individual progess and, if necessary, to as</li> </ul>	questions and seek help.		
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56			
Course achievement	None			
Examination				
Examination duration and				
scale				
Assignment for the	General Engineering Science (German program, 7 semester): Sp	ecialisation Computer Science	: Compulsory	
Following Curricula	General Engineering Science (German program, 7 semester): Sp	ecialisation Biomedical Engine	ering: Compulso	ory
	General Engineering Science (German program, 7 semeste	r): Specialisation Mechanical	Engineering, F	ocus Biomechanics:
	Compulsory			
	General Engineering Science (German program, 7 semester): Sp	pecialisation Mechanical Engin	eering, Focus Th	eoretical Mechanical
	Engineering: Compulsory  General Engineering Science (German program, 7 semester)	. Specialisation Machanical E	inginooring Foc	us Aircraft Systems
	Engineering: Elective Compulsory	. Specialisation Mechanical E	ingineering, roc	us Aliciait Systems
	General Engineering Science (German program, 7 semester): S	pecialisation Mechanical Engin	eering. Focus M	echatronics: Elective
	Compulsory	· ·	3.	
	General Engineering Science (German program, 7 semester)	: Specialisation Mechanical E	ngineering, Foc	us Energy Systems:
	Elective Compulsory			
	General Engineering Science (German program, 7 semester): Sp			
	General Engineering Science (German program, 7 semest	er): Specialisation Mechanica	al Engineering,	Focus Materials in
	Engineering Sciences: Compulsory	aginopring, Floative Committee	2,	
	Bioprocess Engineering: Specialisation A - General Bioprocess En Computer Science: Specialisation II. Mathematics and Engineerin		-	
	Data Science: Core Qualification: Compulsory	ig Science. Liective Compulsor	у	
	Electrical Engineering: Core Qualification: Elective Compulsory			
	Engineering Science: Core Qualification: Compulsory			
	Engineering Science: Core Qualification: Compulsory			
	Computer Science in Engineering: Core Qualification: Compulsor	у		
	Mechanical Engineering: Specialisation Theoretical Mechanical E	ingineering: Compulsory		
	Mechanical Engineering: Specialisation Energy Systems: Elective			
	Theoretical Mechanical Engineering: Technical Complementary (		Compulsory	
	Process Engineering: Specialisation Process Engineering: Electiv	e Compulsory		

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

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

Module M0791: Comp	outer Architecture			
Courses				
Title Computer Architecture (L0793) Computer Architecture (L0794)		<b>Typ</b> Lecture Project-/problem-based Learning	Hrs/wk 2 2	<b>CP</b> 3 2
Computer Architecture (L1864)		Recitation Section (small)	1	1
Module Responsible				
Admission Requirements	None			
Recommended Previous  Knowledge	Module "Computer Engineering"			
Educational Objectives	After taking part successfully, students have reached the following	ng learning results		
Professional Competence	31			
	This module presents advanced concepts from the discipline of various programming models is given, both for general-purp processors). Next, foundational aspects of the micro-architecture so-called pipelining and the methods used for the acceleration know concepts for dynamic scheduling, branch prediction, shierarchies.  The students are able to describe the organization of processors	oose computers and for specia e of processors are covered. Here of instruction execution used in superscalar execution of machi	al-purpose ma e, the focus pa this context. ne instruction	chines (e.g., signal articularly lies on the The students get to as and for memory
•	models. The students examine various structures of pipelined pr analyze them w.r.t. criteria like, e.g., performance or energy effi know parallel computer architectures and are able to distinguish Students are able to solve similar problems alone or in a group a Students are able to acquire new knowledge from specific literat	iciency. They evaluate different s between instruction- and data-le	structures of n evel parallelisr ingly.	nemory hierarchies, n.
Washing die Hauss	Independent Challe Time 110 Challe Time in Lasters 70			
Workload in Hours  Credit points				
Course achievement	Compulsory Bonus Form Description  No 15 % Subject theoretical and practical work			
Examination	Written exam			
	90 minutes, contents of course and 4 attestations from the PBL <sup>a</sup>	'Computer architecture"		
scale				
Assignment for the Following Curricula	General Engineering Science (German program, 7 semester): Sp Computer Science: Specialisation I. Computer and Software Engi Aircraft Systems Engineering: Core Qualification: Elective Compu Computer Science in Engineering: Specialisation I. Computer Sci Microelectronics and Microsystems: Specialisation Embedded Sy	neering: Elective Compulsory ulsory ence: Elective Compulsory	lective Compu	llsory

Course L0793: Computer Arc	hitecture
Тур	Lecture
Hrs/wk	2
СР	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Prof. Heiko Falk
Language	DE/EN
Cycle	WiSe
Content	<ul> <li>Introduction</li> <li>VHDL Basics</li> <li>Programming Models</li> <li>Realization of Elementary Data Types</li> <li>Dynamic Scheduling</li> <li>Branch Prediction</li> <li>Superscalar Machines</li> <li>Memory Hierarchies</li> </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	Course L0794: Computer Architecture	
Тур	Project-/problem-based Learning	
Hrs/wk	2	
СР	2	
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28	
Lecturer	Prof. Heiko Falk	
Language	DE/EN	
Cycle	WiSe	
Content	See interlocking course	
Literature	See interlocking course	

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

Module M1592: Statis	stics			
Courses				
Title		Тур	Hrs/wk	СР
Statistics (L2430)		Lecture	3	4
Statistics (L2431)		Recitation Section (small)	1	2
Module Responsible	Prof. Matthias Schulte			
Admission Requirements				
Recommended Previous	Stochastics (or a comparable class)			
Knowledge				
Educational Objectives	After taking part successfully, students have reache	ed the following learning results		
Professional Competence				
Knowledge	Students can name the basic concepts in Sta	atistics. They are able to explain them usin	g appropriate ex	amples
	Students can discuss logical connections be			
	the help of examples.	.,	, , , , , , , , , , , , , , , , , , ,	
Skills	Students can model statistical problems with	n the help of the concepts studied in this	ourse Moreover	they are canable
	solving them by applying established metho			, and capable
	Students are able to discover and verify furtlength			course.
	For a given problem, the students can dev		•	
	results.			
Personal Competence				
Social Competence	Students are able to work together (e.g. on	their regular home work) in heterogeneo	usly composed t	eams and to prese
	their results appropriately (e.g. during exerc		, , , , , , , , , , , , , , , , , , , ,	
	In doing so, they can communicate new con		perating partners	. Moreover, they c
	design examples to check and deepen the u			
Autonomy	Students are capable of checking their under	erstanding of complex concepts on their o	wn. They can sp	ecify open questio
	precisely and know where to get help in solv	ing them.		
	Students can put their knowledge in relation	to the contents of other lectures.		
	Students have developed sufficient persiste	ence to be able to work for longer period	s in a goal-orien	ted manner on ha
	problems.			
Workload in Hours	Independent Study Time 124, Study Time in Lectur	e 56		
Credit points	6			
Course achievement	None			
Examination	Written exam			
Examination duration and	90 min			
scale				
Assignment for the	General Engineering Science (German program, 7 s	semester): Specialisation Advanced Materi	als: Elective Com	pulsorv
-	General Engineering Science (German program, 7 s			
-	Computer Science: Specialisation II. Mathematics a	nd Engineering Science: Elective Compuls	ory	
	Data Science: Core Qualification: Compulsory		-	
	Engineering Science: Specialisation Advanced Mate	rials: Elective Compulsory		
	Logistics and Mobility: Specialisation Information Te	echnology: Elective Compulsory		
	Technomathematics: Specialisation I. Mathematics:	Elective Compulsory		
	Theoretical Mechanical Engineering: Specialisation	Robotics and Computer Science: Elective	Compulsory	
	Engineering and Management - Major in Logistics a	nd Mobility: Specialisation Information Tec	hnology: Elective	Compulsory

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

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

Module M0562: Computability and Complexity Theory					
Courses					
Title			Тур	Hrs/wk	СР
Computability and Complexity Theo	pry (L0166)		Lecture	2	3
Computability and Complexity Theo	ory (L0167)		Recitation Section (small)	2	3
Module Responsible	NN				
Admission Requirements	None				
Recommended Previous	Discrete Algebraic Structures, Automata Th	neory, Logic, and Form	al Language Theory.		
Knowledge					
Educational Objectives	After taking part successfully, students have	ve reached the following	ng learning results		
Professional Competence					
Knowledge	The students known the important ma	chine models of cor	mputability, the class of p	artial recursive	functions, universal
	computability, Gödel numbering of compu	tations, the theorems	of Kleene, Rice, and Rice-S	hapiro, the conce	ept of decidable and
	undecidable sets, the word problems for semi-Thue systems, Thue systems, semi-groups, and Post correspondence systems,				
	Hilbert's 10-th problem, and the basic concepts of complexity theory.				
Skills	Students are able to investigate the compu	utability of sets and fu	nctions and to analyze the co	mplexity of comp	utable functions.
Personal Competence					
Social Competence	Students are able to solve specific problems alone or in a group and to present the results accordingly.				
Autonomy	Students are able to acquire new knowledge from newer literature and to associate the acquired knowledge with other classes.				
Workload in Hours	Independent Study Time 124, Study Time i	n Lecture 56			
Credit points	6				
Course achievement	None				
Examination	Written exam				
Examination duration and	60 min				
scale					
Assignment for the	General Engineering Science (German program, 7 semester): Specialisation Computer Science: Elective Compulsory				
Following Curricula	Computer Science: Core Qualification: Com	pulsory			
	Data Science: Core Qualification: Elective C	Compulsory			
	Data Science: Specialisation I. Mathematics	s/Computer Science: E	lective Compulsory		
	Computer Science in Engineering: Specialis	sation I. Computer Sci	ence: Elective Compulsory		
	Technomathematics: Specialisation II. Infor	matics: Elective Comp	oulsory		

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

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

Module M0971: Opera	ating Systems			
Courses				
Title		Тур	Hrs/wk	СР
Operating Systems (L1153)		Lecture	2	3
Operating Systems (L1154)	I	Recitation Section (small)	2	3
Module Responsible				
Admission Requirements	None			
Recommended Previous	Object-oriented programming, algorithms, and dates	ata structures		
Knowledge	Procedural programming			
	Experience in using tools related to operating sys	stems such as editors, linkers, compile	rs	
	Experience in using C-libraries			
Educational Objectives	After taking part successfully, students have reached th	e following learning results		
<b>Professional Competence</b>				
Knowledge	Students explain the main abstractions process, virtua	l memory, deadlock, lifelock, and file	of operations sy	stems, describe the
	process states and their transitions, and paraphrase the architectural variants of operating systems. They give examples of			
	existing operating systems and explain their architecture			
	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 schedul	ing 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 program, 7 seme	ester): Specialisation Computer Science	e: Elective Comp	ulsory
Following Curricula				
	Computer Science in Engineering: Specialisation I. Com			
	Technomathematics: Specialisation II. Informatics: Elect	cive Compulsory		

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

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

Module M0732: Softw	vare Engineering			
Courses				
Title		Тур	Hrs/wk	СР
Software Engineering (L0627)		Lecture	2	3
Software Engineering (L0628)		Recitation Section (small)	2	3
Module Responsible	Prof. Sibylle Schupp			
Admission Requirements	None			
Recommended Previous Knowledge	<ul> <li>Automata theory and formal languages</li> </ul>	-		
Educational Objectives	After taking part successfully, students have reached	the following learning results		
Professional Competence				
	Students explain the phases of the software life engineering, and paraphrase the principles of structur of existing large-scale systems. They write test cas different notations, and critique both. They explain maintenance, and project planning.	ed software development. They give e ses for different test strategies and o simple design patterns and the majo	xamples of software devise specification or activities in re	are-engineering tasks ons or models using equirements analysis,
JAIIIS	For a given task in the software life cycle, students identify the corresponding phase and select an appropriate method. They choose the proper approach for quality assurance. They design tests for realistic systems, assess the quality of the tests, and find errors at different levels. They apply and modify non-executable artifacts. They integrate components based on interface specifications.			
Personal Competence				
Social Competence	Students practice peer programming. They explain pro	oblems and solutions to their peer. The	y communicate ii	n English.
Autonomy	Using on-line quizzes and accompanying material for adjust it appropriately. Working on exercise problems	•	level of knowled	dge continuously and
Workload in Hours	Independent Study Time 124, Study Time in Lecture 5	6		
Credit points	6			
Course achievement	CompulsoryBonusFormDescriptionYes15 %Excercises	scription		
Examination	Written exam			
Examination duration and	90 min			
scale				
Assignment for the	General Engineering Science (German program, 7 sen	nester): Specialisation Computer Science	ce: Elective Comp	oulsory
Following Curricula	Computer Science: Core Qualification: Compulsory			
	Data Science: Specialisation I. Mathematics/Computer	Science: Elective Compulsory		
	Computer Science in Engineering: Specialisation I. Cor	mputer Science: Elective Compulsory		
	Technomathematics: Specialisation II. Informatics: Ele	ctive Compulsory		

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

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

Module M1269: Lab C	yber-Physical Systems
Courses	
Title	Typ Hrs/wk CP
Lab Cyber-Physical Systems (L1740	Project-/problem-based Learning 4 6
Module Responsible	Prof. Heiko Falk
Admission Requirements	None
Recommended Previous	Module "Embedded Systems"
Knowledge	
Educational Objectives	After taking part successfully, students have reached the following learning results
Professional Competence	
Knowledge	Cyber-Physical Systems (CPS) are tightly integrated with their surrounding environment, via sensors, A/D and D/A converters, and
	actors. Due to their particular application areas, highly specialized sensors, processors and actors are common. Accordingly, there
	is a large variety of different specification approaches for CPS - in contrast to classical software engineering approaches.
	Based on practical experiments using robot kits and computers, the basics of specification and modelling of CPS are taught. The
	lab introduces into the area (basic notions, characteristical properties) and their specification techniques (models of computation,
	hierarchical automata, data flow models, petri nets, imperative approaches). Since CPS frequently perform control tasks, the lab's
	experiments will base on simple control applications. The experiments will use state-of-the-art industrial specification tools
	(MATLAB/Simulink, LabVIEW, NXC) in order to model cyber-physical models that interact with the environment via sensors and
	actors.
Skills	After successful attendance of the lab, students are able to develop simple CPS. They understand the interdependencies between a
	CPS and its surrounding processes which stem from the fact that a CPS interacts with the environment via sensors, A/D converters,
	digital processors, D/A converters and actors. The lab enables students to compare modelling approaches, to evaluate their advantages and limitations, and to decide which technique to use for a concrete task. They will be able to apply these techniques
	to practical problems. They obtain first experiences in hardware-related software development, in industry-relevant specification
	tools and in the area of simple control applications.
Personal Competence	tools and in the died of Simple control applications.
·	Students are able to solve similar problems alone or in a group and to present the results accordingly.
·	
Autonomy	Students are able to acquire new knowledge from specific literature and to associate this knowledge with other classes.
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56
Credit points	6
Course achievement	None
Examination	Written elaboration
Examination duration and	Execution and documentation of all lab experiments
scale	
Assignment for the	General Engineering Science (German program, 7 semester): Specialisation Computer Science: Elective Compulsory
Following Curricula	Computer Science: Specialisation II. Mathematics and Engineering Science: Elective Compulsory
	Computer Science in Engineering: Specialisation II. Mathematics & Engineering Science: Elective Compulsory
	Mechatronics: Specialisation Intelligent Systems and Robotics: Elective Compulsory
	Mechatronics: Specialisation System Design: Elective Compulsory
	Mechatronics: Technical Complementary Course: Elective Compulsory

Course L1740: Lab Cyber-Phy	ysical Systems
Тур	Project-/problem-based Learning
Hrs/wk	4
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.

specialisation.						
Module M0598: Mech	anical Enginee	ring: Design				
Courses						
Title				Тур	Hrs/wk	СР
Embodiment Design and 3D-CAD (	L0268)			Lecture	2	1
Mechanical Design Project I (L0695	j)			Project-/problem-based Learning	3	2
Mechanical Design Project II (L059)				Project-/problem-based Learning	3	2
Team Project Design Methodology				Project-/problem-based Learning	2	1
Module Responsible						
Admission Requirements						
Recommended Previous	<ul> <li>Fundamentals</li> </ul>	of Mechanical Engineering	g Design			
Knowledge	<ul> <li>Mechanics</li> </ul>					
	<ul> <li>Fundamentals</li> </ul>	of Materials Science				
	Production Eng	gineering				
Educational Objectives		cessfully, students have re	ached the followi	ng learning results		
Professional Competence						
Knowledge	After passing the mod	dule, students are able to:				
	<ul> <li>explain design</li> </ul>	guidelines for machinery	parts e.g. conside	ering load situation, materials and	d manufactur	ing requirements,
	describe basics	s of 3D CAD,				
	<ul> <li>explain basics</li> </ul>	methods of engineering d	esigning.			
CL "!						
SKIIIS	After passing the mod	dule, students are able to:				
	<ul> <li>independently</li> </ul>	create sketches, technica	l drawings and do	ocumentations e.g. using 3D CAD	),	
	<ul> <li>design compor</li> </ul>	nents based on design gui	delines autonomo	ously,		
	<ul> <li>dimension (cal</li> </ul>	culate) used components,				
	<ul> <li>use methods to</li> </ul>	o design and solve engine	ering design task	s systamtically and solution-orier	nted,	
	<ul> <li>apply creativity</li> </ul>	y techniques in teams.				
Personal Competence						
		dule, students are able to:				
	The second are the					
	develop and evaluate solutions in groups including making and documenting decisions,					
	moderate the use of scientific methods,					
	· ·	present and discuss solutions and technical drawings within groups,				
	reflect the own	results in the work group	s of the course.			
Autonomy	Students are able					
	to estimate th	eir level of knowledge usi	ng activating me	thods within the lectures (e.g. wi	th clickers),	
	<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>					
	1 -	ime 40, Study Time in Lec	ture 140			
Credit points		F	B			
Course achievement	Compulsory Bonus Yes None	Form Written elaboration	Description Teamprojekt	Konstruktionsmethodik		
	Yes None	Written elaboration	Konstruktion			
	Yes None	Written elaboration	Konstruktion	• •		
	Yes None	Written elaboration	3D-CAD-Prak	• •		
Examination	1					
Examination duration and						
scale						
Assignment for the		Science (German program	7 semester). Sn	ecialisation Mechanical Engineer	ing: Compule	nrv
Following Curricula				_		-
. cc.mig carricula	General Engineering Science (German program, 7 semester): Specialisation Biomedical Engineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Biomedical Engineering: Compulsory					
		igineering: Core Qualificat			Jpui0	•
	_	-		pulsory		
	Energy and Environmental Engineering: Core Qualification: Compulsory Engineering Science: Core Qualification: Compulsory					
		•	-	ecialisation Biomedical Engineerin	ng: Compulso	ry
	1	· · ·		-	•	

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

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

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

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

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

Module M0933: Funda	amentals of Materials Science				
Courses					
		Tom	Here from	CD	
<b>Title</b> Fundamentals of Materials Science	1 (11085)	Typ Lecture	Hrs/wk	<b>CP</b> 2	
	II (Advanced Ceramic Materials, Polymers and Composites) (L0506)	Lecture	2	2	
Physical and Chemical Basics of Ma		Lecture	2	2	
Module Responsible	Prof. Jörg Weißmüller				
Admission Requirements	None				
Recommended Previous	Highschool-level physics, chemistry und mathematics				
Knowledge	ς · · · · · · · · · · · · · · · · · · ·				
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	netals, ceramics and	d polymers and can describ	ne this knowledge	
	comprehensively. Fundamental knowledge here means specific			-	
	phase transformations, corrosion and mechanical properties. Th				
	for materials and can identify relevant approaches for cha	racterizing specific	properties. They are able	to trace materials	
	phenomena back to the underlying physical and chemical laws	of nature.			
Skills	The students are able to trace materials phenomena back to				
	phenomena here refers to mechanical properties such as stre				
	resistance, and to phase transformations such as solidification between processing conditions and the materials microstructu			-	
	material's behavior.	ire, and they can ac	count for the impact of fine	rostructure on the	
	material 3 behavior.				
Personal Competence					
Social Competence	_				
Autonomy					
	Independent Study Time 96, Study Time in Lecture 84				
Credit points					
Course achievement					
Examination	Written exam				
Examination duration and	180 min				
scale					
Assignment for the	General Engineering Science (German program, 7 semester): S	pecialisation Mechan	ical Engineering: Compulsor	y	
Following Curricula	General Engineering Science (German program, 7 semester): S	pecialisation Biomed	ical Engineering: Compulsory	/	
	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: Com	npulsory			
	Green Technologies: Energy, Water, Climate: Specialisation Ene		ctive Compulsory		
	Logistics and Mobility: Specialisation Engineering Science: Elect				
	Logistics and Mobility: Specialisation Production Management a	nd Processes: Electiv	ve Compulsory		
	Mechanical Engineering: Core Qualification: Compulsory				
	Mechatronics: Core Qualification: Compulsory				
	Naval Architecture: Core Qualification: Compulsory				
	Technomathematics: Specialisation III. Engineering Science: Ele				
	Engineering and Management - Major in Logistics and Mobilit	y: Specialisation Pro	oduction Management and F	rocesses: Elective	
	Compulsory				

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

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

Course L1095: Physical and 0	Chemical Basics of Materials Science
Тур	Lecture
Hrs/wk	2
СР	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Gregor Vonbun-Feldbauer, Prof. Stefan Fritz Müller
Language	DE
Cycle	WiSe
Content	<ul> <li>Motivation: "Atoms in Mechanical Engineering?"</li> <li>Basics: Force and Energy</li> <li>The electromagnetic Interaction</li> <li>"Detour": Mathematics (complex e-funktion etc.)</li> <li>The atom: Bohr's model of the atom</li> <li>Chemical bounds</li> <li>The multi part problem: Solutions and strategies</li> <li>Descriptions of using statistical thermodynamics</li> <li>Elastic theory of atoms</li> <li>Consequences of atomar properties on makroskopic Properties: Discussion of examples (metals, semiconductors, hybrid systems)</li> </ul>
Literature	Für den Elektromagnetismus:  • Bergmann-Schäfer: "Lehrbuch der Experimentalphysik", Band 2: "Elektromagnetismus", de Gruyter  Für die Atomphysik:  • Haken, Wolf: "Atom- und Quantenphysik", Springer  Für die Materialphysik und Elastizität:  • Hornbogen, Warlimont: "Metallkunde", Springer

Courses					
Fitle Advanced Mechanical Engineering	-	Typ Lecture	Hrs/wk	<b>CP</b> 2	
Advanced Mechanical Engineering	_	Recitation Section (large)	2	1	
Advanced Mechanical Engineering		Lecture	2	2	
Advanced Mechanical Engineering		Recitation Section (large)	2	1	
Module Responsible	Prof. Dieter Krause				
Admission Requirements	None				
Recommended Previous	Fundamentals of Mechanical Engineering Designation	ın			
Knowledge	Mechanics	J.,			
	Fundamentals of Materials Science     Production Engineering				
	Production Engineering				
Educational Objectives	After taking part successfully, students have reached	the following learning results			
Professional Competence	-	-			
Knowledge	After passing the module, students are able to:				
	<ul> <li>explain complex working principles and function</li> </ul>	ns of machine elements and of basic ele	ements of fluidics,		
	<ul> <li>explain requirements, selection criteria, application</li> </ul>	ation scenarios and practical examples of	of complex machin	ne elements,	
	<ul> <li>indicate the background of dimensioning calcu</li> </ul>	lations.			
Skills	After passing the module, students are able to:				
	accomplish dimensioning calculations of covere				
	<ul> <li>transfer knowledge learned in the module to no</li> </ul>		ving skills),		
	<ul> <li>recognize the content of technical drawings an</li> </ul>	d schematic sketches,			
	<ul> <li>evaluate complex designs, technically.</li> </ul>				
Personal Competence					
Social Competence					
30ciai competence	<ul> <li>Students are able to discuss technical informat</li> </ul>	ion in the lecture supported by activatir	g methods.		
Autonomy					
Autonomy	<ul> <li>Students are able to independently deepen the</li> </ul>	eir acquired knowledge in exercises.			
	<ul> <li>Students are able to acquire additional knowl</li> </ul>	edge and to recapitulate poorly unders	tood content e.g	. by using the vid	
	recordings of the lectures.				
Workload in Hours	Independent Study Time 68, Study Time in Lecture 1:	12			
Credit points	6				
Course achievement	None				
Examination	Written exam				
Examination duration and	120				
scale					
	General Engineering Science (German program, 7 ser	mester): Specialisation Mechanical Engir	eering: Compuls	nrv.	
	General Engineering Science (German program, 7 Ser				
. onowing curricula	Compulsory	semestery. Specialisation rectiaffical	Lg.iiccinig, 100	as Elicigy Systell	
	Energy and Environmental Engineering: Core Qualification: Elective Compulsory				
	Energy and Environmental Engineering: Core Qualification: Elective Compulsory  Energy Systems: Technical Complementary Course Core Studies: Elective Compulsory				
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	Engineering Science: Specialisation Mechanical Engineering: Compulsory  General Engineering Science (English program, 7 semester): Specialisation Mechanical Engineering: Compulsory				
	General Engineering Science (English program, 7	semester): Specialisation Mechanical	engineering, Foci	us Energy Syster	
	Compulsory				
	Mechanical Engineering: Core Qualification: Compulso	pry			
	Naval Architecture: Core Qualification: Compulsory				

Mrs/wk   2   C   P   2	Course L0264: Advanced Med	chanical Engineering Design II				
Workload hours Lecturer Prof. Dieter Krause, Prof. Otto von Estorff Language OE Content Advanced Mechanical Engineering Design I & II Lecture  • Fundamentals of the following machine elements: • Lunear rolling bearings • Ares & shafts • Seals • Clutches & brakes • Belt & chain drives • Egicyclic gears • Crank drives • Elements of fluidics  Exercise  • Calculation methods of the following machine elements: • Linear rolling bearings • Canse drives • Elements of fluidics  Exercise  • Calculation methods of the following machine elements: • Linear rolling bearings • Calculation fluidics  Exercise  • Calculation methods of the following machine elements: • Linear rolling bearings • Ares & shafts • Clutches & brakes • Belt & chain drives • Gear drives • Elements of fluidics  Literature  • Dubbel, Taschenbuch für den Maschinenbau: Grote, KH., Feldhusen, J.(Hrsg.): Springer-Verlag, aktuelle Auflage. • Maschinenelemente, Band -Illi, Niemann, C., Springer-Verlag, aktuelle Auflage. • Maschinenelemente, Pahl, G.; Seitz, W., Springer-Verlag, aktuelle Auflage. • Maschinenelemente 1-2; Schicht, B., Pearson Verlag, aktuelle Auflage. • Maschinenelemente 1-2; Schicht, B., Pearson Verlag, aktuelle Auflage. • Maschinenelemente 1-2; Schicht, B., Pearson Verlag, aktuelle Auflage. • Maschinenelemente 1-2; Schicht, B., Pearson Verlag, aktuelle Auflage. • Maschinenelemente 1-2; Schicht, B., Pearson Verlag, aktuelle Auflage. • Maschinenelemente 1-2; Schicht, B., Pearson Verlag, aktuelle Auflage. • Maschinenelemente 1-2; Schicht, B., Pearson Verlag, aktuelle Auflage. • RoloffMatek Moschinenelemente: Wittel, H., Muhs, D., Jannasch, D., Vößlek, J., Springer Verlag, aktuelle Auflage.	Тур	Lecture				
Independent Study Time 32, Study Time in Lecture 28   Lecture   Elanguage   DE	Hrs/wk	2				
Lecture  Language DE  Cycle SoSo  Content  Advanced Mechanical Engineering Design I & II  Lecture  Fundamentals of the following machine elements:  Linear rolling bearings  Axes & shafts  Seals  Citiches & brakes  Belt & chain drives  Gear drives  Siding bearings  Elements of fluidics  Exercise  Cutches & shafts  Cutches & shafts  Cutches & brakes  Belt & chain drives  Citank drives  Siding bearings  Elements of fluidics  Exercise  Cutches & shafts  Cutches & shafts  Cutches & brakes  Belt & chain drives  Siding bearings  Elements of fluidics  Exercise  Cutches & brakes  Belt & chain drives  Cutches & brakes  Belt & chain drives  Carak dayses  Carak dayses  Carak dayses  Belt & chain drives  Carak dayses  Carak dayses  Belt & chain drives  Belt & chain drives  Carak dayses  Belt & chain drives  Belt & chain drives  Carak dayses  Belt & chain drives  Belt & chain drives  Carak dayses  Belt & chain drives  Belt & chain drives  Carak dayses  Belt & chain drives  Belt & chain drives  Carak drives  Belt & chain drives  Belt & chain drives  Carak drives  Belt & chain drives  B	СР	2				
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  • Epicyclic gears  • Crank drives  • Siding bearings  • Elements of fluidics  Exercise  • Calculation methods of the following machine elements:  • Linear rolling bearings  • Elements of fluidics  Exercise  • Calculation methods of the following machine elements:  • Linear rolling bearings  • Axes & shafts  • Clutches & brakes  • Belt & Chain drives  • Gear drives  • Belt & Chain drives  • Gear drives  • Epicyclic gears  • Crank gears  • Silding bearings  • Clack gears  • Silding bearings  • Clack gears  • Silding bearings  • Cank gears  • Cank gears  • Silding bearings  • Cank gears  • Silding bearings  • Cank gears  • S	Workload in Hours	Independent Study Time 32, Study Time in Lecture 28				
Content  Advanced Mechanical Engineering Design 1 & II  Lecture  • Fundamentals of the following machine elements:  • Linear rolling bearings  • Axes & shafts  • Seals  • Clutches & brakes  • Belt & chain drives  • Epicyclic gears  • Crank drives  • Sliding bearings  • Elements of fluidics  Exercise  • Calculation methods of the following machine elements:  • Linear rolling bearings  • Elements of fluidics  Exercise  • Calculations of the following machine elements:  • Linear rolling bearings  • Axes & shafts  • Clutches & brakes  • Belt & chain drives  • Siding bearings  • Crank gears  • Siding bearings  • Calculations of hydrostatic systems (fluidics)  Literature  • Dubbel, Taschenbuch für den Maschinenbau; Grote, KH., Feldhusen, J.(Hrsg.); Springer-Verlag, aktuelle Auflage.  • Maschinenelemente, Band -Ill; Niemann, G., Springer-Verlag, aktuelle Auflage.  • Maschinenelemente, Band -Ill; Niemann, G., Springer-Verlag, aktuelle Auflage.  • Maschinenelemente, Beand -Ill; Niemann, G., Springer-Verlag, aktuelle Auflage.  • Maschinenelemente, Beand -Ill; Niemann, G., Springer-Verlag, aktuelle Auflage.  • Maschinenelemente, Beand -Ill; Niemann, G., Springer-Verlag, aktuelle Auflage.  • Maschinenelemente - Castaltung, Berechnung, Anwendung; Haberhauer, H., Bodenstein, F., Springer-Verlag, aktuelle Auflage.  • Maschinenelemente - Gestaltung, Berechnung, Anwendung; Haberhauer, H., Bodenstein, F., Springer-Verlag, aktuelle Auflage.  • Roloff/Matek Maschinenelemente; Wittel, H., Muhs, D., Jannasch, D., Voßlek, J., Springer Vieweg, aktuelle Auflage.	Lecturer	Prof. Dieter Krause, Prof. Otto von Estorff				
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 Bilding bearings Elements of fluidics  Exercise  Carculation methods of the following machine elements: Linear rolling bearings Axes & shafts Clutches & brakes Belt & Chain drives Belt & Chain drives Gear drives Belt & Chain drives Gear drives Belt & Chain drives Gear drives Belt & Chain drives Belt & Chain drives Gear drives Belt & Chain drives Be	Language	DE				
Lecture  • Fundamentals of the following machine elements:  • Linear rolling bearings  • Axes & shafts  • Seals  • Clutches & brakes  • Belt & chain drives  • Cear drives  • Sliding bearings  • Ilements of fluidics  Exercise  • Calculation methods of the following machine elements:  • Linear rolling bearings  • Elements of fluidics  Exercise  • Calculation methods of the following machine elements:  • Linear rolling bearings  • Axes & shafts  • Clutches & brakes  • Belt & chain drives  • Belt & chain drives  • Belt & chain drives  • Gear drives  • Eyercic gears  • Crank gears  • Crank gears  • Crank gears  • Sliding bearings  • Literature  Literature  Literature  Literature  Literature  Literature  Literature  Literature  Literature  Asschinenelemente, Band I-III; Niemann, G., Springer-Verlag, aktuelle Auflage.  • Maschinenelemente, Band I-III; Niemann, G., Springer-Verlag, aktuelle Auflage.  • Maschinenelemente, Band I-III; Niemann, G., Springer-Verlag, aktuelle Auflage.  • Maschinenelemente, Band I-III, Niemann, G., Springer-Verlag, aktuelle Auflage.  • Maschinenelemente, Band I-III, Niemann, G., Springer-Verlag, aktuelle Auflage.  • Maschinenelemente, Band I-III, Niemann, G., Springer-Verlag, aktuelle Auflage.  • Maschinenelemente I-2; Schlecht, B., Pearson Verlag, aktuelle Auflage.  • Maschinenelemente I-2; Schlecht, B., Pearson Verlag, aktuelle Auflage.  • Maschinenelemente - Gestaltung, Berechnung, Anwendung; Haberhauer, H., Bodenstein, F., Springer-Verlag, aktuelle Auflage.  • Roloff/Matek Maschinenelemente; Wittel, H., Muhs, D., Jannasch, D., Voßiek, J., Springer Vieweg, aktuelle Auflage.  • Roloff/Matek Maschinenelemente; Wittel, H., Muhs, D., Jannasch, D., Voßiek, J., Springer Vieweg, aktuelle Auflage.	Cycle	SoSe SoSe				
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Literature  Liter		Lecture				
Axes & shafts Seals Clutches & brakes Belt & chain drives Gear drives Fliptyclic gears Crank drives Sliding bearings Elements of fluidics  Exercise  Calculation methods of the following machine elements: Literature  Clutches & brakes Belt & Chain drives Belt & Chai		Fundamentals of the following machine elements:				
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<ul> <li>Belt &amp; chain drives</li> <li>Gear drives</li> <li>Epicyclic gears</li> <li>Crank drives</li> <li>Sliding bearings</li> <li>Elements of fluidics</li> <li>Exercise</li> <li>Calculation methods of the following machine elements: <ul> <li>Linear rolling bearings</li> <li>Axes &amp; shafts</li> <li>Clutches &amp; brakes</li> <li>Belt &amp; chain drives</li> <li>Gear drives</li> <li>Epicyclic gears</li> <li>Crank gears</li> <li>Sliding bearings</li> </ul> </li> <li>Literature</li> <li>Dubbel, Taschenbuch für den Maschinenbau; Grote, KH., Feldhusen, J.(Hrsg.); Springer-Verlag, aktuelle Auflage.</li> <li>Maschinen-elemente, Band I-Ill; Niemann, G., Springer-Verlag, aktuelle Auflage.</li> <li>Maschinen-elemente, Band I-Ill; Niemann, G., Springer-Verlag, aktuelle Auflage.</li> <li>Einführung in die DIN-Normen; Klein, M., Teubner-Verlag.</li> <li>Konstruktionslehre, Pahl, G.; Beitz, W., Springer-Verlag, aktuelle Auflage.</li> <li>Maschinenelemente 1-2; Schlecht, B., Pearson Verlag, aktuelle Auflage.</li> <li>Maschinenelemente 1 - Gestaltung, Berechnung, Anwendung; Haberhauer, H., Bodenstein, F., Springer-Verlag, aktuelle Auflage.</li> <li>Maschinenelemente 1 - 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>		Seals				
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 Fipicyclic gears Crank gears Crank gears Crank gears Crank gears Eldiding bearings Calculations of hydrostatic systems (fluidics)  Literature  Literature  Literature  Literature  Literature  Figure Amachinenelemente, Band I-III; Niemann, G., Springer-Verlag, aktuelle Auflage. Maschinenelemente, Band I-III; Niemann, G., Springer-Verlag, aktuelle Auflage. Maschinenelemente, Band I-III, Niemann, G., Springer-Verlag, aktuelle Auflage. Maschinenelemente, Selin, M., Teubner-Verlag. Konstruktionslehre, Pahl, G.; Beitz, W., Springer-Verlag, aktuelle Auflage. Maschinenelemente 1-2; Schlecht, B., Pearson Verlag, aktuelle Auflage. Maschinenelemente - Gestaltung, Berechnung, Anwendung; Haberhauer, H., Bodenstein, F., Springer-Verlag, aktuelle Auflage. Maschinenelemente - Gestaltung, Berechnung, Anwendung; Haberhauer, H., Bodenstein, F., Springer-Verlag, aktuelle Auflage. Roloff/Matek Maschinenelemente; Wittel, H., Muhs, D., Jannasch, D., Voßiek, J., Springer Vieweg, aktuelle Auflage.						
Epicyclic gears						
Crank drives Sliding bearings Exercise  Calculation methods of the following machine elements: Linear rolling bearings Axes & shafts Clutches & brakes Belt & chain drives Belt & chain drives Gear drives Expicyclic gears Crank gears Sliding bearings Calculations of hydrostatic systems (fluidics)  Literature  Literature  Dubbel, Taschenbuch für den Maschinenbau; Grote, KH., Feldhusen, J.(Hrsg.); Springer-Verlag, aktuelle Auflage. Maschinenelemente, Band I-III; Niemann, G., Springer-Verlag, aktuelle Auflage. Maschinen- und Konstruktionselemente; Steinhilper, W., Röper, R., Springer Verlag, aktuelle Auflage. Einführung in die DIN-Normen; Klein, M., Teubner-Verlag. Konstruktionslehre, Pahl, G.; Beitz, W., Springer-Verlag, aktuelle Auflage. Maschinenelemente 1-2; Schlecht, B., Pearson Verlag, aktuelle Auflage. Maschinenelemente - Gestaltung, Berechnung, Anwendung; Haberhauer, H., Bodenstein, F., Springer-Verlag, aktuelle Auflage. Roloff/Matek Maschinenelemente; Wittel, H., Muhs, D., Jannasch, D., Voßiek, J., Springer Vieweg, aktuelle Auflage.						
Sliding bearings Exercise  Calculation methods of the following machine elements: Linear rolling bearings Axes & shafts Clutches & brakes Belt & chain drives Belt & chain drives Gear drives Sliding bearings Crank gears Sliding bearings Calculations of hydrostatic systems (fluidics)  Literature  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. Maschinenelemente, Band I-III; Niemann, G., Springer-Verlag, aktuelle Auflage. Einführung in die DIN-Normen; Klein, M., Teubner-Verlag. Konstruktionslehre, Pahl, G.; Beitz, W., Springer-Verlag, aktuelle Auflage. Maschinenelemente 1-2; Schlecht, B., Pearson Verlag, aktuelle Auflage. Maschinenelemente - Gestaltung, Berechnung, Anwendung; Haberhauer, H., Bodenstein, F., Springer-Verlag, aktuelle Auflage. Roloff/Matek Maschinenelemente; Wittel, H., Muhs, D., Jannasch, D., Voßiek, J., Springer Vieweg, aktuelle Auflage.		· · · ·				
Elements of fluidics  Exercise  Calculation methods of the following machine elements: Linear rolling bearings Axes & shafts Clutches & brakes Belt & chain drives Bejricyclic gears Crank gears Sliding bearings Calculations of hydrostatic systems (fluidics)  Literature  Dubbel, Taschenbuch für den Maschinenbau; Grote, KH., Feldhusen, J.(Hrsg.); Springer-Verlag, aktuelle Auflage. Maschinenelemente, Band I-III; Niemann, G., Springer-Verlag, aktuelle Auflage. Maschinen- und Konstruktionselemente; Steinhilper, W., Röper, R., Springer Verlag, aktuelle Auflage. Einführung in die DIN-Normen; Klein, M., Teubner-Verlag. Konstruktionslehre, Pahl, G.; Beitz, W., Springer-Verlag, aktuelle Auflage. Maschinenelemente 1-2; Schlecht, B., Pearson Verlag, aktuelle Auflage. Maschinenelemente - Gestaltung, Berechnung, Anwendung; Haberhauer, H., Bodenstein, F., Springer-Verlag, aktuelle Auflage. Roloff/Matek Maschinenelemente; Wittel, H., Muhs, D., Jannasch, D., Voßiek, J., Springer Vieweg, aktuelle Auflage.						
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<ul> <li>Linear rolling bearings</li> <li>Axes &amp; shafts</li> <li>Clutches &amp; brakes</li> <li>Belt &amp; chain drives</li> <li>Gear drives</li> <li>Epicyclic gears</li> <li>Crank gears</li> <li>Sliding bearings</li> <li>Calculations of hydrostatic systems (fluidics)</li> <li>Literature</li> <li>Dubbel, Taschenbuch für den Maschinenbau; Grote, KH., Feldhusen, J.(Hrsg.); Springer-Verlag, aktuelle Auflage.</li> <li>Maschinenelemente, Band I-III; Niemann, G., Springer-Verlag, aktuelle Auflage.</li> <li>Maschinen- und Konstruktionselemente; Steinhilper, W., Röper, R., Springer Verlag, aktuelle Auflage.</li> <li>Einführung in die DIN-Normen; Klein, M., Teubner-Verlag.</li> <li>Konstruktionslehre, Pahl, G.; Beitz, W., Springer-Verlag, aktuelle Auflage.</li> <li>Maschinenelemente 1-2; Schlecht, B., Pearson Verlag, aktuelle Auflage.</li> <li>Maschinenelemente - Gestaltung, Berechnung, Anwendung; Haberhauer, H., Bodenstein, F., Springer-Verlag, aktuelle Auflage.</li> <li>Roloff/Matek Maschinenelemente; Wittel, H., Muhs, D., Jannasch, D., Voßiek, J., Springer Vieweg, aktuelle Auflage.</li> </ul>		Exercise				
<ul> <li>Axes &amp; shafts</li> <li>Clutches &amp; brakes</li> <li>Belt &amp; chain drives</li> <li>Gear drives</li> <li>Epicyclic gears</li> <li>Crank gears</li> <li>Sliding bearings</li> <li>Calculations of hydrostatic systems (fluidics)</li> </ul> Literature <ul> <li>Dubbel, Taschenbuch für den Maschinenbau; Grote, KH., Feldhusen, J.(Hrsg.); Springer-Verlag, aktuelle Auflage.</li> <li>Maschinenelemente, Band I-III; Niemann, G., Springer-Verlag, aktuelle Auflage.</li> <li>Maschinen- und Konstruktionselemente; Steinhilper, W., Röper, R., Springer Verlag, aktuelle Auflage.</li> <li>Einführung in die DIN-Normen; Klein, M., Teubner-Verlag.</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>		Calculation methods of the following machine elements:				
<ul> <li>Clutches &amp; brakes</li> <li>Belt &amp; chain drives</li> <li>Gear drives</li> <li>Epicyclic gears</li> <li>Crank gears</li> <li>Sliding bearings</li> <li>Calculations of hydrostatic systems (fluidics)</li> </ul> Literature <ul> <li>Dubbel, Taschenbuch für den Maschinenbau; Grote, KH., Feldhusen, J.(Hrsg.); Springer-Verlag, aktuelle Auflage.</li> <li>Maschinenelemente, Band I-III; Niemann, G., Springer-Verlag, aktuelle Auflage.</li> <li>Maschinen- und Konstruktionselemente; Steinhilper, W., Röper, R., Springer Verlag, aktuelle Auflage.</li> <li>Einführung in die DIN-Normen; Klein, M., Teubner-Verlag.</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>		Linear rolling bearings				
<ul> <li>Belt &amp; chain drives</li> <li>Gear drives</li> <li>Epicyclic gears</li> <li>Crank gears</li> <li>Sliding bearings</li> <li>Calculations of hydrostatic systems (fluidics)</li> <li>Literature</li> <li>Dubbel, Taschenbuch für den Maschinenbau; Grote, KH., Feldhusen, J.(Hrsg.); Springer-Verlag, aktuelle Auflage.</li> <li>Maschinenelemente, Band I-III; Niemann, G., Springer-Verlag, aktuelle Auflage.</li> <li>Maschinen- und Konstruktionselemente; Steinhilper, W., Röper, R., Springer Verlag, aktuelle Auflage.</li> <li>Einführung in die DIN-Normen; Klein, M., Teubner-Verlag.</li> <li>Konstruktionslehre, Pahl, G.; Beitz, W., Springer-Verlag, aktuelle Auflage.</li> <li>Maschinenelemente 1-2; Schlecht, B., Pearson Verlag, aktuelle Auflage.</li> <li>Maschinenelemente - Gestaltung, Berechnung, Anwendung; Haberhauer, H., Bodenstein, F., Springer-Verlag, aktuelle Auflage.</li> <li>Roloff/Matek Maschinenelemente; Wittel, H., Muhs, D., Jannasch, D., Voßiek, J., Springer Vieweg, aktuelle Auflage.</li> </ul>		Axes & shafts				
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Sowie weitere Bücher zu speziellen Themen		Sowie weitere Bücher zu speziellen Themen				

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

Course L0262: Advanced Med	chanical Engineering Design I				
Тур	Lecture				
Hrs/wk	2				
СР	2				
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28				
Language					
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:				
	<ul><li>Linear rolling bearings</li><li>Axes &amp; shafts</li></ul>				
	Clutches & brakes				
	Belt & chain drives				
	Gear drives				
	Epicyclic gears				
	Crank gears				
	Sliding bearings				
	Calculations of hydrostatic systems (fluidics)				
Literature					
	<ul> <li>Dubbel, Taschenbuch für den Maschinenbau; Grote, KH., Feldhusen, J.(Hrsg.); Springer-Verlag, aktuelle Auflage.</li> </ul>				
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	Auflage.				
	Roloff/Matek Maschinenelemente; Wittel, H., Muhs, D., Jannasch, D., Voßiek, J., Springer Vieweg, aktuelle Auflage.				
	Sowie weitere Bücher zu speziellen Themen				

Course L0263: Advanced Mechanical Engineering Design I		
Тур	Recitation Section (large)	
Hrs/wk	2	
СР	1	
Workload in Hours	Independent Study Time 2, Study Time in Lecture 28	
Lecturer	Prof. Dieter Krause, Prof. Otto von Estorff	
Language	DE	
Cycle	WiSe	
Content	See interlocking course	
Literature	See interlocking course	

Module M0680: Fluid	Dynamics			
Courses				
Title		Тур	Hrs/wk	СР
Fluid Mechanics (L0454)		Lecture	3	4
Fluid Mechanics (L0455)		Recitation Section (large)	2	2
Module Responsible	Prof. Thomas Rung			
Admission Requirements	None			
Recommended Previous	Sound knowledge of engineering mathematics, engineer	ering mechanics and thermodynamics.		
Knowledge				
<b>Educational Objectives</b>	After taking part successfully, students have reached the	ne following learning results		
Professional Competence				
Knowledge	Students will have the required sound knowledge to	explain the general principles of flui	d engineering a	nd physics of fluids.
	Students can scientifically outline the rationale of flow	physics using mathematical models a	and are familiar v	vith methods for the
	performance analysis and the prediciton of fluid engine	ering devices.		
Skills	Students are able to apply fluid-engineering principles	and flow-physics models for the analy	sis of technical	systems. The lecture
Skiiis	enables the student to carry out all necessary theore			-
	scientific level.			
Personal Competence				
Social Competence	The students are able to discuss problems and jointly develop solution strategies.			
Autonomy	The students are able to develop solution strategies for	complex problems self-consistent and	crtically analyse	results.
Workload in Hours	Independent Study Time 110, Study Time in Lecture 70	)		
Credit points	6			
Course achievement	None			
Examination	Written exam			
Examination duration and	180 min			
scale				
Assignment for the	General Engineering Science (German program, 7 seme	ester): Specialisation Mechanical Engin	eering: Compulso	ory
Following Curricula	General Engineering Science (German program, 7 seme	ester): Specialisation Biomedical Engine	eering: Compulso	ory
	General Engineering Science (German program, 7 seme		e: Compulsory	
	Mechanical Engineering: Core Qualification: Compulsor	У		
	Naval Architecture: Core Qualification: Compulsory			
	Technomathematics: Specialisation III. Engineering Scientific Scie	ence: Elective Compulsory		

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

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

Module M0960: Mechanics IV (Oscillations, Analytical Mechanics, Multibody Systems, Numerical Mechanics)					
Courses					
Title		Тур	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	
-	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 reached the following learning results				
Professional Competence					
Knowledge	The students can				
	<ul> <li>describe the axiomatic procedure used in mechan</li> </ul>	ical contexts;			
	<ul> <li>explain important steps in model design;</li> </ul>				
	<ul> <li>present technical knowledge.</li> </ul>				
61.71					
SKIIIS	The students can				
	• explain the important elements of mathematical	/ mechanical analysis and model for	mation, and apply	y it to the context of	
	their own problems;				
	<ul> <li>apply basic methods to engineering problems;</li> </ul>				
	<ul> <li>estimate the reach and boundaries of the method</li> </ul>	s and extend them to be applicable t	o wider problem	sets.	
Personal Competence					
Social Competence	The students can work in groups and support each other	to overcome difficulties.			
Autonomy	Students are capable of determining their own strengths	and weaknesses and to organize the	eir time and learn	ing based on those.	
Workload in Hours	Independent Study Time 96, Study Time in Lecture 84				
Credit points	6				
Course achievement	None				
	Written exam				
Examination duration and	120 min				
scale					
Assignment for the	General Engineering Science (German program, 7 semes	-		•	
Following Curricula	General Engineering Science (German program, 7 semes			ory	
	General Engineering Science (German program, 7 semes	•	re: Compulsory		
	Energy Systems: Technical Complementary Course Core Mechanical Engineering: Core Qualification: Compulsory	Studies: Elective Compulsory			
	Mechatronics: Core Qualification: Compulsory				
	Naval Architecture: Core Qualification: Compulsory				
	Technomathematics: Specialisation III. Engineering Scien	nce: Elective Compulsory			
	Theoretical Mechanical Engineering: Technical Complem		Compulsorv		
		,			

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

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

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

odule M0956: Measu	rement Technology for Mecha	anical Enginee	rs		
ourses					
ctle actical Course: Measurement and assurement Technology for Mecha assurement Technology for Mecha	nical Engineering (L1116)		Typ Practical Course Lecture Recitation Section (large)	Hrs/wk 2 2 1	CP 2 3 1
Module Responsible	Prof. Thorsten Kern				
	None				
-	Basic knowledge of physics, chemistry and e	electrical engineering			
Educational Objectives	After taking part successfully, students have	e reached the following	ng learning results		
Professional Competence			· · · · · · · · · · · · · · · · · · ·		
	Students are able to name the most import Calibration, Static and Dynamic Properties of They can outline the most important meas Temperature, mechanical quantities, Flow, They can describe important methods of che	of Sensors and Syster uring methods for di Time, Frequency).	ms). fferent kinds of quantities	to be maesured (	Electrical Quantities
	Students can select suitable measuring metl The students are able to orally explain issue place the issues into the right context and a	es in the subject area			
Personal Competence					
-	Students can arrive at work results in groups	s and document them	n in a common report.		
Autonomy	Students are able to familiarize themselves	with new measureme	ent technologies.		
Workload in Hours	Independent Study Time 110, Study Time in	Lecture 70			
Credit points	6				
course demicrement	Compulsory Bonus Form Yes None Subject theoretical practical work	<b>Description</b> I and			
Examination	Subject theoretical and practical work				
Examination duration and scale	105 minutes				
Following Curricula	General Engineering Science (German progr General Engineering Science (German progr General Engineering Science (German progr Digital Mechanical Engineering: Core Qualific Energy and Environmental Engineering: Core Engineering Science: Specialisation Mechani Engineering Science: Specialisation Mechani Engineering Science: Specialisation Biomedi Engineering Science (English progra General Engineering Science (English progra Logistics and Mobility: Specialisation Product Mechanical Engineering: Core Qualification: Mechatronics: Core Qualification: Compulsor	ram, 7 semester): Spe ram, 7 semester): Spe cation: Compulsory e Qualification: Comp ronics: Compulsory ical Engineering: Com cal Engineering: Elec- ted Materials: Elective am, 7 semester): Spe am, 7 semester): Spe am, 7 semester): Spe am, 7 semester): Spe am, 7 semester): Compulsory	ecialisation Biomedical Eng ecialisation Advanced Mate oulsory inpulsory tive Compulsory Compulsory cialisation Mechatronics: Co cialisation Mechanical Engi cialisation Biomedical Engi d Processes: Elective Comp	ineering: Compulso rials: Elective Com ompulsory neering: Compulso neering: Elective C oulsory	ory pulsory ry ompulsory
	Mechatronics: Core Qualification: Compulsor Engineering and Management - Major in Lo Compulsory	-	: Specialisation Production	ı Management and	ΙP

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

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

## **Focus Biomechanics**

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

Module M1277: MED I	l: Introduction to Anatomy
Courses	
Title	Typ Hrs/wk CP
Introduction to Anatomy (L0384)	Lecture 2 3
Module Responsible	Prof. Udo Schumacher
Admission Requirements	None
Recommended Previous	None
Knowledge	
<b>Educational Objectives</b>	After taking part successfully, students have reached the following learning results
<b>Professional Competence</b>	
Knowledge	The students can describe basal structures and functions of internal organs and the musculoskeletal system.
	The students can describe the basic macroscopy and microscopy of those systems.
Skille	The students can recognize the relationship between given anatomical facts and the development of some common diseases; the
Skills	can explain the relevance of structures and their functions in the context of widespread diseases.
	can expand the relevance of structures and their ranctions in the context of macaginate absolutes.
Personal Competence	
Social Competence	The students can participate in current discussions in biomedical research and medicine on a professional level.
Autonomy	The students are able to access anatomical knowledge by themselves, can participate in conversations on the topic and acquir
	the relevant knowledge themselves.
	Independent Study Time 62, Study Time in Lecture 28
Credit points	
Course achievement	
Examination	
Examination duration and	90 minutes
scale	
Assignment for the	
Following Curricula	
	Compulsory  Data Science: Specialisation Medicine: Compulsory
	Electrical Engineering: Specialisation Medical Technology: Elective Compulsory
	Engineering Science: Specialisation Biomedical Engineering: Compulsory
	General Engineering Science (English program, 7 semester): Specialisation Biomedical Engineering: Compulsory
	Mechanical Engineering: Specialisation Biomechanics: Compulsory
	Biomedical Engineering: Specialisation Medical Technology and Control Theory: Elective Compulsory
	Biomedical Engineering: Specialisation Management and Business Administration: Elective Compulsory
	Biomedical Engineering: Specialisation Artificial Organs and Regenerative Medicine: Elective Compulsory
	Biomedical Engineering: Specialisation Implants and Endoprostheses: Elective Compulsory
	Technomathematics: Specialisation III. Engineering Science: Elective Compulsory

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

Module M1278: MED	
Courses	
<b>Fitle</b> ntroduction to Radiology and Radi	Typ Hrs/wk CP iation Therapy (L0383) Lecture 2 3
Module Responsible	
Admission Requirements	
Recommended Previous	None
Knowledge	
Educational Objectives Professional Competence	
Knowledge	
	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 base concepts of projection radiography, including angiography and mammography, a well as sectional imaging techniques (CT, MRT, US).
	The students can explain the diagnostic as well as therapeutic use of imaging techniques, as well as the technical basis for thos techniques.
	The students can choose the right treatment method depending on the patient's clinical history and needs.
	The student can explain the influence of technical errors on the imaging techniques.
	The student can draw the right conclusions based on the images' diagnostic findings or the error protocol.
Skills	Therapy The students can distinguish curative and palliative situations and motivate why they came to that conclusion.
	The students can develop adequate therapy concepts and relate it to the radiation 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, psycho-oncology).
	Diagnostics
	The students can suggest solutions for repairs of imaging instrumentation after having done error analyses.
	The students can classify results of imaging techniques according to different groups of diseases based on their knowledge anatomy, pathology and pathophysiology.
Personal Competence	
•	The students can assess the special social situation of tumor patients and interact with them in a professional way.  The students are aware of the special, often fear-dominated behavior of sick people caused by diagnostic and therapeut measures and can meet them appropriately.
Autonomy	The students can apply their new knowledge and skills to a concrete therapy case.  The students can introduce younger students to the clinical daily routine.
	The students are able to access anatomical knowledge by themselves, can participate competently in conversations on the top and acquire the relevant knowledge themselves.
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Credit points	
Course achievement	
Examination	
Examination duration and scale	
Assignment for the	General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Biomechanic
Assignment for the Following Curricula	School Engineering Science (Science Societies), Specialisation (Science Inglifering), Science Inglifering
-	Compulsory
-	Compulsory Data Science: Specialisation Medicine: Compulsory
-	Compulsory
-	Compulsory  Data Science: Specialisation Medicine: Compulsory  Electrical Engineering: Specialisation Medical Technology: Elective Compulsory  Engineering Science: Specialisation Biomedical Engineering: Compulsory  General Engineering Science (English program, 7 semester): Specialisation Biomedical Engineering: Compulsory
-	Compulsory  Data Science: Specialisation Medicine: Compulsory  Electrical Engineering: Specialisation Medical Technology: Elective Compulsory  Engineering Science: Specialisation Biomedical Engineering: Compulsory  General Engineering Science (English program, 7 semester): Specialisation Biomedical Engineering: Compulsory  Mechanical Engineering: Specialisation Biomechanics: Compulsory
-	Compulsory  Data Science: Specialisation Medicine: Compulsory  Electrical Engineering: Specialisation Medical Technology: Elective Compulsory  Engineering Science: Specialisation Biomedical Engineering: Compulsory  General Engineering Science (English program, 7 semester): Specialisation Biomedical Engineering: Compulsory
-	Compulsory  Data Science: Specialisation Medicine: Compulsory  Electrical Engineering: Specialisation Medical Technology: Elective Compulsory  Engineering Science: Specialisation Biomedical Engineering: Compulsory  General Engineering Science (English program, 7 semester): Specialisation Biomedical Engineering: Compulsory  Mechanical Engineering: Specialisation Biomechanics: Compulsory  Biomedical Engineering: Specialisation Medical Technology and Control Theory: Elective Compulsory

Technomathematics: Specialisation III. Engineering Science: Elective Compulsory

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

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 (small)	2	3
Module Responsible	Prof. Sabine Le Borne			
Admission Requirements	None			
Recommended Previous	Makhamatil I I I for Engineering Chudonto / garren	n or anglish) or Analysis C Linear Ale	vobvol i II for To	ah na maath a maati ai a na
Knowledge	Mathematik I + II for Engineering Students (germa     basic MATLAB/Python knowledge	in or english) <b>or</b> Analysis & Linear Alg	gebra i + ii ior i e	echnomathematicians
Educational Objectives	After taking part successfully, students have reached the	following learning results		
Professional Competence				
Knowledge	Students are able to			
	name numerical methods for interpolation, integral problems and to explain their core ideas,     repeat convergence statements for the numerical     explain aspects for the practical execution of num	methods,		
Skills	Students are able to			
	implement, apply and compare numerical method     justify the convergence behaviour of numerical method     select and execute a suitable solution approach for	ethods with respect to the problem a	nd solution algor	ithm,
Personal Competence				
Social Competence	Students are able to			
	work together in heterogeneously composed team explain theoretical foundations and support each of			
Autonomy	Students are capable			
	to assess whether the supporting theoretical and p     to assess their individual progess and, if necessary		individually or ir	a team,
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56			
Credit points				
Course achievement				
Examination	Written exam			
Examination duration and				
scale				
Assignment for the	General Engineering Science (German program, 7 semes	ter): Specialisation Computer Science	e: Compulsory	
_	General Engineering Science (German program, 7 semes			ory
	General Engineering Science (German program, 7 sc Compulsory General Engineering Science (German program, 7 semes Engineering: Compulsory General Engineering Science (German program, 7 ser Engineering: Elective Compulsory General Engineering Science (German program, 7 semes	ster): Specialisation Mechanical Engir	neering, Focus Th	neoretical Mechanical cus Aircraft Systems
	Compulsory General Engineering Science (German program, 7 ser Elective Compulsory General Engineering Science (German program, 7 semes	ter): Specialisation Advanced Materia	als: Compulsory	
	General Engineering Science (German program, 7 : Engineering Sciences: Compulsory Bioprocess Engineering: Specialisation A - General Biopro	ocess Engineering: Elective Compulso	ory	Focus Materials in
	Computer Science: Specialisation II. Mathematics and En Data Science: Core Qualification: Compulsory Electrical Engineering: Core Qualification: Elective Compu Engineering Science: Core Qualification: Compulsory		n y	
	Engineering Science: Core Qualification: Compulsory Computer Science in Engineering: Core Qualification: Cor Mechanical Engineering: Specialisation Theoretical Mechanical Engineering: Specialisation Theoretical Mechanic			
	Mechanical Engineering: Specialisation Energy Systems: Theoretical Mechanical Engineering: Technical Compleme Process Engineering: Specialisation Process Engineering:	Elective Compulsory entary Course Core Studies: Elective	Compulsory	

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

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

Module M1279: MED	II: Introduction to Biochemist	ry and Molecular Biology		
Courses				
<b>Title</b> Introduction to Biochemistry and M	olecular Biology (L0386)	<b>Typ</b> Lecture	Hrs/wk	<b>CP</b> 3
Module Responsible	Prof. Hans-Jürgen Kreienkamp			
Admission Requirements	None			
Recommended Previous	None			
Knowledge				
<b>Educational Objectives</b>	After taking part successfully, students have	ve reached the following learning results		
Professional Competence				
Knowledge	The students can			
	<ul> <li>describe basic biomolecules;</li> </ul>			
	explain how genetic information is compared to the second of the se	roded in the DNA:		
	explain flow genetic information is construction between DN.			
	- explain the connection between bit	A una processo,		
Skills	The students can			
	recognize the importance of molecular	llar parameters for the course of a disease;		
	describe selected molecular-diagnose			
	explain the relevance of these process.			
Personal Competence				
Social Competence	The students can participate in discussions	s in research and medicine on a technical lev	rel.	
	Students will have an improved understa	anding of current medical problems (e.g. Co	prona pandemic)and will	be able to explain
	these issues to others.	, , , , , , , , , , , , , , , , , , ,		
Autonomy	The students can develop an understandir	ng of topics from the course, using technical I	literature, by themselves.	
	Students will be better equipped to recogn	nize fake news in the media regarding medica	al research topics.	
Workload in Hours	Independent Study Time 62, Study Time in	n Lecture 28		
Credit points				
Course achievement				
Examination				
Examination duration and	60 minutes			
scale				
Assignment for the		gram, 7 semester): Specialisation Biomedical		
Following Curricula		program, 7 semester): Specialisation Mec	nanical Engineering, Fo	cus Biomechanics:
	Compulsory Electrical Engineering: Specialisation Medi	cal Tachnology: Floctive Compulsory		
	Engineering Science: Specialisation Biome			
		gram, 7 semester): Specialisation Biomedical	Engineering: Compulsory	
	Mechanical Engineering: Specialisation Bio	• •	gccg. compaisory	
	, , , , , , , , , , , , , , , , , , ,	nagement and Business Administration: Elect	tive Compulsory	
		ificial Organs and Regenerative Medicine: Ele		
		dical Technology and Control Theory: Elective		
	,	plants and Endoprostheses: Elective Compuls		
	Technomathematics: Specialisation III. Eng	gineering Science: Elective Compulsory		
			sory	

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

Module M1333: BIO I:	Implants and Fracture Healing			
Courses				
Title	Тур		Hrs/wk	СР
Implants and Fracture Healing (L03	R76) Lectur	re	2	3
Module Responsible	Prof. Michael Morlock			
Admission Requirements	None			
Recommended Previous	It is recommended to participate in "Introduction into Anatomie" before	attending "Implants and F	racture Healing	".
Knowledge				
<b>Educational Objectives</b>	After taking part successfully, students have reached the following lear	ning results		
Professional Competence				
Knowledge	The students can describe the different ways how bones heal, and the	requirements for their exis	tence.	
	The students can name different treatments for the spine and hollow b	ones under given fracture	morphologies.	
Skills	The students can determine the forces acting within the human body u	nder quasi-static situations	s under specific	assumptions.
		4		
Personal Competence				
Social Competence	The students can, in groups, solve basic numerical modeling tasks for t	the calculation of internal for	orces.	
Autonomy	The students can, in groups, solve basic numerical modeling tasks for t	the calculation of internal fo	orces.	
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): Spe	ecialisation Mechanical Er	ngineering, Foci	us Biomechanics:
Following Curricula	Compulsory			
	General Engineering Science (German program, 7 semester): Specialisa	_	ng: Compulsory	
	Engineering Science: Specialisation Biomedical Engineering: Compulsor	•		
	General Engineering Science (English program, 7 semester): Specialisa	tion Biomedical Engineerin	g: Compulsory	
	Mechanical Engineering: Specialisation Biomechanics: Compulsory	The ather Comments and		
	Biomedical Engineering: Specialisation Implants and Endoprostheses: E		mulaam.	
	Biomedical Engineering: Specialisation Artificial Organs and Regenerati			
	Biomedical Engineering: Specialisation Management and Business Adm Biomedical Engineering: Specialisation Medical Technology and Control	·	-	
	Orientation Studies: Core Qualification: Elective Compulsory	Theory. Liective compuls	J. y	
	Technomathematics: Specialisation III. Engineering Science: Elective Co	ompulsorv		

Course L0376: Implants and	Fracture Healing
Тур	Lecture
Hrs/wk	
CP	
	Independent Study Time 62, Study Time in Lecture 28  Prof. Michael Morlock
Language	
Cycle	
Content	Topics to be covered include:
	Introduction (history, definitions, background importance)
	2. Bone (anatomy, properties, biology, adaptations in femur, tibia, humerus, radius)
	3. Spine (anatomy, biomechanics, function, vertebral bodies, intervertebral disc, ligaments)
	3.1 The spine in its entirety
	3.2 Cervical spine
	3.3 Thoracic spine
	3.4 Lumbar spine
	3.5 Injuries and diseases
	4. Pelvis (anatomy, biomechanics, fracture treatment)
	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

Module M0730: Comp	outer Engineering			
Courses				
Title		Тур	Hrs/wk	СР
Computer Engineering (L0321)		Lecture	3	4
Computer Engineering (L0324)		Recitation Section (small)	1	2
Module Responsible	Prof. Heiko Falk			
Admission Requirements	None			
Recommended Previous	Basic knowledge in electrical engineering			
Knowledge				
Educational Objectives	After taking part successfully, students have reached the follow	ving learning results		
Professional Competence				
Knowledge	This module deals with the foundations of the functionality of	f computing systems. It covers	the layers from	the assembly-level
	programming down to gates. The module includes the following	g topics:		
	• Introduction			
	Combinational logic: Gates, Boolean algebra, Boolean fu		nbinational netv	vorks
	Sequential logic: Flip-flops, automata, systematic hardw  Tasks alexical foundations	are design		
	Technological foundations     Computer arithmetic Integer addition, subtraction, multi-	inlication and division		
	Computer arithmetic: Integer addition, subtraction, mult     Paging of computer architecture: Programming models.		nolining	
	Basics of computer architecture: Programming models,     Memories: Memory hierarchies, SRAM, DRAM, caches	MF5 Sifigle-Cycle architecture, pr	penning	
	Input/output: I/O from the perspective of the CPU, princi	oles of passing data point-to-poi	nt connections	husses
	impulyoutput. No from the perspective of the cro, princi	oles of passing data, point-to-por	nic connections,	busses
Skills	The students perceive computer systems from the architect's p	perspective, i.e., they identify the	e internal struct	ure and the physical
	composition of computer systems. The students can analyze, h	now highly specific and individua	l computers car	n be built based on a
	collection of few and simple components. They are able to di	stinguish between and to explain	n the different a	abstraction layers of
	today's computing systems - from gates and circuits up to com	plete processors.		
	After successful completion of the module, the students are	able to judge the interdenender	ncies hetween :	a physical computer
	system and the software executed on it. In particular, they should be software executed on it.			
	on the hardware-centric abstraction layers from the assembly			
	the impact that these low abstraction levels have on an entire			
		.,,.		,
Personal Competence				
Social Competence	Students are able to solve similar problems alone or in a group	and to present the results accor	dingly.	
Autonomy	Students are able to acquire new knowledge from specific liter	ature and to associate this knowl	edge with other	r classes.
,				
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56			
Credit points	6			
Course achievement	Compulsory Bonus Form Description Yes 10 % Excercises			
F				
Examination	Written exam			
_	90 minutes, contents of course and labs			
scale				
Assignment for the		•		
Following Curricula	General Engineering Science (German program, 7 semest	er): Specialisation Mechanical	Engineering, F	ocus Mechatronics:
	Compulsory	N. Cracialization Machanical Fu	animanuina Fan	us Airereft Customs
	General Engineering Science (German program, 7 semeste Engineering: Compulsory	). Specialisation Mechanical El	igineering, roc	us Aliciait systems
	General Engineering Science (German program, 7 semester): 9	Specialisation Mechanical Engine	ering Focus Th	eoretical Mechanical
	Engineering: Compulsory	pecialisation ricellatical Engine	ering, rocus rii	coretical Mechanical
	General Engineering Science (German program, 7 semes	ter): Specialisation Mechanical	Engineering.	Focus Materials in
	Engineering Sciences: Compulsory	ter, opecianouton ricenamea	2.19.1.00111.97	rocus riaceriais iii
	General Engineering Science (German program, 7 semester):	Specialisation Mechanical Engine	eering, Focus P	roduct Development
	and Production: Compulsory			
	General Engineering Science (German program, 7 semester	): Specialisation Mechanical En	igineering, Foci	us Energy Systems:
	Compulsory			
	General Engineering Science (German program, 7 semest	er): Specialisation Mechanical	Engineering, F	ocus Biomechanics:
	Compulsory			
	General Engineering Science (German program, 7 semester): S	pecialisation Electrical Engineeri	ng: Compulsory	,
	General Engineering Science (German program, 7 semester): S	pecialisation Green Technologies	s, Focus Renewa	able Energy: Elective
	Compulsory			
	Computer Science: Core Qualification: Compulsory			
	Data Science: Core Qualification: Elective Compulsory			
	Data Science: Specialisation I. Mathematics/Computer Science:	Elective Compulsory		
	Electrical Engineering: Core Qualification: Compulsory			
	Computer Science in Engineering: Core Qualification: Compulso			
	Integrated Building Technology: Core Qualification: Elective Co			
	Technomathematics: Specialisation II. Informatics: Elective Cor	npulsory		

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

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

Module M1280: MED I	II: Introduction to Physiology
Courses	
Title	Typ Hrs/wk CP
Introduction to Physiology (L0385)	Lecture 2 3
Module Responsible	Dr. Roger Zimmermann
Admission Requirements	None
Recommended Previous	None
Knowledge	
Educational Objectives	After taking part successfully, students have reached the following learning results
Professional Competence	
Knowledge	The students can
	describe the basics of the energy metabolism;
	describe physiological relations in selected fields of muscle, heart/circulation, neuro- and sensory physiology.
2	
Skills	The students can describe the effects of basic bodily functions (sensory, transmission and processing of information, developmen
Davisanal Commetence	of forces and vital functions) and relate them to similar technical systems.
Personal Competence	The students can conduct discussions in research and medicine on a technical level.
Social Competence	The students can find solutions to problems in the field of physiology, both analytical and metrological.
	The students can find solutions to problems in the field of physiology, both analytical and methological.
Autonomy	The students can derive answers to questions arising in the course and other physiological areas, using technical literature, b
	themselves.
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Credit points	3
Course achievement	None
Examination	Written exam
Examination duration and	60 minutes
scale	
Assignment for the	General Engineering Science (German program, 7 semester): Specialisation Biomedical Engineering: Compulsory
Following Curricula	General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Biomechanics
	Compulsory
	Data Science: Specialisation Medicine: Compulsory
	Electrical Engineering: Specialisation Medical Technology: Elective Compulsory
	Engineering Science: Specialisation Biomedical Engineering: Elective Compulsory  General Engineering Science (English program, 7 semester): Specialisation Biomedical Engineering: Elective Compulsory
	Mechanical Engineering: Specialisation Biomechanics: Compulsory
	Biomedical Engineering: Specialisation Medical Technology and Control Theory: Elective Compulsory
	Biomedical Engineering: Specialisation Management and Business Administration: Elective Compulsory
	Biomedical Engineering: Specialisation Artificial Organs and Regenerative Medicine: Elective Compulsory
	Biomedical Engineering: Specialisation Implants and Endoprostheses: Elective Compulsory
	Technomathematics: Specialisation III. Engineering Science: Elective Compulsory

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

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

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

Module M0934: Adva	nced Materials for Sustainabilit	у		
Courses				
Title		Тур	Hrs/wk	СР
Advanced Materials Characterization	on (L1087)	Lecture	2	2
Advanced Materials for Sustainabili	ty (L1091)	Lecture	2	2
Advanced Materials for Sustainabili	ty (L1092)	Recitation Section	on (large) 2	2
Module Responsible	Prof. Patrick Huber			
Admission Requirements	None			
Recommended Previous	Fundamentals of Materials Science (I and II)			
Knowledge				
Educational Objectives	After taking part successfully, students have	eached the following learning resu	lts	
Professional Competence				
Knowledge	The students will be able to explain the prop	erties of advanced materials along	with their applications in	technology, in particular
	metallic, ceramic, polymeric, semiconductor,	modern composite materials (biom	aterials) and nanomateria	als.
Sville	The students will be able to select material	configurations according to the	echnical needs and if n	ecessary to design new
Skills	materials considering architectural principle			
	modern materials science, which enables the			-
	modern materials selence, which endsies the	n to select optimum materials con	acpending on a	ne ceeminear appreaatorist
Personal Competence				
Social Competence	The students are able to present solutions to	specialists and to develop ideas fur	ther.	
Autonomy	The students are able to			
	assess their own strengths and weakne	SCAC		
	<ul> <li>define tasks independently.</li> </ul>			
	acime tasks maspendently.			
Workload in Hours	Independent Study Time 96, Study Time in Le	cture 84		
Credit points				
Course achievement				
Examination	Written exam			
Examination duration and				
scale				
Assignment for the	General Engineering Science (German pro	gram 7 semester): Specialisatio	n Mechanical Engineerin	ng Focus Biomechanics:
Following Curricula		gram, 7 semester, specialisatio	recilamear Engineerin	ig, rocus Biomechamesi
<b>3</b>	General Engineering Science (German progra	m, 7 semester): Specialisation Adv	anced Materials: Compuls	ory
	General Engineering Science (German pro	•	•	*
	Engineering Sciences: Compulsory	•		
	Engineering Science: Specialisation Mechanic	al Engineering: Elective Compulsor	у	
	Engineering Science: Specialisation Advanced	Materials: Compulsory		
	Mechanical Engineering: Core Qualification: E	lective Compulsory		

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

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

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

## **Focus Energy Systems**

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

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

Courses		
<b>Fitle</b> Heat Transfer (L0458)	Typ Hrs/wk Lecture 3	<b>CP</b> 4
leat Transfer (L0459)	Recitation Section (large) 2	2
Module Responsible		
Admission Requirements		
Recommended Previous	Technical Thermodynamics I, II and Fluid Dynamics	
Knowledge		
<b>Educational Objectives</b>	After taking part successfully, students have reached the following learning results	
<b>Professional Competence</b>	e	
Knowledge	e The students can	
	- explain the technical terms,	
	- classify the various physical processes of heat transfer in terms of conduction-based and radiation-based	mecnanisms,
	- simplify and critically analyze complex heat transfer processes using models,	
	- methodically develop solutions to tasks.	
Skills	s The students are able to	
	- describe the physics of the different Heat Transfer mechanism,	
	- simplifywith models, calculate and evaluate complex Heat Transfer processes,	
	- critically question and answer statements on heat transfer,	
	enticulty question and district statements of near transfery	
	- solve excersises self-consistent and in small groups.	
Personal Competence		
Social Competence		roups in a goal-orient
Social Competence	manner, develop a solution and present it. Within the exercises, the students can independently develop	
	work out targeted solutions.	
Autonomy	The students can check their level of knowledge by means of repetition questions at the beginning of the I	ectures and describe a
	discuss answers in exchange with the other students. In the exercises, the students work in small groups of	n the methods taught
	the lectures in complex tasks and critically analyze the results in the auditorium.	
Workload in Hours	s Independent Study Time 110, Study Time in Lecture 70	
Credit points		
Course achievement		
	1 Written exam	
Examination duration and		
scale		
Assignment for the	General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering,	Focus Energy System
Following Curricula	a Compulsory	
	General Engineering Science (German program, 7 semester): Specialisation Biomedical Engineering: Comp	
	General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focu	Theoretical Mechani
	Engineering: Compulsory  Engrey Systems: Technical Complementary Course Care Studies: Elective Compulsory	
	Energy Systems: Technical Complementary Course Core Studies: Elective Compulsory Integrated Building Technology: Core Qualification: Compulsory	
	Mechanical Engineering: Specialisation Energy Systems: Compulsory	
	3 3	

Mechanical Engineering: Specialisation Theoretical Mechanical Engineering: Elective Compulsory

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

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

Module M1022: Recip	rocating Machinery			
Courses				
Title		Тур	Hrs/wk	СР
Fundamentals of Reciprocating Eng	gines and Turbomachinery - Part Reciprocating Engines (L0633)	Lecture	1	1
Fundamentals of Reciprocating Eng	gines 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)	1	2
Module Responsible	·			
Admission Requirements	None			
	Thermodynamics, Mechanics, Machine Elements			
Knowledge	After the Life of the Country of the			
	After taking part successfully, students have reached the following	owing learning results		
Professional Competence				
Knowledge	As a result of the part module "Fundamentals of Reciprocatin			-
	power and working machinery and describe the qualitative a			
	multiple types of engines, compressors and pumps. They a			·
	regarding the development of power density and efficience emissions. The students are able to select specific types of m			
	emissions. The students are able to scient specific types of the	definitery and assess design rela-	ica ana operació	iai probicinis.
	As a result of the part module "Internal Combustion Engir	nes I", the students are able re	eflect and utilize	the state-of-the-art
	regarding efficiency limits. In addition, they are able to	utilize their knowledge of desi	gn, mechanical	and thermodynamic
	characteristics and the approach of similarity. They are able	to explain, assess and develop	engines as well a	as charging systems.
	Detailed knowledge is present regarding computer-aided pro-	cess design.		
Skills	The students are skilled to employ basic and detail knowled	lge regarding reciprocating mac	hinery their sele	ection and operation
SKIIIS	They are further able to assess, analyse and solve tech			-
	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 and
	application.			
Autonomy	The widespread scope of gained knowledge enables the stud	ents to handle situations in their	r future professio	n independently and
	confidently.			
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 semest	er): Specialisation Mechanical I	Engineering, Foc	us Energy Systems:
Following Curricula	Compulsory			
	Energy and Environmental Engineering: Core Qualification: El	ective Compulsory		
	Energy Systems: Technical Complementary Course Core Stud	lies: Elective Compulsory		
	Green Technologies: Energy, Water, Climate: Specialisation E	nergy Technology: Elective Com	pulsory	
	Mechanical Engineering: Specialisation Energy Systems: Com	pulsory		

Course L0633: Fundamentals of Reciprocating Engines and Turbomachinery - Part Reciprocating Engines		
Тур	Lecture	
Hrs/wk	1	
СР	1	
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14	
Lecturer	Prof. Christopher Friedrich Wirz	
Language	DE	
Cycle	WiSe	
Content	Verbrennungsmotoren  Historischer Rückblick  Einteilung der Verbrennungsmotoren  Arbeitsverfahren  Vergleichsprozesse  Arbeit, Mitteldrücke, Leistungen  Arbeitsprozess des wirklichen Motors  Wirkungsgrade  Gemischbildung und Verbrennung  Motorkennfeld und Betriebskennlinien  Abgasentgiftung  Gaswechsel  Aufladung  Kühl- und Schmiersystem  Kräfte im Triebwerk  Kolbenverdichter  Thermodynamik des Kolbenverdichters  Einteilung und Verwendung  Kolbenpumpen  Prinzip der Kolbenpumpen	
Literature	Einteilung und Verwendung      A. Urlaub: Verbrennungsmotoren      W. Kalide: Kraft- und Arbeitsmaschinen	

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

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

Module M0730: Comp	outer Engineering			
Courses				
Title		Тур	Hrs/wk	СР
Computer Engineering (L0321)		Lecture	3	4
Computer Engineering (L0324)		Recitation Section (small)	1	2
Module Responsible	Prof. Heiko Falk			
Admission Requirements	None			
Recommended Previous	Basic knowledge in electrical engineering			
Knowledge				
Educational Objectives	After taking part successfully, students have reached the follow	ring learning results		
Professional Competence				
Knowledge	This module deals with the foundations of the functionality o	f computing systems. It covers	the layers from	the assembly-level
	programming down to gates. The module includes the following	topics:		
	• Introduction			
	Combinational logic: Gates, Boolean algebra, Boolean fu		nbinational netv	vorks
	Sequential logic: Flip-flops, automata, systematic hardw      Tasks along foundations	are design		
	Technological foundations     Computer arithmetic lateger addition subtraction multi-	inlication and division		
	Computer arithmetic: Integer addition, subtraction, mult     Regist of computer architecture: Programming models.		nolining	
	<ul> <li>Basics of computer architecture: Programming models, I</li> <li>Memories: Memory hierarchies, SRAM, DRAM, caches</li> </ul>	nirs single-cycle architecture, pr	penning	
	Input/output: I/O from the perspective of the CPU, principle.	oles of passing data point-to-poi	nt connections	husses
	impulyoutput. No from the perspective of the cro, princi	nes of passing data, point-to-por	nic connections,	busses
Skills	The students perceive computer systems from the architect's p	erspective, i.e., they identify the	e internal struct	ure and the physical
	composition of computer systems. The students can analyze, h	ow highly specific and individua	l computers car	be built based on a
	collection of few and simple components. They are able to dis	tinguish between and to explain	n the different a	abstraction layers of
	today's computing systems - from gates and circuits up to com	plete processors.		
	After successful completion of the module, the students are	able to judge the interdepender	ncies hetween a	nhysical computer
	system and the software executed on it. In particular, they sha			
	on the hardware-centric abstraction layers from the assembly			
	the impact that these low abstraction levels have on an entire			
	·		•	
Personal Competence				
Social Competence	Students are able to solve similar problems alone or in a group	and to present the results accor	dingly.	
Autonomy	Students are able to acquire new knowledge from specific litera	ature and to associate this knowl	edge with other	classes.
Workload in Hours				
Credit points	6			
Course achievement	Compulsory Bonus Form Description Yes 10 % Excercises			
Examination	Written exam			
scale	90 minutes, contents of course and labs			
Assignment for the	General Engineering Science (German program, 7 semester): S	nocialisation Computer Science:	Compulsory	
Following Curricula	General Engineering Science (German program, 7 semester). 3	•		ocus Mechatronics
rollowing curricula	Compulsory	er). Specialisation Mechanical	Liigineeriiig, i	ocus Mecharionics.
	General Engineering Science (German program, 7 semester	): Specialisation Mechanical Fr	ngineering Foc	ıs Δircraft Systems
	Engineering: Compulsory	, specialisation recitation 2	.geeg, . ee	as / in craire by seems
	General Engineering Science (German program, 7 semester): S	specialisation Mechanical Engine	ering, Focus Th	eoretical Mechanical
	Engineering: Compulsory	,	J.	
	General Engineering Science (German program, 7 semes	ter): Specialisation Mechanical	Engineering,	Focus Materials in
	Engineering Sciences: Compulsory			
	General Engineering Science (German program, 7 semester):	Specialisation Mechanical Engin	eering, Focus P	roduct Development
	and Production: Compulsory			
	General Engineering Science (German program, 7 semester	): Specialisation Mechanical En	gineering, Focu	us Energy Systems:
	Compulsory			
	General Engineering Science (German program, 7 semest	er): Specialisation Mechanical	Engineering, F	ocus Biomechanics:
	Compulsory			
	General Engineering Science (German program, 7 semester): S			
	General Engineering Science (German program, 7 semester): S	pecialisation Green Technologies	s, Focus Renewa	able Energy: Elective
	Compulsory			
	Computer Science: Core Qualification: Compulsory			
	Data Science: Core Qualification: Elective Compulsory	Elective Communication		
	Data Science: Specialisation I. Mathematics/Computer Science:	Elective Compulsory		
	Electrical Engineering: Core Qualification: Compulsory	nrv		
	Computer Science in Engineering: Core Qualification: Compulso			
	Integrated Building Technology: Core Qualification: Elective Co Technomathematics: Specialisation II. Informatics: Elective Cor			
	. coomathematics. Specialisation ii. informatics. Elective Col	.pa.501 y		

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

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

Module M0662: Nume	rical Mathematics I
Courses	
Title	Typ Hrs/wk CP
Numerical Mathematics I (L0417)	Lecture 2 3
Numerical Mathematics I (L0418)	Recitation Section (small) 2 3
Module Responsible	Prof. Sabine Le Borne
	None
Recommended Previous	• Mathematik I + II for Engineering Students (german or english) or Analysis & Linear Algebra I + II for Technomathematicians
Knowledge	basic MATLAB/Python knowledge
	Secretary, Jacob Monaege
Educational Objectives	After taking part successfully, students have reached the following learning results
Professional Competence	
Knowledge	Students are able to
	<ul> <li>name numerical methods for interpolation, integration, least squares problems, eigenvalue problems, nonlinear root finding</li> </ul>
	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 respect to computational and storage complexitx.</li> </ul>
Chille	Students are able to
SKIIIS	Students are able to
	<ul> <li>implement, apply and compare numerical methods using MATLAB/Python,</li> </ul>
	• justify the convergence behaviour of numerical methods with respect to the problem and solution algorithm,
	<ul> <li>select and execute a suitable solution approach for a given problem.</li> </ul>
	- Solect and execute a saltable solution approach for a given problem.
Personal Competence	
Social Competence	Students are able to
	<ul> <li>work together in heterogeneously composed teams (i.e., teams from different study programs and background knowledge),</li> </ul>
	explain theoretical foundations and support each other with practical aspects regarding the implementation of algorithms.
Autonomy	Students are capable
	<ul> <li>to assess whether the supporting theoretical and practical excercises are better solved individually or in a team,</li> </ul>
	to assess their individual progess and, if necessary, to ask questions and seek help.
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56
Credit points	6
Course achievement	None
Examination	Written exam
	90 minutes
Examination duration and	30 Illiliates
ceale	
scale	
Assignment for the	General Engineering Science (German program, 7 semester): Specialisation Computer Science: Compulsory
Assignment for the Following Curricula	General Engineering Science (German program, 7 semester): Specialisation Biomedical Engineering: Compulsory
Assignment for the Following Curricula	
Assignment for the Following Curricula	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 General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Biomechanics:
Assignment for the Following Curricula	General Engineering Science (German program, 7 semester): Specialisation Biomedical Engineering: Compulsory  General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Biomechanics: Compulsory
Assignment for the Following Curricula	General Engineering Science (German program, 7 semester): Specialisation Biomedical Engineering: Compulsory  General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Biomechanics:  Compulsory  General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Theoretical Mechanical
Assignment for the Following Curricula	General Engineering Science (German program, 7 semester): Specialisation Biomedical Engineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Biomechanics: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Theoretical Mechanical Engineering: Compulsory
Assignment for the Following Curricula	General Engineering Science (German program, 7 semester): Specialisation Biomedical Engineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Biomechanics: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Theoretical Mechanical Engineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Aircraft Systems
Assignment for the Following Curricula	General Engineering Science (German program, 7 semester): Specialisation Biomedical Engineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Biomechanics: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Theoretical Mechanical Engineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Aircraft Systems Engineering: Elective Compulsory
Assignment for the Following Curricula	General Engineering Science (German program, 7 semester): Specialisation Biomedical Engineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Biomechanics: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Theoretical Mechanical Engineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Aircraft Systems Engineering: Elective Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Mechatronics: Elective Compulsory
Assignment for the Following Curricula	General Engineering Science (German program, 7 semester): Specialisation Biomedical Engineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Biomechanics: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Theoretical Mechanical Engineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Aircraft Systems Engineering: Elective Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Mechatronics: Elective Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Energy Systems:
Assignment for the Following Curricula	General Engineering Science (German program, 7 semester): Specialisation Biomedical Engineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Biomechanics: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Theoretical Mechanical Engineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Aircraft Systems Engineering: Elective Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Mechatronics: Elective Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Mechatronics: Elective Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Energy Systems: Elective Compulsory
Assignment for the Following Curricula	General Engineering Science (German program, 7 semester): Specialisation Biomedical Engineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Biomechanics: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Theoretical Mechanical Engineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Aircraft Systems Engineering: Elective Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Mechatronics: Elective Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Energy Systems: Elective Compulsory General Engineering Science (German program, 7 semester): Specialisation Advanced Materials: Compulsory
Assignment for the Following Curricula	General Engineering Science (German program, 7 semester): Specialisation Biomedical Engineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Biomechanics: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Theoretical Mechanical Engineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Aircraft Systems Engineering: Elective Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Mechatronics: Elective Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Energy Systems: Elective Compulsory General Engineering Science (German program, 7 semester): Specialisation Advanced Materials: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Materials in
Assignment for the Following Curricula	General Engineering Science (German program, 7 semester): Specialisation Biomedical Engineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Biomechanics: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Theoretical Mechanical Engineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Aircraft Systems Engineering: Elective Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Mechatronics: Elective Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Energy Systems: Elective Compulsory General Engineering Science (German program, 7 semester): Specialisation Advanced Materials: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Materials in Engineering Sciences: Compulsory
Assignment for the Following Curricula	General Engineering Science (German program, 7 semester): Specialisation Biomedical Engineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Biomechanics: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Theoretical Mechanical Engineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Aircraft Systems Engineering: Elective Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Mechatronics: Elective Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Energy Systems: Elective Compulsory General Engineering Science (German program, 7 semester): Specialisation Advanced Materials: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Materials in Engineering Sciences: Compulsory Bioprocess Engineering: Specialisation A - General Bioprocess Engineering: Elective Compulsory
Assignment for the Following Curricula	General Engineering Science (German program, 7 semester): Specialisation Biomedical Engineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Biomechanics: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Theoretical Mechanical Engineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Aircraft Systems Engineering: Elective Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Mechatronics: Elective Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Energy Systems: Elective Compulsory General Engineering Science (German program, 7 semester): Specialisation Advanced Materials: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Materials in Engineering Sciences: Compulsory Bioprocess Engineering: Specialisation A - General Bioprocess Engineering: Elective Compulsory Computer Science: Specialisation II. Mathematics and Engineering Science: Elective Compulsory
Assignment for the Following Curricula	General Engineering Science (German program, 7 semester): Specialisation Biomedical Engineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Biomechanics: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Theoretical Mechanical Engineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Aircraft Systems Engineering: Elective Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Mechatronics: Elective Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Energy Systems: Elective Compulsory General Engineering Science (German program, 7 semester): Specialisation Advanced Materials: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Materials in Engineering Sciences: Compulsory Bioprocess Engineering: Specialisation A - General Bioprocess Engineering: Elective Compulsory Computer Science: Specialisation II. Mathematics and Engineering Science: Elective Compulsory Data Science: Core Qualification: Compulsory
Assignment for the Following Curricula	General Engineering Science (German program, 7 semester): Specialisation Biomedical Engineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Biomechanics: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Theoretical Mechanical Engineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Aircraft Systems Engineering: Elective Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Mechatronics: Elective Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Energy Systems: Elective Compulsory General Engineering Science (German program, 7 semester): Specialisation Advanced Materials: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Materials in Engineering Sciences: Compulsory Bioprocess Engineering: Specialisation A - General Bioprocess Engineering: Elective Compulsory Computer Science: Specialisation II. Mathematics and Engineering Science: Elective Compulsory Data Science: Core Qualification: Compulsory Electrical Engineering: Core Qualification: Elective Compulsory
Assignment for the Following Curricula	General Engineering Science (German program, 7 semester): Specialisation Biomedical Engineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Biomechanics: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Theoretical Mechanical Engineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Aircraft Systems Engineering: Elective Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Mechatronics: Elective Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Energy Systems: Elective Compulsory General Engineering Science (German program, 7 semester): Specialisation Advanced Materials: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Materials in Engineering Sciences: Compulsory Bioprocess Engineering: Specialisation A - General Bioprocess Engineering: Elective Compulsory Computer Science: Specialisation II. Mathematics and Engineering Science: Elective Compulsory Data Science: Core Qualification: Compulsory
Assignment for the Following Curricula	General Engineering Science (German program, 7 semester): Specialisation Biomedical Engineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Biomechanics: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Theoretical Mechanical Engineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Aircraft Systems Engineering: Elective Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Mechatronics: Elective Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Energy Systems: Elective Compulsory General Engineering Science (German program, 7 semester): Specialisation Advanced Materials: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Materials in Engineering Sciences: Compulsory Bioprocess Engineering: Specialisation A - General Bioprocess Engineering: Elective Compulsory Computer Science: Specialisation II. Mathematics and Engineering Science: Elective Compulsory Data Science: Core Qualification: Compulsory Electrical Engineering: Core Qualification: Elective Compulsory
Assignment for the Following Curricula	General Engineering Science (German program, 7 semester): Specialisation Biomedical Engineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Biomechanics: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Theoretical Mechanical Engineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Aircraft Systems Engineering: Elective Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Mechatronics: Elective Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Energy Systems: Elective Compulsory General Engineering Science (German program, 7 semester): Specialisation Advanced Materials: Compulsory General Engineering Science (German program, 7 semester): Specialisation Advanced Materials: Compulsory General Engineering: Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Materials in Engineering Sciences: Compulsory Bioprocess Engineering: Specialisation A - General Bioprocess Engineering: Elective Compulsory Computer Science: Specialisation II. Mathematics and Engineering Science: Elective Compulsory Data Science: Core Qualification: Compulsory Electrical Engineering: Core Qualification: Elective Compulsory Engineering Science: Core Qualification: Compulsory
Assignment for the Following Curricula	General Engineering Science (German program, 7 semester): Specialisation Biomedical Engineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Biomechanics: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Theoretical Mechanical Engineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Aircraft Systems Engineering: Elective Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Mechatronics: Elective Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Energy Systems: Elective Compulsory General Engineering Science (German program, 7 semester): Specialisation Advanced Materials: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Materials in Engineering Science: Compulsory Bioprocess Engineering: Specialisation A - General Bioprocess Engineering: Elective Compulsory Computer Science: Specialisation II. Mathematics and Engineering Science: Elective Compulsory Electrical Engineering: Core Qualification: Compulsory Engineering Science: Core Qualification: Elective Compulsory Engineering Science: Core Qualification: Compulsory Engineering Science: Core Qualification: Compulsory
Assignment for the Following Curricula	General Engineering Science (German program, 7 semester): Specialisation Biomedical Engineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Biomechanics: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Theoretical Mechanical Engineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Aircraft Systems Engineering: Elective Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Mechatronics: Elective Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Energy Systems: Elective Compulsory General Engineering Science (German program, 7 semester): Specialisation Advanced Materials: Compulsory General Engineering Science (German program, 7 semester): Specialisation Advanced Materials: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Materials in Engineering Sciences: Compulsory Bioprocess Engineering: Specialisation A - General Bioprocess Engineering: Elective Compulsory Computer Science: Specialisation II. Mathematics and Engineering Science: Elective Compulsory Electrical Engineering: Core Qualification: Elective Compulsory Engineering Science: Core Qualification: Compulsory Engineering Science: Core Qualification: Compulsory Engineering Science: Core Qualification: Compulsory Computer Science in Engineering: Core Qualification: Compulsory
Assignment for the Following Curricula	General Engineering Science (German program, 7 semester): Specialisation Biomedical Engineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Biomechanics: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Theoretical Mechanical Engineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Aircraft Systems Engineering: Elective Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Mechatronics: Elective Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Energy Systems: Elective Compulsory General Engineering Science (German program, 7 semester): Specialisation Advanced Materials: Compulsory General Engineering Science (German program, 7 semester): Specialisation Advanced Materials: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Materials in Engineering Sciences: Compulsory Bioprocess Engineering: Specialisation A - General Bioprocess Engineering: Elective Compulsory Data Science: Specialisation II. Mathematics and Engineering Science: Elective Compulsory Electrical Engineering: Core Qualification: Elective Compulsory Engineering Science: Core Qualification: Compulsory Engineering Science: Core Qualification: Compulsory Computer Science in Engineering: Core Qualification: Compulsory Mechanical Engineering: Specialisation Theoretical Mechanical Engineering: Compulsory

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

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

Module MU655: Comp	utational Fluid Dynamics I			
Courses				
Title		Тур	Hrs/wk	CP
Computational Fluid Dynamics I (LC		Lecture	2	3
Computational Fluid Dynamics I (LC		Recitation Section (large)	2	3
Module Responsible	-			
Admission Requirements	None			
Recommended Previous	Students should have sound knowledge of engineering			
Knowledge	with the foundations of partial/ordinary differential enthermodynamics.	quations. They should also be familiar v	with engineering	nuiu mechanics and
	thermodynamics.			
<b>Educational Objectives</b>	After taking part successfully, students have reached	the following learning results		
<b>Professional Competence</b>				
Knowledge	Students will have the required combined knowled	ge of thermo-/fluid dynamics and nur	nerical analysis	to translate genera
	principles of thermo-/fluid engineering into discrete			
	(potential theory) ansatz functions. They are familia			
	approximation concepts for investigating coupled sexplain the motivation for applying them. Students h.			
	numerical algorithms dedicated to the solution of their	, ,		
	to predict thermofluid dynamic fields, in particular the		ar with most han	icrical metriods asec
Skills	The students are able choose and apply appropriate r			
	in space and time. They can apply/optimise nume			•
	computational algorithms in a structured way, appl	ly these codes for parameter investiga	ations and supp	lement interfaces to
	extract simulation data for an engineering analysis.			
Personal Competence				
Social Competence	The students are able to discuss problems, present the		tly develop, imp	lement and report or
	solution strategies that address given technical refere	nce problems.		
Autonomy	The students can independently analyse numerical		problems. They	are able to critically
	analyse own results as well as external data with rega	irds to the plausibility and reliability.		
Workload in Hours	Independent Study Time 124, Study Time in Lecture 5	56		
Credit points				
Course achievement				
Examination	Written exam			
Examination duration and	2h			
scale				
Assignment for the	General Engineering Science (German program, 7	semester): Specialisation Mechanical	Engineering, Foo	cus Aircraft Systems
Following Curricula	Engineering: Elective Compulsory			
	General Engineering Science (German program, 7 sen	•		
	General Engineering Science (German program, 7	semester): Specialisation Mechanical I	Engineering, Foo	us Energy Systems
	Elective Compulsory	6. 1. 5 5		
	Energy Systems: Technical Complementary Course Co	. ,		
	Mechanical Engineering: Specialisation Energy System	is: Elective Compulsory		
	Naval Architecture: Core Qualification: Compulsory Technomathematics: Specialisation III. Engineering Sc	ience: Flective Compulsory		
	recimomathematics, specialisation III. Engineering Sc	nence. Elective Compulsory		

Course L0235: Computational Fluid Dynamics I	
Тур	Lecture
Hrs/wk	2
СР	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Prof. Thomas Rung
Language	DE
Cycle	WiSe
Content	Fundamentals of computational modelling of thermofluid dynamic problems. Development of numerical algorithms.
	1. Partial differential equations 2. Foundations of finite numerical approximations 3. Computation of potential flows 4. Introduction of finite-differences 5. Approximation of convective, diffusive and transient transport processes 6. Formulation of boundary conditions and initial conditions 7. Assembly and solution of algebraic equation systems 8. Facets of weighted -residual approaches 9. Finite volume methods 10. Basics of grid generation
Literature	Ferziger and Peric: Computational Methods for Fluid Dynamics, Springer

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

Courses				
litle .		Тур	Hrs/wk	CP
Electrical Machines and Actuators (		Lecture	3	4
Electrical Machines and Actuators (		Recitation Section (large)	2	2
Module Responsible				
Admission Requirements	None			
Recommended Previous	Basics of mathematics, in particular complexe nu	mbers, integrals, differentials		
Knowledge	Basics of electrical engineering and mechanical e	ngineering		
<b>Educational Objectives</b>	After taking part successfully, students have read	hed the following learning results		
Professional Competence				
Knowledge	Students can to draw and explain the basic princi	ples of electric and magnetic fields.		
	The control of the state of the state of	and the same of all about a same big and a same		
	They can describe the function of the standa			
	characteristic curves. For typically used drives th from the power grid to the driven engine.	ey can explain the major parameters of the	energy emciency	or the whole system
	from the power grid to the driven engine.			
Skills	Students are able to calculate two-dimensional	electric and magnetic fields in particular fe	rromagnetic circ	uits with air gap. Fo
	this they apply the usual methods of the design a	uf electric machines.		
	They can calulate the operational performance	of electric machines from their given chara	cteristic data an	d selected quantitie
	and characteristic curves. They apply the usual e		eteristic data dir	a serected quartities
	3,443	4		
Personal Competence				
Social Competence	none			
Autonomy		ctric and magnatic fields for applications. Th	nev are able to a	nalvse independentl
·	the operational performance of electric machine			
	and characteristic curves.			
Workload in Hours	Independent Study Time 110, Study Time in Lect	ure 70		
Credit points	6			
Course achievement	None			
Examination	Subject theoretical and practical work			
Examination duration and	Design of four machines and actuators, review of	design files		
scale				
Assignment for the	General Engineering Science (German program,	semester): Specialisation Electrical Engine	ering: Elective Co	ompulsory
Following Curricula	General Engineering Science (German program	, 7 semester): Specialisation Mechanical	Engineering, Foo	cus Energy Systems
	Compulsory			
	General Engineering Science (German progra	m, 7 semester): Specialisation Mechanica	al Engineering,	Focus Mechatronics
	Compulsory			
	General Engineering Science (German program,	7 semester): Specialisation Mechanical Engi	neering, Focus Th	heoretical Mechanica
	Engineering: Elective Compulsory			
	Digital Mechanical Engineering: Core Qualification	' '		
	Electrical Engineering: Core Qualification: Electric	' '		
	Engineering Science: Specialisation Electrical Eng		laam.	
	Green Technologies: Energy, Water, Climate: Spe Logistics and Mobility: Specialisation Engineering		ipuisory	
	Logistics and Mobility: Specialisation Traffic Plant			
	Logistics and Mobility: Specialisation Production N		Isory	
	Mechanical Engineering: Core Qualification: Elect			
	Mechatronics: Core Qualification: Compulsory	· · · · · · · · · · · · · · · · · · ·		
	Technomathematics: Specialisation III. Engineering	ng Science: Elective Compulsory		
	Engineering and Management - Major in Logistics	, ,	and Systems: El	ective Compulsorv
	Engineering and Management - Major in Logisti		-	
	Compulsory	, ,	3	

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

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

Module M0618: Renewables Energy Systems und Energy Economy				
Courses				
Title		<b>Typ</b> Lecture	Hrs/wk	<b>CP</b>
Power Industry (L0316) Energy Systems and Energy Industry (L0315)		Lecture	2	2
Renewable Energy (L0313)	., (2001)	Lecture	2	2
Renewable Energy (L1434)		Recitation Section (small)	1	1
Module Responsible	Prof. Martin Kaltschmitt			
Admission Requirements	None			
Recommended Previous	none			
Knowledge				
Educational Objectives	After taking part successfully, students have reached th	e following learning results		
Professional Competence				
Skills	With completion of this module, the students can provide an overview of characteristics of energy systems and their economic efficiency. They can explain the issues occurring in this context. Furthermore, they can explain details of power generation, power distribution and power trading wih regard to subject-related contexts. The students can explain these aspects, which are applicable to many energy systems in general, especially for renewable energy systems and critical discuss them. Furthermore, the students can explain the environmental benefits from the use of such systems.  Students are able to apply methodologies for detailed determination of energy demand or energy production for various types of energy systems. Furthermore, they can evaluate energy systems technically, environmentally and economically and design them under certain given conditions. Therefore, they can choose the necessary subject-specific calculation rules, also for not standardized solutions of a problem.  The students are able to explain questions and possible approaches to its processing from the field of renewable energies orally			
	and to put them them into the right context.			
Personal Competence				
Social Competence	The students are able to analyze suitable technical a criteria under sustainability aspects. This allows them to			
Autonomy	Students can independently exploit sources , acquire questions.	the particular knowledge about the	subject area and	transform it to new
Workload in Hours	Independent Study Time 96, Study Time in Lecture 84			
Credit points	6			
Course achievement	None			
Examination	Written exam			
Examination duration and	3 hours written exam			
scale				
Assignment for the	General Engineering Science (German program, 7 se	emester): Specialisation Mechanical	Engineering, Foci	us Energy Systems:
Following Curricula	Elective Compulsory			
	Energy and Environmental Engineering: Core Qualificati	on: Compulsory		

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

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

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

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

## **Focus Aircraft Systems Engineering**

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

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

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

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

Module M0730: Comp	outer Engineering			
Courses				
Title		Тур	Hrs/wk	СР
Computer Engineering (L0321)		Lecture	3	4
Computer Engineering (L0324)		Recitation Section (small)	1	2
Module Responsible	Prof. Heiko Falk			
Admission Requirements	None			
Recommended Previous				
	Basic knowledge in electrical engineering			
Knowledge				
Educational Objectives	After taking part successfully, students have reached the following	ng learning results		
Professional Competence				
Knowledge	This module deals with the foundations of the functionality of	computing systems. It covers	the layers from	the assembly-level
	programming down to gates. The module includes the following	topics:		
	Introduction			
	Combinational logic: Gates, Boolean algebra, Boolean fund	tions hardware synthesis com	nhinational netw	iorks
	Sequential logic: Flip-flops, automata, systematic hardwar		ibiliational netw	70185
	Technological foundations	e design		
		lication and division		
	Computer arithmetic: Integer addition, subtraction, multip			
	Basics of computer architecture: Programming models, MI	PS single-cycle architecture, pi	pelining	
	Memories: Memory hierarchies, SRAM, DRAM, caches			
	Input/output: I/O from the perspective of the CPU, principle	es of passing data, point-to-poi	nt connections,	busses
Skills	The students perceive computer systems from the architect's pe	rspective, i.e., they identify the	internal struct	ure and the physical
	composition of computer systems. The students can analyze, ho			
	collection of few and simple components. They are able to disti		•	
	today's computing systems - from gates and circuits up to compl		Title difference	abstraction layers of
	today's computing systems - from gates and circuits up to compl	iete processors.		
	After successful completion of the module, the students are all	ole to judge the interdepender	ncies between a	a physical computer
	system and the software executed on it. In particular, they shall	understand the consequences	that the execu	tion of software has
	on the hardware-centric abstraction layers from the assembly la	nguage down to gates. This wa	ay, they will be	enabled to evaluate
	the impact that these low abstraction levels have on an entire sy	stem's performance and to pro	pose feasible o	ptions.
Personal Competence				
Social Competence	Students are able to solve similar problems alone or in a group a	nd to present the results accor-	dingly.	
Autonomy	Students are able to acquire new knowledge from specific literat	uro and to accociato this knowl	odgo with other	classos
Autonomy	Students are able to acquire new knowledge from specific interact	are and to associate this known	eage with other	ciasses.
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56			
Credit points	6			
Course achievement	Compulsory Bonus Form Description			
	Yes 10 % Excercises			
Examination	Written exam			
Examination duration and	90 minutes, contents of course and labs			
scale				
Assignment for the	General Engineering Science (German program, 7 semester): Spi	ecialisation Computer Science	Compulsory	
Following Curricula	General Engineering Science (German program, 7 semester). Sp.	·		ocus Machatronics:
Tollowing curricula	Compulsory	7. Specialisation Mechanical	Linginicering, 1	ocus Mechatronics.
	General Engineering Science (German program, 7 semester):	Specialisation Mechanical En	nainoorina Eoc	is Aircraft Systoms
	Engineering: Compulsory	Specialisation Mechanical En	igineering, 1 oct	as Alliciait Systems
		ocialization Mochanical Engine	oring Focus Th	paratical Machanical
	General Engineering Science (German program, 7 semester): Sp	ecialisation Mechanical Engine	ering, rocus rin	eoretical Mechanical
	Engineering: Compulsory	ul. Consistination March 1 1	Engine	Facus Materials
	General Engineering Science (German program, 7 semeste	er): Specialisation Mechanical	Engineering,	Focus Materials in
	Engineering Sciences: Compulsory			
	General Engineering Science (German program, 7 semester): S	pecialisation Mechanical Engine	ering, Focus Pi	roduct Development
	and Production: Compulsory			
	General Engineering Science (German program, 7 semester):	Specialisation Mechanical En	gineering, Focu	is Energy Systems:
	Compulsory			
	General Engineering Science (German program, 7 semester	): Specialisation Mechanical	Engineering, Fo	ocus Biomechanics:
	Compulsory			
	General Engineering Science (German program, 7 semester): Spi	ecialisation Electrical Engineeri	ng: Compulsory	
	General Engineering Science (German program, 7 semester): Spi	ecialisation Green Technologies	, Focus Renewa	able Energy: Elective
	Compulsory			
	Computer Science: Core Qualification: Compulsory			
	Data Science: Core Qualification: Elective Compulsory			
	Data Science: Specialisation I. Mathematics/Computer Science: E	lective Compulsory		
	Electrical Engineering: Core Qualification: Compulsory			
	Computer Science in Engineering: Core Qualification: Compulsor	у		
	Integrated Building Technology: Core Qualification: Elective Com	pulsory		
	Technomathematics: Specialisation II. Informatics: Elective Comp	oulsory		

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

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

Produce Prooper Comp	utational Fluid Dynamics I			
Courses				
Title		Тур	Hrs/wk	СР
Computational Fluid Dynamics I (LC Computational Fluid Dynamics I (LC		Lecture Recitation Section (large)	2	3
		Recitation Section (large)	2	3
Module Responsible				
Admission Requirements Recommended Previous	None Students should have sound knowledge of engineer	ing mathematics (series expansions, inter	nal & voctor calc	ulus) and ho familia
Knowledge	with the foundations of partial/ordinary differential			
	thermodynamics.	equations. They should also be runnian.	The congressions	naid incentines an
	,			
Educational Objectives	After taking part successfully, students have reache	d the following learning results		
Professional Competence				
Knowledge	Students will have the required combined knowled	-	-	_
	principles of thermo-/fluid engineering into discre (potential theory) ansatz functions. They are fami			
	approximation concepts for investigating coupled			
	explain the motivation for applying them. Students			
	numerical algorithms dedicated to the solution of th	, , ,	• •	
	to predict thermofluid dynamic fields, in particular ti	heir realms and limitations.		
Ckilla	The students are able shoose and apply approximate	numerical property that integrate the		andivid dumancia DDF
SKIIIS	The students are able choose and apply appropriate in space and time. They can apply/optimise nur			
	computational algorithms in a structured way, ap			-
	extract simulation data for an engineering analysis.	pry these codes for parameter investiga	acions una sapp	rement interruces t
Personal Competence	The short see and the discussion will be a	All a secondar of the state of	No deceles inco	
Social Competence	The students are able to discuss problems, present		tly develop, imp	lement and report o
	solution strategies that address given technical refe	refice problems.		
Autonomy	The students can independently analyse numerica	al methods to solving fluid engineering	nroblems They	are able to criticall
riaconomy	analyse own results as well as external data with re		problemo. Trey	are able to chican
Mouldond in House	Independent Chiefe Time 124 Chiefe Time in Lockies			
Credit points	Independent Study Time 124, Study Time in Lecture	: 30		
Course achievement				
Examination				
Examination duration and	2h			
scale				
Applement for the	Conoral Engineering Science (Correct average)	7 competer), Specialization Machania	Enginooring 5-	oue Aircraft Cust
Assignment for the Following Curricula		semester): Specialisation Mechanical	Engineering, Fo	cus Aircraft System
Following Curricula	General Engineering Science (German program, 7 so	emester): Specialisation Naval Architectur	e: Compulsory	
	General Engineering Science (German program, 7 Science)	•		us Energy Systems
	Elective Compulsory		J	. 5, -,
	Energy Systems: Technical Complementary Course	Core Studies: Elective Compulsory		
	Mechanical Engineering: Specialisation Energy Syste	ems: Elective Compulsory		
	Naval Architecture: Core Qualification: Compulsory			
	Technomathematics: Specialisation III. Engineering :	Science: Elective Compulsory		

Course L0235: Computational Fluid Dynamics I	
Тур	Lecture
Hrs/wk	2
СР	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Prof. Thomas Rung
Language	DE
Cycle	WiSe
Content	Fundamentals of computational modelling of thermofluid dynamic problems. Development of numerical algorithms.
	1. Partial differential equations 2. Foundations of finite numerical approximations 3. Computation of potential flows 4. Introduction of finite-differences 5. Approximation of convective, diffusive and transient transport processes 6. Formulation of boundary conditions and initial conditions 7. Assembly and solution of algebraic equation systems 8. Facets of weighted -residual approaches 9. Finite volume methods 10. Basics of grid generation
Literature	Ferziger and Peric: Computational Methods for Fluid Dynamics, Springer

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

Module M1320: Simul	ation and Design of Mechatronic Sys	tems		
Courses				
Title Typ Hrs/wk CP				СР
Simulation and Design of Mechatro	nic Systems (L1822)	Lecture	2	2
Simulation and Design of Mechatro		Recitation Section (large)	1	2
Simulation and Design of Mechatro		Practical Course	1	2
Module Responsible	NN			
Admission Requirements	None			
Recommended Previous	Fundatmentals of mechanics, control theory and elect	rical engineering		
Knowledge				
Educational Objectives	After taking part successfully, students have reached	the following learning results		
Professional Competence				
Knowledge	Students are able to describe methods and calculation	ns for design, modeling, simulation and	optimization of m	echatronic systems.
Skills	Students are able to apply modern algorithms for modern	deling of mechatronic systems. They ca	n identify, simula	te and design simple
	systems and implement those in laboratory conditions	-	•	,
Personal Competence				
Social Competence	Students are able to work goal-oriented in small mixed	d groups and present results to target o	roups.	
Autonomy	Students are able to recognize and improve knowledg	Students are able to recognize and improve knowledge deficits independently.		
	With instructor assistance, students are able to evalua	ate their own knowledge level and defin	e a further course	e of study.
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56			
Credit points	6	6		
Course achievement	None			
Examination	Written exam			
Examination duration and	90 min			
scale				
Assignment for the	General Engineering Science (German program, 7 ser	mester): Specialisation Mechanical Engi	ineering, Focus M	echatronics: Elective
Following Curricula	Compulsory			
	General Engineering Science (German program, 7	semester): Specialisation Mechanical	Engineering, Foo	us Aircraft Systems
	Engineering: Elective Compulsory			
	Digital Mechanical Engineering: Core Qualification: Co	mpulsory		
	Mechanical Engineering: Specialisation Aircraft Systen	ns Engineering: Compulsory		
	Mechanical Engineering: Specialisation Mechatronics:	Compulsory		
	Mechatronics: Core Qualification: Compulsory			

Course L1822: Simulation an	d Design of Mechatronic Systems
Тур	Lecture
Hrs/wk	2
СР	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	NN
Language	DE
Cycle	WiSe
Content	Mechatronic Design
	Modeling
	Model Identifikation
	Numerical Methods in simulation
	Applications and examples in Matlab <sup>®</sup> and Simulink <sup>®</sup>
Literature	Skript zur Veranstaltung
	Weitere Literatur in der Veranstaltung

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

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

Module M0662: Nume	erical Mathematics I			
Courses				
Title	1	<sup>-</sup> ур	Hrs/wk	СР
Numerical Mathematics I (L0417)		ecture	2	3
Numerical Mathematics I (L0418)		Recitation Section (small)	2	3
Module Responsible				
Admission Requirements				
Recommended Previous	<ul> <li>Mathematik I + II for Engineering Students (german or engli</li> </ul>	sh) <b>or</b> Analysis & Linear Alge	ebra I + II for Te	chnomathematicians
Knowledge	basic MATLAB/Python knowledge			
	After taking part successfully, students have reached the following	learning results		
Professional Competence				
Knowieage	Students are able to			
	<ul> <li>name numerical methods for interpolation, integration, leas</li> </ul>	t squares problems, eigenva	alue problems, n	onlinear root finding
	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 met	hods with respect to comput	tational and stor	age complexitx.
Skills	Students are able to			
	implement, apply and compare numerical methods using Ma	ATLAB/Python,		
	justify the convergence behaviour of numerical methods wit	th respect to the problem and	d solution algori	thm,
	select and execute a suitable solution approach for a given	problem.		
Personal Competence				
-	Students are able to			
Social competence	Stadents are able to			
	work together in heterogeneously composed teams (i.e., te	ams from different study pro	grams and back	kground knowledge),
	explain theoretical foundations and support each other with	practical aspects regarding	the implementa	tion of algorithms.
Autonomy	Students are capable			
	to assess whether the supporting theoretical and practical e     to assess their individual progess and if processary to ask a		ndividually or in	a team,
	<ul> <li>to assess their individual progess and, if necessary, to ask q</li> </ul>	destions and seek neip.		
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56			
Credit points	6			
Course achievement	None			
Examination	Written exam			
Examination duration and	90 minutes			
scale				
Assignment for the	General Engineering Science (German program, 7 semester): Spec	ialisation Computer Science	Compulsory	
Following Curricula	General Engineering Science (German program, 7 semester): Spec	-		-
	General Engineering Science (German program, 7 semester):	Specialisation Mechanical	Engineering, F	ocus Biomechanics:
	Compulsory	sialization Machanical Engine	aning Facus Th	acretical Machanical
	General Engineering Science (German program, 7 semester): Spec Engineering: Compulsory	ransation Mechanical Engine	eering, Focus Tri	eoretical Mechanical
	General Engineering Science (German program, 7 semester): 9	Specialisation Mechanical E	naineerina Foc	us Aircraft Systems
	Engineering: Elective Compulsory	specialisación ricenamear 2		as runerare systems
	General Engineering Science (German program, 7 semester): Spe	cialisation Mechanical Engin	eering, Focus M	echatronics: Elective
	Compulsory			
	General Engineering Science (German program, 7 semester): S	Specialisation Mechanical E	ngineering, Foc	us Energy Systems:
	Elective Compulsory			
	General Engineering Science (German program, 7 semester): Spec	ialisation Advanced Material	s: Compulsory	
	General Engineering Science (German program, 7 semester)	: Specialisation Mechanica	I Engineering,	Focus Materials in
	Engineering Sciences: Compulsory			
	Bioprocess Engineering: Specialisation A - General Bioprocess Engi	-	-	
	Computer Science: Specialisation II. Mathematics and Engineering	ocience: Elective Compulsor	у	
	Data Science: Core Qualification: Compulsory Electrical Engineering: Core Qualification: Elective Compulsory			
	Engineering Science: Core Qualification: Compulsory			
	Engineering Science: Core Qualification: Compulsory  Engineering Science: Core Qualification: Compulsory			
	Computer Science in Engineering: Core Qualification: Compulsory			
	Mechanical Engineering: Specialisation Theoretical Mechanical Engineering	jineering: Compulsory		
	Mechanical Engineering: Specialisation Energy Systems: Elective C			
	Theoretical Mechanical Engineering: Technical Complementary Co	urse Core Studies: Elective C	ompulsory	
	Theoretical Free and Engineering. Feeting and Completionally			l l

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

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

Module M0599: Integ	rated Product Deve	lopment and	Lightweight	: Design		
Courses						
<b>Title</b> CAE-Team Project (L0271)				<b>Typ</b> Project-/problem-based Learning	Hrs/wk	<b>CP</b> 2
Development of Lightweight Desig				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 design	n:			
Knowledge	Fundamentals of Mechanica	l Engineering Desi	ŋn			
	Mechanical Engineering: De	sign				
	Advanced Mechanical Engin	eering Design				
<b>Educational Objectives</b>	After taking part successfull	y, students have re	eached the following	ng learning results		
Professional Competence				<u> </u>		
Knowledge	After completing the module	e, students are cap	able of:			
	<ul> <li>explaining the function</li> </ul>	onal principle of 3D	-CAD-Systems, PD	M- and FEM-Systems		
	<ul> <li>describing the interaction</li> </ul>	tion of the differen	t CAE-Systems in	the product development proc	ess	
Skills						
Skills						
	After completing the module	e, students are able	e to:			
	<ul> <li>evaluate different CA</li> </ul>	AD- and PDM-Syste	ems with regards	to the desired requirements :	such as classifi	cation schemes and
	product structuring					
	<ul> <li>design an exemplary</li> </ul>	product using CAD	-,PDM- and/or FEM	-Systems with shared workloa	b	
Personal Competence						
Social Competence	After completing the module	e, students are able	e to:			
	• To dovolon a project	nlan and allocato w	ork appropriato w	ork nackagos in the framewor	k of group disc	iccione
	Present project result			ork packages in the framewor	k or group disc	15510115
	Fresent project result	s as a team for mis	tance in a present	ation		
Autonomy	Students are capable of:					
	• indopendently adapt	to a CAE Tool and	complete a given r	practical tack with it		
	<ul> <li>independently adapt</li> </ul>	to a CAL-1001 and t	complete a given p	oractical task with it		
Workload in Hours	Independent Study Time 96	, Study Time in Lec	ture 84			
Credit points	6					
Course achievement	Compulsory Bonus Form		Description	<u> </u>		
	Yes 20 % Subj		andCAE-Teampro	jekt inkl. Vortrag und Ausarbei	tung	
		tical work				
	Written exam					
Examination duration and	90					
scale						
Assignment for the		ce (German progr	am, 7 semester):	Specialisation Mechanical Er	ngineering, Foo	cus Aircraft Systems
Following Curricula	Engineering: Compulsory					
			n, 7 semester): Sp	pecialisation Mechanical Engin	eering, Focus F	Product Development
	and Production: Compulsory					
	Engineering Science: Specia					
				cialisation Mechanical Enginee	ring: Elective C	ompulsory
	Mechanical Engineering: Sp					
	Mechanical Engineering: Sp					
	Product Development Mate	rials and Production	n. Technical Comp	lementary Course Core Studies	: Flective Com	nulcory

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

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

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

Module M0865: Funda	amentals of Production and Qua	ality Management		
Courses				
Title		Тур	Hrs/wk	СР
Production Process Organization (LG	0925)	Lecture	2	3
Quality Management (L0926)		Lecture	2	3
Module Responsible	Prof. Hermann Lödding			
Admission Requirements	None			
Recommended Previous	None			
Knowledge				
<b>Educational Objectives</b>	After taking part successfully, students have r	eached the following learning results		
Professional Competence				
Knowledge	Students are able to explain the contents of the	ne lecture of the module.		
Skills	Students are able to apply the methods and n	nodels in the module to industrial problen	ns.	
Personal Competence				
Social Competence	-			
Autonomy	-			
Workload in Hours	Independent Study Time 124, Study Time in L	ecture 56		
Credit points	6			
Course achievement	None			
Examination	Written exam			
Examination duration and	180 Minuten			
scale				
Assignment for the	General Engineering Science (German prog	ram, 7 semester): Specialisation Mecha	nical Engineering, Focu	ıs Aircraft Systems
Following Curricula	Engineering: Compulsory			
	General Engineering Science (German progra	m, 7 semester): Specialisation Mechanic	al Engineering, Focus Pr	oduct Development
	and Production: Compulsory			
	General Engineering Science (German program	m, 7 semester): Specialisation Advanced	Materials: Elective Comp	ulsory
	Engineering Science: Core Qualification: Comp	pulsory		
	Engineering Science: Specialisation Mechatron	nics: Elective Compulsory		
	Engineering Science: Specialisation Mechanica	al Engineering: Elective Compulsory		
	Engineering Science: Specialisation Advanced	' '		
	Logistics and Mobility: Specialisation Production	-	ory	
	Logistics and Mobility: Specialisation Engineer	- · · · ·		
	Mechanical Engineering: Core Qualification: El			
	Engineering and Management - Major in Logis	tics and Mobility: Specialisation Productio	n Management and Proc	esses: 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	EN
Cycle	SoSe
Content	(A) Introduction
	(B) Product planning
	(C) Process planning
	(D) Procurement
	(E) Manufacturing
	(F) Production planning and control (PPC)
	(G) Distribution
	(H) Cooperation
Literature	Wiendahl, HP.: Betriebsorganisation für Ingenieure
	Vorlesungsskript

Course L0926: Quality Manag	Course L0926: Quality Management		
Тур	Lecture		
Hrs/wk	2		
СР	3		
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28		
Lecturer	Prof. Hermann Lödding		
Language	EN		
Cycle	SoSe		
Content	<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	nautical Systems			
Courses				
Title		Тур	Hrs/wk	СР
Fundamentals of Aircraft Systems (	(L0741)	Lecture	2	2
Fundamentals of Aircraft Systems (	(L0742)	Recitation Section (small)	1	1
Air Transportation Systems (L0591		Lecture	2	2
Air Transportation Systems (L0816		Recitation Section (large)	1	1
Module Responsible	Prof. Frank Thielecke			
Admission Requirements				
Recommended Previous	Basics of mathematics, mechanics and thermodynamic	s		
Knowledge				
Educational Objectives	After taking part successfully, students have reached t	ne following learning results		
<b>Professional Competence</b>				
Knowledge	Students get a basic understanding of the structure and design of an aircraft, as well as an overview of the systems inside an			
	aircraft. In addition, a basic knowledge of the relationc	hips, the key parameters, roles and wa	ys of working in	different subsystems
	in the air transport is acquired.			
Skills	Due to the learned cross-system thinking students can gain a deeper understanding of different system concepts and their			
	technical system implementation. In addition, they can apply the learned methods for the design and assessment of subsystems of			
	the air transportation system in the context of the over	all system.		
Personal Competence				
Social Competence	Students are made aware of interdisciplinary communication in groups.			
Autonomy	Students are able to independently analyze different	system concepts and their technical	implementation	as well as to think
	system oriented.			
Workload in Hours	Independent Study Time 96, Study Time in Lecture 84			
Credit points	6			
Course achievement	None			
Examination	Written exam			
Examination duration and	150 min			
scale				
Assignment for the	General Engineering Science (German program, 7 s	emester): Specialisation Mechanical I	Engineering, Foo	cus Aircraft Systems
Following Curricula	Engineering: Compulsory			
	Logistics and Mobility: Specialisation Logistics and Mob	ility: Elective Compulsory		
	Logistics and Mobility: Specialisation Traffic Planning a	nd Systems: Elective Compulsory		
	Mechanical Engineering: Specialisation Aircraft System	s Engineering: Compulsory		
	Engineering and Management - Major in Logistics and I	Mobility: Specialisation Traffic Planning	and Systems: Ele	ective Compulsory

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

Course L0742: Fundamentals of Aircraft Systems		
Тур	Recitation Section (small)	
Hrs/wk	1	
СР	1	
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14	
Lecturer	Prof. Frank Thielecke	
Language	DE	
Cycle	SoSe	
Content	See interlocking course	
Literature	See interlocking course	

Course L0591: Air Transportation Systems				
Тур	Lecture			
Hrs/wk	2			
СР	2			
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28			
Lecturer	Prof. Volker Gollnick			
Language	DE			
Cycle	SoSe			
Content	1. Air transport as part of the global transportation system 2. Legal basis of air transportation 3. Safety and security aspects 4. Aircraft basics 5. The role of the aircraft amnufacturer 6. The role of the aircraft operator 7. Airport operation 8. The principles of air traffic management 9. Environmental aspects of air transportation			
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 Transporta	purse L0816: Air Transportation Systems		
Тур	Recitation Section (large)		
Hrs/wk	1		
СР	1		
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14		
Lecturer	Prof. Volker Gollnick		
Language	DE		
Cycle	SoSe		
Content	See interlocking course		
Literature	See interlocking course		

Module M1573: Mode	ling, Simulation and Optimization (EN			
Courses				
Title		Тур	Hrs/wk	CP
Modeling, Simulation and Optimizat	ion (EN) (L2446)	Integrated Lecture	4	6
Module Responsible	Prof. Benedikt Kriegesmann			
Admission Requirements	None			
Recommended Previous	Sound knowledge of engineering mathematics, enginee	ring mechanics and fluid mechanic	S	
Knowledge				
Educational Objectives	After taking part successfully, students have reached th	e following learning results		
Professional Competence				
Knowledge	Students will have an overview of various technical pro-	oblems and the differential equati	ons, which describe	them. Students will
	gave an overview of different solution approaches and $\ensuremath{f}$	or which kind of problems they can	be used for.	
Skills	Students are able to solve different technical problems	with the introduced discretization n	nethods	
SKIIIS	Stadents are able to solve amerene technical problems	with the mirodaced discretization is	netrious.	
Personal Competence				
Social Competence	The students are able to discuss problems and jointly de	evelop solution strategies.		
Autonomy	The students are able to develop solution strategies for	complex problems self-consistent a	and critically analyse	results.
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56			
Credit points	6			
Course achievement	None			
Examination	Oral exam			
Examination duration and	30 min			
scale				
Assignment for the	General Engineering Science (German program, 7 seme	ster): Specialisation Mechanical Er	ngineering, Focus Th	eoretical Mechanical
Following Curricula	Engineering: Compulsory			
	General Engineering Science (German program, 7 seme	ster): Specialisation Advanced Mat	erials: Compulsory	
	General Engineering Science (German program, 7 se	mester): Specialisation Mechanic	al Engineering, Foc	us Aircraft Systems
	Engineering: Elective Compulsory			
	Engineering Science: Core Qualification: Compulsory			
	Mechanical Engineering: Specialisation Theoretical Mechanical			
	Technomathematics: Specialisation III. Engineering Scie	nce: Elective Compulsory		

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

## **Focus 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.

outer Engineering			
Typ Hrs/wk CP			
Lecture 3 4			
Recitation Section (small) 1 2			
Prof. Heiko Falk			
Basic knowledge in electrical engineering			
This module deals with the foundations of the functionality of computing systems. It covers the layers from the assembly-lev programming down to gates. The module includes the following topics:			
programming down to gates. The module includes the following topics.			
Introduction			
Combinational logic: Gates, Boolean algebra, Boolean functions, hardware synthesis, combinational networks			
Sequential logic: Flip-flops, automata, systematic hardware design			
Technological foundations			
Computer arithmetic: Integer addition, subtraction, multiplication and division      Design of assessment with the New York and the MISC stands and the stands are likely as a second seco			
Basics of computer architecture: Programming models, MIPS single-cycle architecture, pipelining     Memories: Memory hierarchies SPAM_DRAM_caches			
<ul> <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>			
pag sagua. 40 from the perspective of the circ, principles of passing data, point-to-point conflections, pusses			
The students perceive computer systems from the architect's perspective, i.e., they identify the internal structure and the physic			
composition of computer systems. The students can analyze, how highly specific and individual computers can be built based on			
collection of few and simple components. They are able to distinguish between and to explain the different abstraction layers			
today's computing systems - from gates and circuits up to complete processors.			
After successful completion of the module, the students are able to judge the interdependencies between a physical comput			
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 evalua			
the impact that these low abstraction levels have on an entire system's performance and to propose feasible options.			
Students are able to solve similar problems alone or in a group and to present the results accordingly.			
Students are able to acquire new knowledge from specific literature and to associate this knowledge with other classes.			
Independent Study Time 124 Study Time in Lecture 55			
Written exam			
90 minutes, contents of course and labs			
Canada Fraincada Cainne (Caman maggan 7 canadan). Chadialization Camantay Cainnes Camantay			
General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Mechatronic Compulsory			
General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Aircraft System			
Engineering: Compulsory			
General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Theoretical Mechanic			
Engineering: Compulsory			
General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Materials			
Engineering Sciences: Compulsory			
General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Product Developmen			
and Production: Compulsory			
and Production: Compulsory			
General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Energy System			
General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Energy System Compulsory			
General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Energy System Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Biomechanic			
General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Energy System Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Biomechanic Compulsory			
General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Energy System Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Biomechanic Compulsory General Engineering Science (German program, 7 semester): Specialisation Electrical Engineering: Compulsory			
General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Energy System Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Biomechanic Compulsory General Engineering Science (German program, 7 semester): Specialisation Electrical Engineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Green Technologies, Focus Renewable Energy: Electrical Engineering Science (German program, 7 semester): Specialisation Green Technologies, Focus Renewable Energy: Electrical Engineering Science (German program, 7 semester): Specialisation Green Technologies, Focus Renewable Energy: Electrical Engineering Science (German program, 7 semester): Specialisation Green Technologies, Focus Renewable Energy: Electrical Engineering Science (German program, 7 semester): Specialisation Green Technologies, Focus Renewable Energy: Electrical Engineering Science (German program, 7 semester): Specialisation Green Technologies, Focus Renewable Energy: Electrical Engineering Science (German program, 7 semester): Specialisation Green Technologies, Focus Renewable Energy: Electrical Engineering Science (German program, 7 semester): Specialisation Green Technologies, Focus Renewable Energy: Electrical Engineering Science (German program, 7 semester): Specialisation Green Technologies, Focus Renewable Energy: Electrical Engineering Science (German program, 7 semester): Specialisation Green Technologies, Focus Renewable Energy: Electrical Engineering Science (German program, 7 semester): Specialisation Green Technologies, Focus Renewable Energy: Electrical Engineering Science (German program, 7 semester): Specialisation Green Technologies, Focus Renewable Energy: Electrical Engineering Science (German program, 7 semester): Specialisation Electrical Engineering Science (German program, 7 semester): Specialisation Electrical Engineering Science (German program, 7 semester): Specialisation Electrical Engineer			
General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Energy System Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Biomechanic Compulsory General Engineering Science (German program, 7 semester): Specialisation Electrical Engineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Green Technologies, Focus Renewable Energy: Electric Compulsory			
General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Energy System Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Biomechanic Compulsory General Engineering Science (German program, 7 semester): Specialisation Electrical Engineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Green Technologies, Focus Renewable Energy: Electric Compulsory Computer Science: Core Qualification: Compulsory			
General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Energy System Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Biomechanic Compulsory General Engineering Science (German program, 7 semester): Specialisation Electrical Engineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Green Technologies, Focus Renewable Energy: Electric Compulsory Computer Science: Core Qualification: Compulsory Data Science: Core Qualification: Elective Compulsory			
General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Energy System Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Biomechanic Compulsory General Engineering Science (German program, 7 semester): Specialisation Electrical Engineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Green Technologies, Focus Renewable Energy: Electric Compulsory Computer Science: Core Qualification: Compulsory			

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

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

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

Module M1009: Mater	rial Science Laboratory			
Courses				
Title		Тур	Hrs/wk	СР
Companion Lecture for Materials So	-	Lecture	2	2
Material Science Laboratory (L1235	5) Practical Course 4 4			
Module Responsible	Prof. Kaline Pagnan Furlan			
Admission Requirements	None			
Recommended Previous	none			
Knowledge				
Educational Objectives	After taking part successfully, students have reached th	e following learning results		
Professional Competence				
Knowledge	Students are able to give a summary of the technical	al details of experiments in the a	rea of materials sc	iences and illustrate
	respective relationships. They are capable of describing	g and communicating relevant pr	oblems and questio	ns using appropriate
	technical language. They can explain the typical proces	s of solving practical problems and	present related res	ults.
Skills	The students can transfer their fundamental knowledg	e on material sciences to the pro	cess of solving prac	tical problems. They
SKIIIS	identify and overcome typical problems during the reali	·		
	, , , , , , , , , , , , , , , , , , ,			
Personal Competence				
Social Competence	Students are able to cooperate in small groups in order	to conduct experiments in the con	text of materials sci	ences. They are able
	to effectively present and explain their results alone or	in groups in front of a qualified aud	lience.	
Autonomy	Students are capable of solving problems in the contex	t of materials sciences using prov	ided literature. They	are able to fill gaps
	in as well as extent their knowledge using the literature	- ·	-	3.1
Workload in Hours	Independent Study Time 96, Study Time in Lecture 84			
Credit points				
Course achievement	None			
Examination	Subject theoretical and practical work			
Examination duration and	Test reports on the respective tests and online learning	modules with integrated success of	ontrol	
scale				
Assignment for the	General Engineering Science (German program, 7 sem	ester): Specialisation Mechanical I	Engineering, Focus F	roduct Development
Following Curricula	and Production: Elective Compulsory			
	General Engineering Science (German program, 7 seme	ster): Specialisation Advanced Mat	erials: Compulsory	
	General Engineering Science (German program, 7	semester): Specialisation Mecha	anical Engineering,	Focus Materials in
	Engineering Sciences: Compulsory			
	Engineering Science: Specialisation Advanced Materials	: Compulsory		
	Mechanical Engineering: Specialisation Product Develop	ment and Production: Compulsory		
	Mechanical Engineering: Specialisation Materials in Eng			
	Product Development, Materials and Production: Techni	cal Complementary Course Core St	udies: Elective Com	pulsory

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

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

Module M0662: Nume	erical Mathematics I			
Courses				
Title		Тур	Hrs/wk	СР
Numerical Mathematics I (L0417)		Lecture	2	3
Numerical Mathematics I (L0418)		Recitation Section (small)	2	3
Module Responsible				
Admission Requirements	None			
Recommended Previous	Mathematik I + II for Engineering Students (german or en	glish) <b>or</b> Analysis & Linear Alg	ebra I + II for Te	chnomathematicians
Knowledge	basic MATLAB/Python knowledge			
Educational Objectives	After teling worth acceptability attribute house week at the follows	na lagraina regulta		
	After taking part successfully, students have reached the follow	ng learning results		
Professional Competence	Students are able to			
Knowieuge	Students are able to			
	<ul> <li>name numerical methods for interpolation, integration, le</li> </ul>	east squares problems, eigenv	alue problems, n	nonlinear root finding
	problems and to explain their core ideas,			
	repeat convergence statements for the numerical method			
	explain aspects for the practical execution of numerical n	nethods with respect to compu	tational and stor	rage complexitx.
Skille	Students are able to			
Skills	Students are able to			
	<ul> <li>implement, apply and compare numerical methods using</li> </ul>			
	justify the convergence behaviour of numerical methods		d solution algori	thm,
	<ul> <li>select and execute a suitable solution approach for a give</li> </ul>	n problem.		
Personal Competence				
Social Competence	Students are able to			
	work together in heterogeneously composed teams (i.e.,	toams from different study pro	arams and had	karound knowledge)
	explain theoretical foundations and support each other w			
	explain allow calcul roundations and support catch other in	an practical aspects regarding	and imprementa	alon or algorithms.
Autonomy	Students are capable			
	to assess whether the supporting theoretical and practical	l excercises are better solved	individually or in	a team,
	<ul> <li>to assess their individual progess and, if necessary, to as</li> </ul>	questions and seek help.		
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56			
Course achievement	None			
Examination				
Examination duration and				
scale				
Assignment for the	General Engineering Science (German program, 7 semester): Sp	ecialisation Computer Science	: Compulsory	
Following Curricula	General Engineering Science (German program, 7 semester): Sp	ecialisation Biomedical Engine	ering: Compulso	ory
	General Engineering Science (German program, 7 semeste	r): Specialisation Mechanical	Engineering, F	ocus Biomechanics:
	Compulsory			
	General Engineering Science (German program, 7 semester): S	pecialisation Mechanical Engine	eering, Focus Th	eoretical Mechanical
	Engineering: Compulsory  General Engineering Science (German program, 7 semester)	. Specialisation Machanical E	nainoorina Foc	us Aircraft Systems
	Engineering: Elective Compulsory	. Specialisation Mechanical E	rigineering, Foc	us Aircrait Systems
	General Engineering Science (German program, 7 semester): S	pecialisation Mechanical Engin	eering, Focus M	echatronics: Elective
	Compulsory	,	3.	
	General Engineering Science (German program, 7 semester)	: Specialisation Mechanical E	ngineering, Foc	us Energy Systems:
	Elective Compulsory			
	General Engineering Science (German program, 7 semester): Sp			
	General Engineering Science (German program, 7 semest	er): Specialisation Mechanica	l Engineering,	Focus Materials in
	Engineering Sciences: Compulsory	agingoring, Flactive Commit	24	
	Bioprocess Engineering: Specialisation A - General Bioprocess E Computer Science: Specialisation II. Mathematics and Engineeri		-	
	Data Science: Core Qualification: Compulsory	ig Science. Liective Compuisor	у	
	Electrical Engineering: Core Qualification: Elective Compulsory			
	Engineering Science: Core Qualification: Compulsory			
	Engineering Science: Core Qualification: Compulsory			
	Computer Science in Engineering: Core Qualification: Compulsor	у		
	Mechanical Engineering: Specialisation Theoretical Mechanical E	ingineering: Compulsory		
	Mechanical Engineering: Specialisation Energy Systems: Elective			
	Theoretical Mechanical Engineering: Technical Complementary		Compulsory	
	Process Engineering: Specialisation Process Engineering: Electiv	e Compulsory		

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

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

Module M1746: Mater	rials Engineering: Materials S	Selection, Processing and Mode	elling	
Courses				
Title		Тур	Hrs/wk	СР
Materials and Process Modeling (L2		Lecture	3	3
Materials Selection and Processing		Lecture	3	3
Module Responsible	Prof. Norbert Huber			
Admission Requirements	None			
Recommended Previous		al equations, integration), materials science (	classes of materials,	structure, properties,
Knowledge	tensile test) and engineering mechanics (	·		
Educational Objectives	After taking part successfully, students ha	ave reached the following learning results		
Professional Competence				
Knowledge	material processing, the associated micro	nd properties of engineering materials. Particu ostructure and the achievable mechanical prop nomic efficiency. Metallic materials are in the fo available materials.	perties. In conjunction	n with the costs, these
	laws for plasticity under monotonic and cy also plays a major role in manufacturin	onsideration, the modeling of material behavi yclic loading is worked out. In addition to the e ig processes and thus provides the basis for turing processes, such as rolling or forming, ar	valuation of componer process simulation	ent behavior, plasticity . Process models and
Skills	Students are able to			
	as the associated velocity-depende  to relate the deformation behavior  to assess how processing procedure	netallic materials for general load histories with ent material behavior and describe it with correct to the underlying microstructural mechanisms res affect the chain microstructure - process - properties of metallic materials can be tailored	esponding material la	ws
Personal Competence				
Social Competence	Students are able to			
	actively enrich and shape the cours     develop solutions to given problem	se by contributing to the discussion. Is and explain them in English in the plenum an	nd discuss them with	their fellow students.
Autonomy	Students are able to,			
	assess their own strengths and wea	aknassas		
	_	learning status and define further work steps o	n this basis	
	· ·	y them to new problems by transferring the ta		
Workload in Hours	Independent Study Time 96, Study Time in	n Lecture 84		
Course ashievement	6 Compulsory Bonus Form	Description		
Course achievement	Yes 20 % Excercises	Wir stellen Übungsaufgaben (ÜA), d den wöchentlichen Übungen vorgesi bis zu 20% bei der Prüfung berücksio	tellt werden. Diese k	
Examination	Written exam			
Examination duration and scale	120 min			
Assignment for the	General Engineering Science (German	program, 7 semester): Specialisation Med	chanical Engineering	, Focus Materials in
Following Curricula	Engineering Sciences: Compulsory			
		ogram, 7 semester): Specialisation Advanced M	laterials: Compulsory	'
	Engineering Science: Specialisation Mecha			
	Engineering Science: Specialisation Advar Engineering Science: Specialisation Advar	• •		
		aterials in Engineering Sciences: Compulsory		
	Prechanical Engineering, Specialisation Me	accinate in Engineering Sciences. Compuisory		

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

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

Module M0934: Adva	nced Materials for Sustainabil	ity			
Courses					
Title		Тур		Hrs/wk	СР
Advanced Materials Characterization	on (L1087)	Lecture		2	2
Advanced Materials for Sustainabili	ity (L1091)	Lecture		2	2
Advanced Materials for Sustainabili	ity (L1092)	Recitation	on Section (large)	2	2
Module Responsible	Prof. Patrick Huber				
Admission Requirements	None				
Recommended Previous	Fundamentals of Materials Science (I and II)	)			
Knowledge					
<b>Educational Objectives</b>	After taking part successfully, students hav	e reached the following learni	ng results		
<b>Professional Competence</b>					
Knowledge	The students will be able to explain the pro	operties of advanced material	s along with their ap	oplications in tech	nnology, in particular
	metallic, ceramic, polymeric, semiconducto	r, modern composite material	s (biomaterials) and	nanomaterials.	
Sville	The students will be able to select mater	ial configurations according	to the technical nee	ads and if neces	sary to design new
Skiiis	materials considering architectural princip				
	modern materials science, which enables th			_	
	modern materials science, which chaples to	iem to serect optimam materi	als combinations ac	pending on the te	crimear applications.
Personal Competence					
Social Competence	The students are able to present solutions t	o specialists and to develop in	deas further.		
Autonomy	The students are able to				
	- cocce their own atropaths and week				
	<ul> <li>assess their own strengths and weak</li> <li>define tasks independently.</li> </ul>	nesses.			
	• define tasks independently.				
Workload in Hours	Independent Study Time 96, Study Time in	Lecture 84			
		Lecture 04			
Credit points Course achievement					
Examination					
Examination duration and	90 min				
scale					
Assignment for the	General Engineering Science (German p	rogram, 7 semester): Speci	alisation Mechanica	l Engineering, F	ocus Biomechanics:
Following Curricula		ram 7 comoctes): Chasis !!+!	on Advanced Met	ale: Compulses:	
	General Engineering Science (German prog				Focus Materials in
	General Engineering Science (German p	orogram, / semester): Spe	Liansation Mechanic	.ai Engineering,	rocus Materiais In
	Engineering Sciences: Compulsory Engineering Science: Specialisation Mechar	nical Engineering, Floctive Co-	anulson/		
	Engineering Science: Specialisation Mechan Engineering Science: Specialisation Advance		iipuis01 y		
	Mechanical Engineering: Core Qualification:				
	Mechanical Engineering, Core Qualification.	Liective Compuisory			

C 11007- Ad d M	And to Characteristics
Course L1087: Advanced Mat	terials Characterization
Тур	Lecture
Hrs/wk	2
СР	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Prof. Patrick Huber
Language	DE
Cycle	SoSe
Content	
Literature	William D. Callister und David G. Rethwisch, Materialwissenschaften und Werkstofftechnik, Wiley&Sons, Asia (2011).
	William D. Callister, Materials Science and Technology, Wiley& Sons, Inc. (2007).

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

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

Title Typ Hrs/wk CP Materials for Energy Storage and Conversion (DE) (L1086) Lecture 2 3 Enhanced Fundamentals: Ceramics and Polymers (L1231) Lecture 2 2 Enhanced Fundamentals: Ceramics and Polymers (L1234) Recitation Section (large) 1 1  Module Responsible Prof. Geroid Schneider  Admission Requirements  Recommended Previous Knowledge Module "Materials Science Laboratory"  Module "Advanced Materials"  Educational Objectives After taking part successfully, students have reached the following learning results  Professional Competence Knowledge  **Nowledge**  **Foressional Competence Knowledge**  *	Module M1005: Enhai	nced Fundamentals of Materials Science			
Materials for Energy Storage and Conversion (DE) (1.086) Enhanced Fundamentals: Ceramics and Polymers (1.233) Enhanced Fundamentals: Ceramics and Polymers (1.234) Recitation Section (large)  Prof. Gerold Schneider  Admission Requirements Recommended Previous Knowledge Module "Materials Science Laboratory" Module "Advanced Materials"  Educational Objectives Resolutional Objectives Professional Competence Knowledge The students are able to give an enhanced overview over the following learning results  Personal Competence Social Competence Johnson Autonomy The students are able to apply the appropriate physical and chemical methods for the above mentioned subjects.  Personal Competence Johnson Autonomy The students are capable to understand independently the structure and propeties of ceramics, metals and polymers. They should be able to critally evaluate the profoundness of their knowledge.  Workload in Hours Independent Study Time 110, Study Time in Lecture 70 Credit points Scale Assignment for the Examination General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Materials in Engineering, Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Materials in Engineering, Sciences: Compulsory	Courses				
Enhanced Fundamentals: Ceramics and Polymers (L1234)  Module Responsible Prof. Gerold Schneider  Admission Requirements  Recommended Previous Knowledge  Knowledge  Module "Advanced Materials Science" Admissional Objectives  Responsible Prof. Gerold Schneider  Module "Materials Science Laboratory" Module "Fundamentals of Materials Science"  Module "Advanced Materials"  Educational Objectives  After taking part successfully, students have reached the following learning results  Professional Competence  Knowledge  Knowledge  Knowledge  The students are able to give an enhanced overview over the following topics in metals, polymers and ceramics: Atomic bonds, crystal and amorphous structures, defects , electrical and mass transport microstructure and phase diagrams. They are capable to explain the corresponding technical terms.  Skills  Personal Competence  Social Competence  Autonomy  The students are able to apply the appropriate physical and chemical methods for the above mentioned subjects.  Personal Competence  Autonomy  The students are capable to understand independently the structure and propeties of ceramics, metals and polymers. They should be able to critally evaluate the profoundness of their knowledge.  Workload in Hours  Credit points  Course achievement  Examination  Mone  Examination duration and scale  Assignment for the Following Curricula  General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Materials in Following Curricula  Following Curricula	Title		Тур	Hrs/wk	СР
### Professional Competence  **Skills**  **Personal Competence  **Scial Competence  **Autonomy**  **Personal Competence  **Autonomy**  **Autonomy**  **Personal Competence  **Scial Competence  **Autonomy**  **Autonomy**  **The students are able to apply the appropriate physical and chemical methods for the above mentioned subjects.**  **Personal Competence  **Scial Competence  **Scial Competence  **Scial Competence  **Course achievement  **Subdents are capable to understand independently the structure and propeties of ceramics, metals and polymers. They should be able to critally evaluate the profoundness of their knowledge.**  **Workload in Hours**  **Workload in Hours**  **Workload in Hours**  **None  **Examination Written exam**  **Examination Written exam**  **Eamination duration and scale**  **Assignment for the Following Curricula**  **Assignment for the Following Curricula**  **Following Curricula**  **Personal Science**  **Personal Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Materials in Engineering, Focus Materials in Engineering, Focus Materials in Engineering, Focus Materials in Engineering Sciences: Compulsory**  **Personal Competence**  **Personal Competence**  **Autonomy**  **Workload in Hours**  **Personal Competence**  **Autonomy**  **Workload in Hours**  **Workload in Hours**  **None**  **Examination Written exam**  **Examination Written exam**  **Examination General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Materials in Engineering Sciences: Compulsory**  **Personal Competence**  **Assignment for the Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Materials in Engineering Sciences: Compulsory**  **Personal Competence**  **Personal Competence**  **Assignment for the Engineering Science**  **Personal Competence**  **Assignment for the Engineering Science**  **Educational Science**  **Personal Competence**  **Assignment for the Engineering Science**	Materials for Energy Storage and C	onversion (DE) (L1086)	Lecture	2	3
Module Responsible Admission Requirements None  Recommended Previous Knowledge Module "Fundamentals of Materials Science" Module "Materials Science Laboratory" Module "Materials Science Laboratory" Module "Advanced Materials"  Educational Objectives After taking part successfully, students have reached the following learning results  Professional Competence Knowledge The students are able to give an enhanced overview over the following topics in metals, polymers and ceramics: Atomic bonds, crystal and amorphous structures, defects , electrical and mass transport microstructure and phase diagrams. They are capable to explain the corresponding technical terms.  Skills  The students are able to apply the appropriate physical and chemical methods for the above mentioned subjects.  Personal Competence Autonomy The students are capable to understand independently the structure and propeties of ceramics, metals and polymers. They should be able to critally evaluate the profoundness of their knowledge.  Workload in Hours Independent Study Time 110, Study Time in Lecture 70  Credit points 6  Course achievement None  Examination Written exam  Examination duration and scale  Assignment for the Following Curricula Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Materials in Engineering Sciences: Compulsory			Lecture	2	2
Recommended Previous Module "Fundamentals of Materials Science" Module "Materials Science Laboratory" Module "Materials Science Laboratory" Module "Advanced Materials" After taking part successfully, students have reached the following learning results  Professional Competence Knowledge The students are able to give an enhanced overview over the following topics in metals, polymers and ceramics: Atomic bonds, crystal and amorphous structures, defects , electrical and mass transport microstructure and phase diagrams. They are capable to explain the corresponding technical terms.  Skills  Personal Competence Autonomy  The students are able to apply the appropriate physical and chemical methods for the above mentioned subjects.  Personal Competence Autonomy  The students are capable to understand independently the structure and propeties of ceramics, metals and polymers. They should be able to critally evaluate the profoundness of their knowledge.  Workload in Hours  Credit points 6  Course achievement None  Examination  Examination duration and scale  Assignment for the Following Curricula  Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Materials in Engineering Sciences: Compulsory	Enhanced Fundamentals: Ceramics	and Polymers (L1234)	Recitation Section (large)	1	1
Recommended Previous Knowledge Module "Materials Science Laboratory" Module "Advanced Materials"  Educational Objectives Professional Competence Knowledge  The students are able to give an enhanced overview over the following topics in metals, polymers and ceramics: Atomic bonds, crystal and amorphous structures, defects , electrical and mass transport microstructure and phase diagrams. They are capable to explain the corresponding technical terms.  Skills Personal Competence Social Competence Autonomy The students are able to apply the appropriate physical and chemical methods for the above mentioned subjects.  Personal Competence Autonomy The students are capable to understand independently the structure and propeties of ceramics, metals and polymers. They should be able to critally evaluate the profoundness of their knowledge.  Workload in Hours Independent Study Time 110, Study Time in Lecture 70 Credit points Course achievement Examination Examination Examination duration and scale Assignment for the Following Curricula Events and polymers of points and polymers of points and polymers of points and polymers. They should be defined points and polymers of their knowledge.  Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Materials in Engineering Sciences: Compulsory	Module Responsible	Prof. Gerold Schneider			
Module "Materials Science Laboratory"  Module "Advanced Materials"  Educational Objectives After taking part successfully, students have reached the following learning results  Professional Competence Knowledge  The students are able to give an enhanced overview over the following topics in metals, polymers and ceramics: Atomic bonds, crystal and amorphous structures, defects , electrical and mass transport microstructure and phase diagrams. They are capable to explain the corresponding technical terms.  Skills  Personal Competence Social Competence Autonomy  The students are able to apply the appropriate physical and chemical methods for the above mentioned subjects.  Personal Competence Autonomy  The students are capable to understand independently the structure and propeties of ceramics, metals and polymers. They should be able to critally evaluate the profoundness of their knowledge.  Workload in Hours  Independent Study Time 110, Study Time in Lecture 70  Credit points  Course achievement Examination  Examination duration and scale  Assignment for the Following Curricula and Science German program, 7 semester): Specialisation Mechanical Engineering, Focus Materials in Engineering Sciences: Compulsory	Admission Requirements	None			
Module "Materials Science Laboratory"  Module "Advanced Materials"  Educational Objectives  After taking part successfully, students have reached the following learning results  Professional Competence  Knowledge  The students are able to give an enhanced overview over the following topics in metals, polymers and ceramics: Atomic bonds, crystal and amorphous structures, defects , electrical and mass transport microstructure and phase diagrams. They are capable to explain the corresponding technical terms.  Skills  Personal Competence  Social Competence  Autonomy  The students are able to apply the appropriate physical and chemical methods for the above mentioned subjects.  Personal Competence  Autonomy  The students are capable to understand independently the structure and propeties of ceramics, metals and polymers. They should be able to critally evaluate the profoundness of their knowledge.  Workload in Hours  Credit points  Course achievement  None  Examination  Examination  Examination duration and scale  Assignment for the Following Curricula  Following Curricula  Engineering Sciences: Compulsory	Recommended Previous	Module "Fundamentals of Materials Science"			
Educational Objectives After taking part successfully, students have reached the following learning results  Professional Competence  Knowledge The students are able to give an enhanced overview over the following topics in metals, polymers and ceramics: Atomic bonds, crystal and amorphous structures, defects, electrical and mass transport microstructure and phase diagrams. They are capable to explain the corresponding technical terms.  Skills The students are able to apply the appropriate physical and chemical methods for the above mentioned subjects.  Personal Competence Social Competence Autonomy The students are capable to understand independently the structure and propeties of ceramics, metals and polymers. They should be able to critally evaluate the profoundness of their knowledge.  Workload in Hours Credit points Credit points 6 Course achievement None Examination Examination Examination duration and scale Assignment for the Following Curricula Engineering Sciences: Compulsory	Knowledge	Module "Materials Science Laboratory"			
Educational Objectives Professional Competence  Knowledge The students are able to give an enhanced overview over the following topics in metals, polymers and ceramics: Atomic bonds, crystal and amorphous structures, defects, electrical and mass transport microstructure and phase diagrams. They are capable to explain the corresponding technical terms.  Skills  Personal Competence Social Competence Autonomy The students are able to apply the appropriate physical and chemical methods for the above mentioned subjects.  Personal Competence Autonomy The students are capable to understand independently the structure and propeties of ceramics, metals and polymers. They should be able to critally evaluate the profoundness of their knowledge.  Workload in Hours Independent Study Time 110, Study Time in Lecture 70 Credit points 6 Course achievement None Examination Examination duration and Scale  Assignment for the Following Curricula Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Materials in Engineering Sciences: Compulsory		,			
Educational Objectives Professional Competence  Knowledge The students are able to give an enhanced overview over the following topics in metals, polymers and ceramics: Atomic bonds, crystal and amorphous structures, defects, electrical and mass transport microstructure and phase diagrams. They are capable to explain the corresponding technical terms.  Skills  Personal Competence Social Competence Autonomy The students are able to apply the appropriate physical and chemical methods for the above mentioned subjects.  Personal Competence Autonomy The students are capable to understand independently the structure and propeties of ceramics, metals and polymers. They should be able to critally evaluate the profoundness of their knowledge.  Workload in Hours Independent Study Time 110, Study Time in Lecture 70 Credit points 6 Course achievement None Examination Examination duration and Scale  Assignment for the Following Curricula Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Materials in Engineering Sciences: Compulsory					
Professional Competence  Knowledge  Knowledge  The students are able to give an enhanced overview over the following topics in metals, polymers and ceramics: Atomic bonds, crystal and amorphous structures, defects , electrical and mass transport microstructure and phase diagrams. They are capable to explain the corresponding technical terms.  Skills  The students are able to apply the appropriate physical and chemical methods for the above mentioned subjects.  Personal Competence  Social Competence  Autonomy  The students are capable to understand independently the structure and propeties of ceramics, metals and polymers. They should be able to critally evaluate the profoundness of their knowledge.  Workload in Hours  Independent Study Time 110, Study Time in Lecture 70  Credit points  Course achievement  Examination  Mone  Examination duration and scale  Assignment for the Following Curricula  Engineering Sciences: Compulsory		Module "Advanced Materials"			
The students are able to give an enhanced overview over the following topics in metals, polymers and ceramics: Atomic bonds, crystal and amorphous structures, defects, electrical and mass transport microstructure and phase diagrams. They are capable to explain the corresponding technical terms.  Skills  Personal Competence Social Competence Autonomy The students are able to apply the appropriate physical and chemical methods for the above mentioned subjects.  The students are capable to understand independently the structure and propeties of ceramics, metals and polymers. They should be able to critally evaluate the profoundness of their knowledge.  Workload in Hours Credit points Course achievement None Examination Examination Examination duration and scale Assignment for the Following Curricula General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Materials in Engineering Sciences: Compulsory	Educational Objectives	After taking part successfully, students have reached the fo	llowing learning results		
in metals, polymers and ceramics: Atomic bonds, crystal and amorphous structures, defects, electrical and mass transport microstructure and phase diagrams. They are capable to explain the corresponding technical terms.    Skills   The students are able to apply the appropriate physical and chemical methods for the above mentioned subjects.    Personal Competence   Social Competence   Autonomy	Professional Competence				
microstructure and phase diagrams. They are capable to explain the corresponding technical terms.  Skills  The students are able to apply the appropriate physical and chemical methods for the above mentioned subjects.  Personal Competence Social Competence Autonomy The students are capable to understand independently the structure and propeties of ceramics, metals and polymers. They should be able to critally evaluate the profoundness of their knowledge.  Workload in Hours Credit points Course achievement None Examination Written exam Examination duration and scale Assignment for the Following Curricula Engineering Sciences: Compulsory	Knowledge	The students are able to give an enhanced overview over the	ne following topics		
Personal Competence Social Competence Autonomy The students are capable to understand independently the structure and propeties of ceramics, metals and polymers. They should be able to critally evaluate the profoundness of their knowledge.  Workload in Hours Independent Study Time 110, Study Time in Lecture 70 Credit points 6 Course achievement Examination Written exam Examination duration and scale Assignment for the Following Curricula Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Materials in Engineering Sciences: Compulsory	_			ects , electrical	and mass transport,
Personal Competence Social Competence Autonomy The students are capable to understand independently the structure and propeties of ceramics, metals and polymers. They should be able to critally evaluate the profoundness of their knowledge.  Workload in Hours Independent Study Time 110, Study Time in Lecture 70  Credit points 6  Course achievement Examination Written exam  Examination duration and scale  Assignment for the Following Curricula Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Materials in Engineering Sciences: Compulsory		microstructure and phase diagrams. They are capable to ex	plain the corresponding technical	terms.	
Personal Competence Social Competence Autonomy The students are capable to understand independently the structure and propeties of ceramics, metals and polymers. They should be able to critally evaluate the profoundness of their knowledge.  Workload in Hours Independent Study Time 110, Study Time in Lecture 70  Credit points 6  Course achievement Examination Written exam  Examination duration and scale  Assignment for the Following Curricula Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Materials in Engineering Sciences: Compulsory					
Personal Competence Social Competence Autonomy The students are capable to understand independently the structure and propeties of ceramics, metals and polymers. They should be able to critally evaluate the profoundness of their knowledge.  Workload in Hours Independent Study Time 110, Study Time in Lecture 70  Credit points 6  Course achievement Examination Written exam  Examination duration and scale  Assignment for the Following Curricula Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Materials in Engineering Sciences: Compulsory					
Social Competence Autonomy The students are capable to understand independently the structure and propeties of ceramics, metals and polymers. They should be able to critally evaluate the profoundness of their knowledge.  Workload in Hours Independent Study Time 110, Study Time in Lecture 70  Credit points 6  Course achievement Examination Written exam  Examination duration and scale  Assignment for the Following Curricula Engineering Sciences: Compulsory	Skills	The students are able to apply the appropriate physical and	chemical methods for the above	mentioned subje	ects.
Social Competence Autonomy The students are capable to understand independently the structure and propeties of ceramics, metals and polymers. They should be able to critally evaluate the profoundness of their knowledge.  Workload in Hours Independent Study Time 110, Study Time in Lecture 70  Credit points 6  Course achievement Examination Written exam  Examination duration and scale  Assignment for the Following Curricula Engineering Sciences: Compulsory					
Autonomy The students are capable to understand independently the structure and propeties of ceramics, metals and polymers. They should be able to critally evaluate the profoundness of their knowledge.  Workload in Hours Independent Study Time 110, Study Time in Lecture 70  Credit points 6  Course achievement Examination Written exam  Examination duration and scale  Assignment for the Following Curricula Engineering Sciences: Compulsory					
Workload in Hours Independent Study Time 110, Study Time in Lecture 70  Credit points 6  Course achievement None  Examination Written exam  Examination duration and scale  Assignment for the Following Curricula  Engineering Sciences: Compulsory	,				
Workload in Hours Independent Study Time 110, Study Time in Lecture 70  Credit points 6  Course achievement None  Examination Written exam  Examination duration and scale  Assignment for the Following Curricula Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Materials in Engineering Sciences: Compulsory	Autonomy			ics, metals and p	olymers. They should
Credit points 6  Course achievement None  Examination Written exam  Examination duration and scale  Assignment for the Following Curricula Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Materials in Engineering Sciences: Compulsory		be able to critally evaluate the profoundness of their knowle	edge.		
Credit points 6  Course achievement None  Examination Written exam  Examination duration and scale  Assignment for the Following Curricula Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Materials in Engineering Sciences: Compulsory					
Credit points 6  Course achievement None  Examination Written exam  Examination duration and scale  Assignment for the Following Curricula Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Materials in Engineering Sciences: Compulsory					
Course achievement None  Examination Written exam  Examination duration and scale  Assignment for the Following Curricula Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Materials in Engineering Sciences: Compulsory	Workload in Hours	Independent Study Time 110, Study Time in Lecture 70			
Examination Written exam  Examination duration and scale  Assignment for the Following Curricula Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Materials in Engineering Sciences: Compulsory	Credit points	6			
Examination duration and scale  Assignment for the Following Curricula Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Materials in Engineering Sciences: Compulsory	Course achievement	None			
scale  Assignment for the General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Materials in Following Curricula Engineering Sciences: Compulsory	Examination	Written exam			
Assignment for the General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Materials in Engineering Sciences: Compulsory	Examination duration and	180 min			
Following Curricula Engineering Sciences: Compulsory	scale				
	Assignment for the	General Engineering Science (German program, 7 ser	nester): Specialisation Mechanic	cal Engineering,	Focus Materials in
Data Science: Core Qualification: Elective Compulsory	Following Curricula	Engineering Sciences: Compulsory			
		Data Science: Core Qualification: Elective Compulsory			
Mechanical Engineering: Specialisation Materials in Engineering Sciences: Compulsory		Mechanical Engineering: Specialisation Materials in Enginee	ring Sciences: Compulsory		
Technomathematics: Specialisation III. Engineering Science: Elective Compulsory		Technomathematics: Specialisation III. Engineering Science	Elective Compulsory		

Түр	Lecture
Hrs/wk	
СР	
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
	Prof. Jörg Weißmüller
Language	DE
Cycle	
	Advanced understanding of metals:
	Physical materials properties
	o Materials behaviour - elastic, thermal, electrical
	o Superelasticity and shape memory effect
	o Fundamentals of electrical conductivity in metals and semiconductors
	o Superconductivity
	Chemical (or "dry") corrosion
	o Driving forces and mechanisms
	o Passivation
	o Growth laws
	Introduction to electrochemistry
	o Electrolytes
	o lons
	o Solvatation
	o Dissolution and deposition of metals
	o Galvanic cells and cell voltage
	o Galvanic series
	o Nernst equation
	o Polarizable electrodes
	o Electrochemical double layer
	o Capacitive and pseudocapacitive processes
	o Capacitive currents and Faraday currents
	Electrochemical (or "wet") corrosion and corrosion protection

- o Basic observations
- o Galvanic corrosion
- o Protection against galvanic corrosion
- o Stainless steel
- o sacrificial anodes
- o Passivation and Pourbaix diagrams
- o Corrosion through gas reduction
- o Crevice corrosion
- o Stress corrosion cracking
- o Alloy corrosion and nanoporous metals
- Electrochemical energy storage
  - o How a battery works
  - o Lead accumulators
  - o Alkaline batteries
  - o Nickel-metal hydride accumulators
- o Flux batteries
- o Lithium-ion accumulators
- o Electrolytic and super capacitors
- o Fuel cells
- Materials for hydrogen storage
- o Storage strategies
- o Requirements for storage materials
- o State of the art
- · Magnetism and magnetic materials
- o Phenomenology: magnetic field and magnetization
- o Para-, ferro-, antiferromagnets; Curie transition
- o Magnetism at the atomic scale; exchange coupling
- o Magnetization isotherms, domains
- o Measurement methods
- o Magnetocrystalline anisotropy and domain walls
- o Hard magnetic materials and their applications
- o Soft magnetic materials and their applications

## Literature - Vorlesungsskript

- W.D. Callister, "Materialwissenschaften und Werkstofftechnik", Wiley-VCH 2012
- Carl H. Hamann, Wolf Vielstich, "Elektrochemie", Wiley-VCH; 4. Auflage 2005
- Kurzweil, Dietlmeier, "Elektrochemische Speicher" Springer Vieweg (2015) (eBook: https://link.springer.com/book/10.1007/978-3-658-10900-4 )
- B. D. Cullity, C.D. Graham, "Introduction to magnetic materials", John Wiley & Sons, 2011
- D. Jiles, "Introduction to magnetism and magnetic materials", CRC press, 2015

Course I 1233: Enhanced Fun	damentals: Ceramics and Polymers
Тур	Lecture
Hrs/wk	
СР	
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Prof. Gerold Schneider, Prof. Robert Meißner
Language	DE/EN
Cycle	SoSe SoSe
Content	1. Einführung
	Natürliche "Keramiken" - Steine "Künstliche" Keramik - vom Porzellan bis zur Hochleistungskeramik Anwendungen von Hochleistungskeramik
	2. Pulverherstellung
	Einteilung der Pulversyntheseverfahren
	Der Bayer-Prozess zur Al2O3-Herstellung
	Der Acheson-Prozess zur SiC-Herstellung
	Chemical Vapour Deposition
	Pulveraufbereitung
	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
	Janisch of aith historie
	Ionische Leitfähigkeit  Detiertes Zirkenevid in der Brannstoffreile und Lambdasende
	Dotiertes Zirkonoxid in der Brennstoffzelle und Lambdasonde
Literature	D R H Jones, Michael F. Ashby, Engineering Materials 1, An Introduction to Properties, Applications and Design, Elesevier
	D.W. Richerson, Modern Ceramic Engineering, Marcel Decker, New York, 1992
	W.D. Kingery, Introduction to Ceramics, John Wiley & Sons, New York, 1975
	D.J. Green, An introduction to the mechanical properties of ceramics", Cambridge University Press, 1998
	D. Munz, T. Fett, Ceramics, Springer, 2001
	Polymerwerkstoffe
	Struktur und mechanische Eigenschaften G.W.Ehrenstein; Hanser Verlag; ISBN 3-446-12478-0; ca. 20 €
	Kunststoffphysik
	W.Retting, H.M.Laun; Hanser Verlag; ISBN 3446162356; ca. 25 €
	Werkstoffkunde Kunststoffe G.Menges; Hanser Verlag; ISBN 3-446-15612-7; ca. 25 €
	Kunststoff-Kompendium
	A.Frank, K. Biederbick; Vogel Buchverlag; ISBN 3-8023-0135-8; ca.30 €

Course L1234: Enhanced 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	

## **Focus Mechatronics**

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

Module M0708: Electrical Engineering III: Circuit Theory and Transients				
Courses				
Title Circuit Theory (L0566) Circuit Theory (L0567)	Typ         Hrs/wk         CP           Lecture         3         4           Recitation Section (small)         2         2			
Module Responsible				
Admission Requirements				
Recommended Previous Knowledge	Electrical Engineering I and II, Mathematics I and II			
Educational Objectives	After taking part successfully, students have reached the following learning results			
Professional Competence				
Knowledge	Students are able to explain the basic methods for calculating electrical circuits. They know the Fourier series analysis of linear networks driven by periodic signals. They know the methods for transient analysis of linear networks in time and in frequency domain, and they are able to explain the frequency behaviour and the synthesis of passive two-terminal-circuits.			
Skills	The students are able to calculate currents and voltages in linear networks by means of basic methods, also when driven by periodic signals. They are able to calculate transients in electrical circuits in time and frequency domain and are able to explain the respective transient behaviour. They are able to analyse and to synthesize the frequency behaviour of passive two-terminal-circuits.			
Personal Competence				
Social Competence	Students work on exercise tasks in small guided groups. They are encouraged to present and discuss their results within th group.			
Autonomy	The students are able to find out the required methods for solving the given practice problems. Possibilities are given to test their knowledge during the lectures continuously by means of short-time tests. This allows them to control independently their educational objectives. They can link their gained knowledge to other courses like Electrical Engineering I and Mathematics I.			
Workload in Hours	Independent Study Time 110, Study Time in Lecture 70			
Credit points				
Course achievement	None			
Examination	Written exam			
Examination duration and				
scale				
Assignment for the				
Following Curricula				
	General Engineering Science (German program, 7 semester): Specialisation Electrical Engineering: Compulsory			
	Electrical Engineering: Core Qualification: Compulsory			
	Engineering Science: Specialisation Electrical Engineering: Compulsory  Computer Science in Engineering: Specialisation II. Mathematics & Engineering Science: Elective Compulsory			
	Mechatronics: Core Qualification: Compulsory			
	Technomathematics: Specialisation III. Engineering Science: Elective Compulsory			

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

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

Module M1320: Simulation and Design of Mechatronic Systems				
Courses				
Title	Тур	Hrs/wk	СР	
Simulation and Design of Mechatronic Systems (L1822)		Lecture	2	2
Simulation and Design of Mechatronic Systems (L1823) Recitation Section (large) 1			2	
Simulation and Design of Mechatron	ronic Systems (L1824) Practical Course 1 2			
Module Responsible				
Admission Requirements	None			
Recommended Previous	Fundatmentals of mechanics, control theory and electrical engineering			
Knowledge				
Educational Objectives	After taking part successfully, students have reached the	following learning results		
Professional Competence				
Knowledge	Students are able to describe methods and calculations for	or design, modeling, simulation and o	optimization of m	echatronic systems.
Skills	Students are able to apply modern algorithms for modeling of mechatronic systems. They can identify, simulate and design simple			
	systems and implement those in laboratory conditions.			
	-,,			
Personal Competence				
Social Competence	Students are able to work goal-oriented in small mixed gr	oups and present results to target g	roups.	
Autonomy	Students are able to recognize and improve knowledge de	eficits 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				
Course achievement				
Examination	Written exam			
Examination duration and	90 min			
scale				
Assignment for the	General Engineering Science (German program, 7 semes	ter): Specialisation Mechanical Engir	neering. Focus M	echatronics: Elective
Following Curricula		. ,	3,	
<b>J</b>	General Engineering Science (German program, 7 sem	nester): Specialisation Mechanical I	Engineering, Foo	us Aircraft Systems
	Engineering: Elective Compulsory	•		
	Digital Mechanical Engineering: Core Qualification: Compulsory			
	Mechanical Engineering: Specialisation Aircraft Systems Engineering: Compulsory			
	Mechanical Engineering: Specialisation Mechatronics: Compulsory			
	Mechatronics: Core Qualification: Compulsory			

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

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

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

Module M0730: Comp	outer Engineering				
Courses					
Title		Тур	Hrs/wk	СР	
Computer Engineering (L0321)		Lecture	3	4	
Computer Engineering (L0324)		Recitation Section (small)	1	2	
Module Responsible	Prof. Heiko Falk				
Admission Requirements	None				
Recommended Previous	Basic knowledge in electrical engineering				
Knowledge					
Educational Objectives	After taking part successfully, students have reached the follow	ving learning results			
Professional Competence					
Knowledge	This module deals with the foundations of the functionality of computing systems. It covers the layers from the assembly-level				
	programming down to gates. The module includes the following topics:				
	Introduction     Combinational larger Cates Basican also have Basican functions have been supplied to a suppl				
	Combinational logic: Gates, Boolean algebra, Boolean functions, hardware synthesis, combinational networks     Sequential logic: Flip flore, automata, systematic hardware design.				
	Sequential logic: Flip-flops, automata, systematic hardware design      Technological foundations				
	Technological foundations     Computer arithmetic: Integer addition, subtraction, multiplication and division.				
	<ul> <li>Computer arithmetic: Integer addition, subtraction, multiplication and division</li> <li>Basics of computer architecture: Programming models, MIPS single-cycle architecture, pipelining</li> </ul>				
	Memories: Memory hierarchies, SRAM, DRAM, caches	rirs single-cycle architecture, pr	penning		
	Input/output: I/O from the perspective of the CPU, principle.	oles of passing data point-to-poi	nt connections	husses	
	imput/output: 1/0 from the perspective of the cro, princi	or passing data, point-to-por	nic connections,	busses	
Skills	The students perceive computer systems from the architect's p	perspective, i.e., they identify the	e internal struct	ure and the physical	
	composition of computer systems. The students can analyze, h	ow highly specific and individua	l computers car	be built based on a	
	collection of few and simple components. They are able to dis	stinguish between and to explain	n the different a	abstraction layers of	
	today's computing systems - from gates and circuits up to com	plete processors.			
	After successful completion of the module, the students are				
	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				
	the impact that these low abstraction levels have on an entire				
	·		•		
Personal Competence					
Social Competence	Students are able to solve similar problems alone or in a group	and to present the results accor	dingly.		
Autonomy	Students are able to acquire new knowledge from specific literations	ature and to associate this knowl	edge with other	classes.	
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56				
Credit points	6				
Course achievement	Compulsory Bonus Form Description Yes 10 % Excercises				
Examination	Written exam				
_	90 minutes, contents of course and labs				
scale Assignment for the	General Engineering Science (German program, 7 semester): S	nocialization Computer Science	Compulsory		
Following Curricula	General Engineering Science (German program, 7 semester). 3	•		ocus Mechatronics	
rollowing curricula	Compulsory	er). Specialisation Mechanical	Liigineeriiig, i	ocus Mecharionics.	
	General Engineering Science (German program, 7 semester	·): Specialisation Mechanical Fr	ngineering Foc	ıs Δircraft Systems	
	Engineering: Compulsory	7. Specialisation Mechanical El	igineering, 1 oc	as Aircraft Systems	
	General Engineering Science (German program, 7 semester): 9	Specialisation Mechanical Engine	ering. Focus Th	eoretical Mechanical	
	Engineering: Compulsory				
	General Engineering Science (German program, 7 semes	ter): Specialisation Mechanical	Engineering,	Focus Materials in	
	Engineering Sciences: Compulsory		3 3.		
	General Engineering Science (German program, 7 semester):	Specialisation Mechanical Engin	eering, Focus P	roduct Development	
	and Production: Compulsory				
	General Engineering Science (German program, 7 semester	): Specialisation Mechanical En	gineering, Foci	us Energy Systems:	
	Compulsory				
	General Engineering Science (German program, 7 semest	er): Specialisation Mechanical	Engineering, F	ocus Biomechanics:	
	Compulsory				
	General Engineering Science (German program, 7 semester): S	pecialisation Electrical Engineeri	ng: Compulsory		
	General Engineering Science (German program, 7 semester): S	pecialisation Green Technologies	s, Focus Renewa	able Energy: Elective	
	Compulsory				
	Computer Science: Core Qualification: Compulsory				
	Data Science: Core Qualification: Elective Compulsory				
	Data Science: Specialisation I. Mathematics/Computer Science:	Elective Compulsory			
	Electrical Engineering: Core Qualification: Compulsory				
	Computer Science in Engineering: Core Qualification: Compulso				
	Integrated Building Technology: Core Qualification: Elective Co				
	Technomathematics: Specialisation II. Informatics: Elective Cor	npulsory			

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

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

Module M0662: Nume	erical Mathematics I				
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	a Makhamakik I I I fay Faninaaying Chudanka (gaye	an ar anglish) ar Anglysis C Lincov Al	nobro I I II for To		
Knowledge	<ul> <li>Mathematik I + II for Engineering Students (germ</li> <li>basic MATLAB/Python knowledge</li> </ul>	ian or english) <b>or</b> Analysis & Linear Ali	gebra i + ii ior i e	echnomathematicians	
Educational Objectives	After taking part successfully, students have reached th	ne following learning results			
Professional Competence					
Knowledge	Students are able to				
	<ul> <li>name numerical methods for interpolation, integration, least squares problems, eigenvalue problems, nonlinear root finding problems and to explain their core ideas,</li> <li>repeat convergence statements for the numerical methods,</li> <li>explain aspects for the practical execution of numerical methods with respect to computational and storage complexitx.</li> </ul>				
Skills	Students are able to				
	<ul> <li>implement, apply and compare numerical methods using MATLAB/Python,</li> <li>justify the convergence behaviour of numerical methods with respect to the problem and solution algorithm,</li> <li>select and execute a suitable solution approach for a given problem.</li> </ul>				
Personal Competence					
Social Competence	Students are able to				
	<ul> <li>work together in heterogeneously composed teams (i.e., teams from different study programs and background knowledge explain theoretical foundations and support each other with practical aspects regarding the implementation of algorithms.</li> </ul>				
Autonomy	Students are capable				
	to assess whether the supporting theoretical and     to assess their individual progess and, if necessa		individually or in	n a team,	
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56				
Credit points					
Course achievement					
Examination					
Examination duration and					
scale	50 minutes				
	General Engineering Science (German program, 7 seme	ester): Specialisation Computer Science	e: Compulsory		
_	General Engineering Science (German program, 7 seme			ory	
	General Engineering Science (German program, 7 Compulsory General Engineering Science (German program, 7 seme Engineering: Compulsory General Engineering Science (German program, 7 seme Engineering: Elective Compulsory General Engineering Science (German program, 7 seme Compulsory General Engineering Science (German program, 7 seme Elective Compulsory General Engineering Science (German program, 7 seme Elective Compulsory General Engineering Science (German program, 7 seme	ester): Specialisation Mechanical Enginemester): Specialisation Mechanical ester): Specialisation Mechanical Enginemester): Specialisation Mechanical	Engineering, Focus M neering, Focus M Engineering, Foc	neoretical Mechanical cus Aircraft Systems lechatronics: Elective	
	General Engineering Science (German program, 7 Engineering Sciences: Compulsory Bioprocess Engineering: Specialisation A - General Biop Computer Science: Specialisation II. Mathematics and E Data Science: Core Qualification: Compulsory Electrical Engineering: Core Qualification: Elective Compunity Engineering Science: Core Qualification: Compulsory Engineering Science: Core Qualification: Compulsory Computer Science in Engineering: Core Qualification: Computer Science in Engineering: Core Qualification: Computer Science in Engineering: Specialisation Theoretical Mechanical Engineering: Specialisation Energy Systems Theoretical Mechanical Engineering: Technical Compler	semester): Specialisation Mechanic rocess Engineering: Elective Compulsor ngineering Science: Elective Compulsor pulsory  ompulsory hanical Engineering: Compulsory :: Elective Compulsory	al Engineering, ory ory	Focus Materials in	

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

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

Courses				
litle		Тур	Hrs/wk	СР
Electrical Machines and Actuators (		Lecture	3	4
Electrical Machines and Actuators (		Recitation Section (large)	2	2
Module Responsible				
Admission Requirements	None			
Recommended Previous	Basics of mathematics, in particular complexe nur	mbers, integrals, differentials		
Knowledge	Basics of electrical engineering and mechanical en	ngineering		
Educational Objectives	After taking part successfully, students have reach	hed the following learning results		
<b>Professional Competence</b>				
Knowledge	Students can to draw and explain the basic princip	ples of electric and magnetic fields.		
	They can describe the function of the standar			
	characteristic curves. For typically used drives the	ey can explain the major parameters of the	energy efficiency	of the whole syster
	from the power grid to the driven engine.			
Skills	Students are able to calculate two-dimensional e	electric and magnetic fields in particular fe	rromagnetic circ	uits with air gap. Fo
	this they apply the usual methods of the design a	uf electric machines.		
	They can calulate the operational performance of	of electric machines from their given chara	cteristic data an	d selected quantitie
	and characteristic curves. They apply the usual ec		eccristic data dir	a serected quartere
	,	4		
Personal Competence				
Social Competence	none			
Autonomy	Students are able independently to calculate elec	tric and magnatic fields for applications. The	nev are able to a	nalyse independent
ratonomy	the operational performance of electric machines			
	and characteristic curves.	· · · · · · · · · · · · · · · · · · ·		,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,
Workload in Hours	Independent Study Time 110, Study Time in Lectu	ure 70		
Credit points				
Course achievement	None			
Examination	Subject theoretical and practical work			
Examination duration and		docian files		
scale	Design of four machines and actuators, review of	design files		
Assignment for the	Conoral Engineering Science (Corman program 7	competer), Specialization Flortrical Engine	oring, Floctive Co	mpulcony
Following Curricula	General Engineering Science (German program, 7			
rollowing curricula	General Engineering Science (German program, Compulsory	, 7 Semester). Specialisation Mechanical	Eligilieerilig, Foc	us chergy systems
	n, 7 semester): Specialisation Mechanica	al Engineering	Focus Mechatronic	
	Compulsory	.,, , semester, specialisation recitation	a. Engineering,	. ocus i recitationici
	General Engineering Science (German program, 7	semester): Specialisation Mechanical Engi	neerina. Focus Th	neoretical Mechanic
	Engineering: Elective Compulsory		3.	
	Digital Mechanical Engineering: Core Qualification	: Compulsory		
	Electrical Engineering: Core Qualification: Elective	Compulsory		
	Engineering Science: Specialisation Electrical Engi	ineering: Elective Compulsory		
	Green Technologies: Energy, Water, Climate: Spec	cialisation Energy Technology: Elective Com	pulsory	
	Logistics and Mobility: Specialisation Engineering	Science: Elective Compulsory		
	Logistics and Mobility: Specialisation Traffic Plann	ing and Systems: Elective Compulsory		
	Logistics and Mobility: Specialisation Production M	lanagement and Processes: Elective Compu	lsory	
	Mechanical Engineering: Core Qualification: Election	ve Compulsory		
	Mechatronics: Core Qualification: Compulsory			
	Technomathematics: Specialisation III. Engineerin	g Science: Elective Compulsory		
	Engineering and Management - Major in Logistics	and Mobility: Specialisation Traffic Planning	and Systems: El	ective Compulsory
	Engineering and Management - Major in Logistic	cs and Mobility: Specialisation Production	Management and	d Processes: Electiv
	Compulsory			

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

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

Module M0777: Semi	conductor Circuit Design			
Courses				
Title		Тур	Hrs/wk	СР
Semiconductor Circuit Design (L076		Lecture	3	4
Semiconductor Circuit Design (L086		Recitation Section (small)	1	2
Module Responsible				
Admission Requirements	None			
Recommended Previous	Fundamentals of electrical engineering			
Knowledge	Basics of physics, especially semiconductor physics	sics		
<b>Educational Objectives</b>	After taking part successfully, students have rea	ched the following learning results		
<b>Professional Competence</b>				
Knowledge	Students are able to explain the functions	ality of different MOS devices in electronic cir	cuite	
		circuits functions and where they are applied.		
		ality of fundamental operational amplifiers an		ions.
		gic circuits and can discuss their advantages		
		circuits and can explain their functionality ar		
	Students know the appropriate fields for the students know the appropriate fields for the students are students.	he use of bipolar transistors.		
Skills	Chudonto con coloulata the angelfications	of different MOC devises and son define the	annessana of ala	atuania ainevita
		of different MOS devices and can define the		ctronic circuits.
		ic circuits and can design different types of lo al amplifiers and bipolar transistors for speci	-	
	• Students can use MOS devices, operation	arampimers and bipolar transistors for speci-	ic applications.	
Personal Competence				
Social Competence				
Social competence	Students are able work efficiently in heter	rogeneous teams.		
	<ul> <li>Students working together in small group</li> </ul>	s can solve problems and answer professiona	l questions.	
Autonomy	Students are able to assess their level of	knowledge		
	- Stadents are able to assess their level of	Milowicage.		
Workload in Hours	Independent Study Time 124, Study Time in Lec	ture 56		
Credit points	6			
Course achievement	None			
Examination	Written exam			
Examination duration and	120 min			
scale				
Assignment for the	General Engineering Science (German program,			
Following Curricula	General Engineering Science (German progra	am, 7 semester): Specialisation Mechanic	al Engineering,	Focus Mechatronics
	Compulsory	uleon.		
	Data Science: Core Qualification: Elective Comp	•		
	Electrical Engineering: Core Qualification: Comp	•		
	Engineering Science: Specialisation Electrical En Engineering Science: Specialisation Mechatronic			
	General Engineering Science (English program,	• •	ring: Compulsor	
	General Engineering Science (English program,			
		•		
	Computer Science in Engineering: Specialisation II. Mathematics & Engineering Science: Elective Compulsory  Mechanical Engineering: Specialisation Mechatronics: Compulsory			
	Mechatronics: Core Qualification: Compulsory			

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

Course L0864: Semiconducto	or Circuit Design
Тур	Recitation Section (small)
Hrs/wk	1
СР	2
Workload in Hours	Independent Study Time 46, Study Time in Lecture 14
Lecturer	Prof. Matthias Kuhl, Weitere Mitarbeiter
Language	DE
Cycle	SoSe
Content	Basic circuits and characteristic curves of bipolar transistors Basic circuits and characteristic curves of MOS transistors for amplifiers Realization and dimensioning of operational amplifiers Realization of logic functions Basic circuits with MOS transistors for combinational and sequential logic Memory circuits Circuits for analog-to-digital and digital-to-analog converters Design of exemplary circuits
Literature	U. Tietze und Ch. Schenk, E. Gamm, Halbleiterschaltungstechnik, Springer Verlag, 14. Auflage, 2012, ISBN 3540428496  R. J. Baker, CMOS - Circuit Design, Layout and Simulation, J. Wiley & Sons Inc., 3. Auflage, 2011, ISBN: 047170055S  H. Göbel, Einführung in die Halbleiter-Schaltungstechnik, Berlin, Heidelberg Springer-Verlag Berlin Heidelberg, 2011, ISBN: 9783642208874 ISBN: 9783642208867  URL: http://site.ebrary.com/lib/alltitles/docDetail.action?docID=10499499  URL: http://dx.doi.org/10.1007/978-3-642-20887-4  URL: http://ebooks.ciando.com/book/index.cfm/bok_id/319955  URL: http://www.ciando.com/img/bo

Module M0854: Matho	ematics IV			
Courses				
Title     Typ       Differential Equations 2 (Partial Differential Equations) (L1043)     Lecture       Differential Equations 2 (Partial Differential Equations) (L1044)     Recitation Section (s			Hrs/wk 2 1	<b>CP</b> 1 1
Differential Equations 2 (Partial Differential Equations) (L1045) Complex Functions (L1038) Complex Functions (L1041)		Recitation Section (large) Lecture Recitation Section (small)	1 2 1	1 1 1
Complex Functions (L1042)	I	Recitation Section (large)	1	1
Module Responsible				
Admission Requirements				
Recommended Previous Knowledge	Mathematics I - III			
Educational Objectives	After taking part successfully, students have reached	the following learning results		
Professional Competence				
Knowledge				
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>			e course.
Personal Competence Social Competence				
Autonomy	<ul> <li>Students are capable of checking their unders precisely and know where to get help in solving</li> <li>Students have developed sufficient persistent problems.</li> </ul>	g them.		
Workload in Hours	Independent Study Time 68, Study Time in Lecture 1:	12		
Credit points	6			
Course achievement				
Examination	Written exam			
Examination duration and scale	60 min (Complex Functions) + 60 min (Differential Eq	juations 2)		
	General Engineering Science (German program 7 ser	mester): Specialisation Electrical Enginee	ring: Compulsor	v
Following Curricula	General Engineering Science (German program, 7 semester): Specialisation Electrical Engineering: Compulsory  General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Mechatronics:			
	Compulsory			
	General Engineering Science (German program, 7 ser	•		and the second
	General Engineering Science (German program, 7 ser Engineering: Elective Compulsory	mester): Specialisation Mechanical Engir	ieering, Focus 11	neoreticai Mechanicai
	Electrical Engineering: Core Qualification: Compulsory	<i>y</i>		
	General Engineering Science (English program, 7 sem		ing: Compulsory	,
	Computer Science in Engineering: Specialisation II. M		ive Compulsory	
	Mechanical Engineering: Specialisation Mechatronics:		orv.	
	Mechanical Engineering: Specialisation Theoretical Me Mechatronics: Core Qualification: Compulsory	echanical Engineering: Elective Compuls	ui y	
	Naval Architecture: Core Qualification: Compulsory			
	Theoretical Mechanical Engineering: Technical Compl	ementary Course Core Studies: Elective	Compulsory	

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

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

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

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

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

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

## **Focus Product Development and Production**

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

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

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

Module M0726: Produ	iction Technology			
Courses				
Title Fundamentals of Machine Tools (L0 Fundamentals of Machine Tools (L1 Forming and Cutting Technology (L	992)	<b>Typ</b> Lecture Recitation Section (large) Lecture	Hrs/wk 2 1 2	CP 2 1 2
Forming and Cutting Technology (L	0614)	Recitation Section (large)	1	1
Module Responsible	Prof. Wolfgang Hintze			
<b>Admission Requirements</b>	None			
Recommended Previous Knowledge	without major course assessment internship recommended Previous knowledge in mathematics, mechan	ics and electrical engineering		
Educational Objectives	After taking part successfully, students have	reached the following learning results		
Professional Competence	Students are able to  explain the basics of chip formation an explain methods and parameters for deexplain technical concepts of machine		n the machine too	l industry.
Skills	Students are able to  • select tool geometry, cutting materials, process parameters and appropriate measuring technique in accordance with the requirements.  • estimate occurring forces and temperatures during chip formation.  • select appropriate machine tools for machining and create NC programs for turning and milling.  • assess the quality of a machine tools and to detect weak points.			
Personal Competence Social Competence	Students are able to  • develop solutions in a production envir	ronment with qualified personnel at technical le	evel and represen	t decisions.
Autonomy	Students are able to  interpret independently cutting proces create independently NC programs. select independently machine tools by assess own strengths and weaknesses assess their learning progress and defi assess possible consequences of their	reference to appropriate requirements. in general. ne gaps to be improved.		
Workload in Hours	Independent Study Time 96, Study Time in Le	ecture 84		
Credit points	6			
Course achievement				
Examination	Written exam			
Examination duration and scale				
-	and Production: Compulsory Mechanical Engineering: Specialisation Produ	am, 7 semester): Specialisation Mechanical Er ct Development and Production: Compulsory on: Technical Complementary Course Core Stu		·

Course L0689: Fundamentals	s of Machine Tools
	Lecture
Hrs/wk	
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Prof. Thorsten Schüppstuhl
Language	DE
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
	seim (a.a.). Springer, 2000

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

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

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

Module M0725: Produ	uction Engineering			
Courses				
Title		Тур	Hrs/wk	СР
Production Engineering I (L0608)		Lecture	2	2
Production Engineering I (L0612)		Recitation Section (large)	1	1
Production Engineering II (L0610)		Lecture	2	2
Production Engineering II (L0611)	_	Recitation Section (large)	1	1
Module Responsible	Prof. Wolfgang Hintze			
Admission Requirements	None			
	no course assessments required			
Knowledge	internship recommended			
Educational Objectives	After taking part successfully, students have reached	the following learning results		
Professional Competence				
•	Students are able to			
raremeage	Stage.nes are able to m			
	<ul> <li>name basic criteria for the selection of manufa</li> </ul>	cturing processes.		
	name the main groups of Manufacturing Techr	ology.		
	<ul> <li>name the application areas of different manufactors</li> </ul>	acturing processes.		
	<ul> <li>name boundaries, advantages and disadvanta</li> </ul>	ges of the different manufacturing proce	SS.	
	<ul> <li>describe elements, geometric properties and k</li> </ul>	inematic variables and requirements for	tools, workpiece	and process.
	explain the essential models of manufacturing	technology.		
Skills	Students are able to			
	- colock manufacturing processes in accordance	with the requirements		
	select manufacturing processes in accordance     design as a suffacturing processes for already to the second			d
	design manufacturing processes for simple tas		e component to b	e produced.
	assess components in terms of their productio	n-oriented construction.		
Personal Competence				
Social Competence	Students are able to			
	develop solutions in a production environment	with qualified personnel at technical lev	el and represent	decisions.
			·	
Autonomy	Students are able to			
	interpret independently the manufacturing pro	cess.		
	assess own strengths and weaknesses in gene	ral.		
	assess their learning progress and define gaps	s to be improved.		
	assess possible consequences of their actions			
Workload in Hours	Independent Study Time 96, Study Time in Lecture 8	1		
Credit points	6			
Course achievement				
Examination	Written exam			
Examination duration and				
scale		um octou). Cu oci-li-ti ta la	incomin F ==	no duct Day 1
Assignment for the		erriester): Specialisation Mechanical Engi	meering, Focus P	roduct Developme
Following Curricula	and Production: Compulsory	manatan). Canadalis-tis tt	andre 5- =	namahia-184 :
	General Engineering Science (German program, 7 se	mester): Specialisation Mechanical Engir	ieering, Focus Th	euretical Mechanic
	Engineering: Elective Compulsory			
	Digital Mechanical Engineering: Core Qualification: Co	, .		
	Engineering Science: Specialisation Mechanical Engin			
	General Engineering Science (English program, 7 sen			ry
	Green Technologies: Energy, Water, Climate: Speciali		pulsory	
	Logistics and Mobility: Specialisation Production Mana			
	Logistics and Mobility: Specialisation Engineering Science			
	Mechanical Engineering: Core Qualification: Compulso	ory		
	Mechatronics: Core Qualification: Compulsory			
	Engineering and Management - Major in Logistics and			

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

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

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

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

Module M0730: Comp	outer Engineering			
Courses				
Title		Тур	Hrs/wk	СР
Computer Engineering (L0321)		Lecture	3	4
Computer Engineering (L0324)		Recitation Section (small)	1	2
Module Responsible	Prof. Heiko Falk			
Admission Requirements	None			
Recommended Previous				
	Basic knowledge in electrical engineering			
Knowledge				
Educational Objectives	After taking part successfully, students have reached the following	ng learning results		
Professional Competence				
Knowledge	This module deals with the foundations of the functionality of	computing systems. It covers	the layers from	the assembly-level
	programming down to gates. The module includes the following	topics:		
	Introduction			
		ctions hardware synthesis com	shinational note	orks
	Combinational logic: Gates, Boolean algebra, Boolean fund     Convential logic: Flip flore, automate, gustomatic barduna		ibiliational netw	IOIKS
	Sequential logic: Flip-flops, automata, systematic hardwar  Tackgrafa sized form detical.	e design		
	Technological foundations			
	Computer arithmetic: Integer addition, subtraction, multip			
	Basics of computer architecture: Programming models, MI	PS single-cycle architecture, pi	pelining	
	Memories: Memory hierarchies, SRAM, DRAM, caches			
	Input/output: I/O from the perspective of the CPU, principl	es of passing data, point-to-poi	nt connections,	busses
Skille	The students perceive computer systems from the architect's pe	renactive i.e. they identify the	internal structi	ure and the physical
Skills	composition of computer systems. The students can analyze, ho			
	collection of few and simple components. They are able to dist		i the different a	abstraction layers of
	today's computing systems - from gates and circuits up to comp	ete processors.		
	After successful completion of the module, the students are al	ole to judge the interdepender	icies between a	physical computer
	system and the software executed on it. In particular, they shall			
	on the hardware-centric abstraction layers from the assembly la			
	the impact that these low abstraction levels have on an entire sy			
			,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,	
Personal Competence				
Social Competence	Students are able to solve similar problems alone or in a group a	nd to present the results accord	dingly.	
Autonomy	Students are able to acquire new knowledge from specific literat	ure and to associate this knowle	edge with other	classes.
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56			
Credit points	6			
Course achievement	Compulsory Bonus Form Description			
course acmevement	Yes 10 % Excercises			
Examination	Written exam			
Examination duration and	90 minutes, contents of course and labs			
	90 minutes, contents of course and labs			
scale				
Assignment for the		·		
Following Curricula	General Engineering Science (German program, 7 semester	r): Specialisation Mechanical	Engineering, F	ocus Mechatronics:
	Compulsory			
	General Engineering Science (German program, 7 semester):	Specialisation Mechanical En	gineering, Focu	us Aircraft Systems
	Engineering: Compulsory			
	General Engineering Science (German program, 7 semester): Sp	ecialisation Mechanical Engine	ering, Focus The	eoretical Mechanical
	Engineering: Compulsory			
	General Engineering Science (German program, 7 semeste	er): Specialisation Mechanical	Engineering,	Focus Materials in
	Engineering Sciences: Compulsory			
	General Engineering Science (German program, 7 semester): S	pecialisation Mechanical Engine	eering, Focus Pr	roduct Development
	and Production: Compulsory			
	General Engineering Science (German program, 7 semester):	Specialisation Mechanical En	gineering, Focι	is Energy Systems:
	Compulsory			
	General Engineering Science (German program, 7 semester	): Specialisation Mechanical	Engineering, Fo	ocus Biomechanics:
	Compulsory			
	General Engineering Science (German program, 7 semester): Sp	ecialisation Electrical Engineeri	ng: Compulsorv	
	General Engineering Science (German program, 7 semester): Sp			
	Compulsory			
	Computer Science: Core Qualification: Compulsory			
	Data Science: Core Qualification: Elective Compulsory			
	Data Science: Specialisation I. Mathematics/Computer Science: E	lective Compulsory		
	Electrical Engineering: Core Qualification: Compulsory			
	Computer Science in Engineering: Core Qualification: Compulsory	V.		
	Integrated Building Technology: Core Qualification: Elective Com			
	Technomathematics: Specialisation II. Informatics: Elective Comp	ouisUl y		

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

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

Courses						
<b>Title</b> CAE-Team Project (L0271)				<b>Typ</b> Project-/problem-based Learning	Hrs/wk 2	<b>CP</b> 2
Development of Lightweight Design	n Products (L0270)			Lecture	2	2
Integrated Product Development I (				Lecture	2	2
	Prof. Dieter Krause					
Admission Requirements	None					
Recommended Previous	Advanced Knowledge ab	out engineering desig	n:			
Knowledge	Fundamentals of Mechai					
	Mechanical Engineering:	Design				
	Advanced Mechanical Er	ngineering Design				
Educational Objectives	After taking part success	sfully, students have re	eached the followin	ig learning results		
Professional Competence				<u> </u>		
-	After completing the mo	dule, students are cap	able of:			
		nctional principle of 3D eraction of the differer	•	M- and FEM-Systems the product development proces	SS .	
Skills						
	After completing the mo	dule, students are abl	e to:			
	product structurin	ng	-	to the desired requirements su -Systems with shared workload	ıch as classifi	cation schemes ar
Personal Competence						
Social Competence	After completing the mo	dule, students are abl	e to:			
	<ul> <li>To develop a proje</li> </ul>	ect plan and allocate v	vork appropriate w	ork packages in the framework	of group discu	ussions
	<ul> <li>Present project re</li> </ul>	sults as a team for ins	tance in a presenta	ation		
Autonomy	Students are capable of:					
	independently add	apt to a CAE-Tool and	complete a given p	practical task with it		
Workload in Hours	Independent Study Time	96, Study Time in Led	ture 84			
Credit points	6					
Course achievement		orm	Description		<u> </u>	
			andCAE-Teampro	jekt inkl. Vortrag und Ausarbeiti	ung	
		ractical work				
Examination						
Examination duration and scale	90					
	Gonoral Engineering Sc	cionco (Gorman progr	am 7 somostor):	Specialisation Mechanical End	incoring Foc	us Aircraft Systom
•	3		am, / semester):	Specialisation Mechanical Eng	meemig, FOC	us Allicialt System
rollowing Curricula	Engineering: Compulsory		m 7 comostor\. C=	pocialisation Mochanical Engine	oring Facus D	roduct Dovolones
			ii, / semester): Sp	ecialisation Mechanical Engine	ening, rocus P	roduct Developme
	and Production: Compuls	-	l Enginopring: Elec	tivo Compulson		
	Engineering Science: Sp				na: Elective C	ompulsory
				cialisation Mechanical Engineeri	ng: Elective Co	umpuisory
	Mechanical Engineering: Mechanical Engineering:	•		Production: Compulsory		
	rmechanicai Engineering:			mu, compuisory		

Course L0271: CAE-Team Project		
Тур	Project-/problem-based Learning	
Hrs/wk	2	
СР	2	
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28	
Lecturer	Prof. Dieter Krause	
Language	DE	
Cycle	SoSe	
Content	<ul> <li>Practical Introduction in the used software systems (Creo, Windchill, Hyperworks)</li> <li>Team formation, allocation of tasks and generation of a project plan</li> <li>Collective creation of one product out of CAD models supported by FEM calculations and PDM system</li> <li>Manufacturing of selected parts using 3D printer</li> <li>Presentation of results</li> <li>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.</li> </ul>	
Literature	-	

Course I 0270: Development	of Linkhusinkh Darius Burdusk
•	of Lightweight Design Products
Тур	Lecture
Hrs/wk	2
СР	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Prof. Dieter Krause, Prof. Benedikt Kriegesmann
Language	DE
Cycle	SoSe
Content	<ul> <li>Lightweight design materials</li> <li>Product development process for lightweight structures</li> <li>Dimensioning of lightweight structures</li> </ul>
Literature	<ul> <li>Schürmann, H., "Konstruieren mit Faser-Kunststoff-Verbunden", Springer, Berlin, 2005.</li> <li>Klein, B., "Leichtbau-Konstruktion", Vieweg &amp; Sohn, Braunschweig, 1989.</li> <li>Krause, D., "Leichtbau", In: Handbuch Konstruktion, Hrsg.: Rieg, F., Steinhilper, R., München, Carl Hanser Verlag, 2012.</li> <li>Schulte, K., Fiedler, B., "Structure and Properties of Composite Materials", Hamburg, TUHH - TuTech Innovation GmbH, 2005.</li> <li>Wiedemann, J., "Leichtbau Band 1: Elemente", Springer, Berlin, Heidelberg, 1986.</li> </ul>

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

Module M0865: Funda	amentals of Production and Qu	ality Management		
Courses				
Title		Тур	Hrs/wk	СР
Production Process Organization (LG	0925)	Lecture	2	3
Quality Management (L0926) Lecture 2 3			3	
Module Responsible	Prof. Hermann Lödding			
Admission Requirements	None			
Recommended Previous	None			
Knowledge				
<b>Educational Objectives</b>	After taking part successfully, students have	reached the following learning results		
Professional Competence				
Knowledge	Students are able to explain the contents of	the lecture of the module.		
Skills	Students are able to apply the methods and models in the module to industrial problems.			
Personal Competence				
Social Competence	-			
Autonomy	-			
Workload in Hours	Independent Study Time 124, Study Time in	Lecture 56		
Credit points	6			
Course achievement	None			
Examination	Written exam			
Examination duration and	180 Minuten			
scale				
Assignment for the	General Engineering Science (German pro	gram, 7 semester): Specialisation Mecha	nical Engineering, Focu	ıs Aircraft Systems
Following Curricula	Engineering: Compulsory			
	General Engineering Science (German progr	am, 7 semester): Specialisation Mechanica	l Engineering, Focus Pr	oduct Development
	and Production: Compulsory			
	General Engineering Science (German progra	nm, 7 semester): Specialisation Advanced N	laterials: Elective Comp	ulsory
	Engineering Science: Core Qualification: Com	pulsory		
	Engineering Science: Specialisation Mechatro	onics: Elective Compulsory		
	Engineering Science: Specialisation Mechanic			
	Engineering Science: Specialisation Advance			
	Logistics and Mobility: Specialisation Product	-	ry	
	Logistics and Mobility: Specialisation Enginee			
	Mechanical Engineering: Core Qualification: E	• •		
	Engineering and Management - Major in Logi	stics and Mobility: Specialisation Production	n Management and Proc	esses: 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	EN
Cycle	SoSe
Content	(A) Introduction
	(B) Product planning
	(C) Process planning
	(D) Procurement
	(E) Manufacturing
	(F) Production planning and control (PPC)
	(G) Distribution
	(H) Cooperation
Literature	Wiendahl, HP.: Betriebsorganisation für Ingenieure
	Vorlesungsskript

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

## **Focus Theoretical Mechanical Engineering**

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

Courses	
	To Hartel OR
Title Numerical Mathematics I (L0417)	Typ Hrs/wk CP Lecture 2 3
Numerical Mathematics I (L0417)	Recitation Section (small) 2 3
	Prof. Sabine Le Borne
Admission Requirements	
Recommended Previous	<ul> <li>Mathematik I + II for Engineering Students (german or english) or Analysis &amp; Linear Algebra I + II for Technomathematic</li> </ul>
Knowledge	basic MATLAB/Python knowledge
Educational Objectives	
Professional Competence	
Knowledge	Students are able to
	<ul> <li>name numerical methods for interpolation, integration, least squares problems, eigenvalue problems, nonlinear root fin</li> </ul>
	problems and to explain their core ideas,
	repeat convergence statements for the numerical methods,
	<ul> <li>explain aspects for the practical execution of numerical methods with respect to computational and storage complexitx.</li> </ul>
	Copper deposit of the proceed of the control of the
61.77	Chudanta ava abla ta
Skills	Students are able to
	implement, apply and compare numerical methods using MATLAB/Python,
	• justify the convergence behaviour of numerical methods with respect to the problem and solution algorithm,
	<ul> <li>select and execute a suitable solution approach for a given problem.</li> </ul>
Personal Competence	
Social Competence	Students are able to
	work together in heterogeneously composed teams (i.e., teams from different study programs and background knowledge)
	explain theoretical foundations and support each other with practical aspects regarding the implementation of algorithm
Autonomy	Students are capable
, income my	Section of Copus
	to assess whether the supporting theoretical and practical excercises are better solved individually or in a team,
	to assess their individual progess and, if necessary, to ask questions and seek help.
Workload in Hours	
Credit points	6
Course achievement	None
Examination	Written exam
Examination duration and	90 minutes
scale	
Assignment for the	
Following Curricula	General Engineering Science (German program, 7 semester): Specialisation Biomedical Engineering: Compulsory
	General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Biomechan
	Compulsory
	General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Theoretical Mechan
	Engineering: Compulsory
	Zingineering, compaisory
	General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Aircraft Syst
	General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Aircraft Syst
	General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Aircraft Syst Engineering: Elective Compulsory
	General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Aircraft Syst Engineering: Elective Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Mechatronics: Elec
	General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Aircraft Syst Engineering: Elective Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Mechatronics: Electromorphisms
	General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Aircraft Syst Engineering: Elective Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Mechatronics: Elec Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Energy Systems
	General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Aircraft Syst Engineering: Elective Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Mechatronics: Electompulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Energy System Elective Compulsory General Engineering Science (German program, 7 semester): Specialisation Advanced Materials: Compulsory
	General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Aircraft Syst Engineering: Elective Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Mechatronics: Elective Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Energy Syste Elective Compulsory
	General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Aircraft Syst Engineering: Elective Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Mechatronics: Electromorphics Electromorphics (German program, 7 semester): Specialisation Mechanical Engineering, Focus Energy System Elective Compulsory General Engineering Science (German program, 7 semester): Specialisation Advanced Materials: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Material Engineering Sciences: Compulsory
	General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Aircraft Syst Engineering: Elective Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Mechatronics: Electompulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Energy System Elective Compulsory General Engineering Science (German program, 7 semester): Specialisation Advanced Materials: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Material Engineering Sciences: Compulsory Bioprocess Engineering: Specialisation A - General Bioprocess Engineering: Elective Compulsory
	General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Aircraft Syst Engineering: Elective Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Mechatronics: Electompulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Energy Syste Elective Compulsory General Engineering Science (German program, 7 semester): Specialisation Advanced Materials: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Material Engineering Sciences: Compulsory Bioprocess Engineering: Specialisation A - General Bioprocess Engineering: Elective Compulsory Computer Science: Specialisation II. Mathematics and Engineering Science: Elective Compulsory
	General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Aircraft Syst Engineering: Elective Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Mechatronics: Electompulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Energy Syste Elective Compulsory General Engineering Science (German program, 7 semester): Specialisation Advanced Materials: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Material Engineering Sciences: Compulsory Bioprocess Engineering: Specialisation A - General Bioprocess Engineering: Elective Compulsory Computer Science: Specialisation II. Mathematics and Engineering Science: Elective Compulsory Data Science: Core Qualification: Compulsory
	General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Aircraft Syst Engineering: Elective Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Mechatronics: Electompulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Energy Syste Elective Compulsory General Engineering Science (German program, 7 semester): Specialisation Advanced Materials: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Material Engineering Sciences: Compulsory Bioprocess Engineering: Specialisation A - General Bioprocess Engineering: Elective Compulsory Computer Science: Specialisation II. Mathematics and Engineering Science: Elective Compulsory Data Science: Core Qualification: Compulsory Electrical Engineering: Core Qualification: Elective Compulsory
	General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Aircraft Syst Engineering: Elective Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Mechatronics: Electompulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Energy Syste Elective Compulsory General Engineering Science (German program, 7 semester): Specialisation Advanced Materials: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Material Engineering Sciences: Compulsory Bioprocess Engineering: Specialisation A - General Bioprocess Engineering: Elective Compulsory Computer Science: Specialisation II. Mathematics and Engineering Science: Elective Compulsory Data Science: Core Qualification: Compulsory Electrical Engineering: Core Qualification: Elective Compulsory Engineering Science: Core Qualification: Compulsory
	General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Aircraft Syst Engineering: Elective Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Mechatronics: Electory Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Energy Syste Elective Compulsory General Engineering Science (German program, 7 semester): Specialisation Advanced Materials: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Material Engineering Sciences: Compulsory Bioprocess Engineering: Specialisation A - General Bioprocess Engineering: Elective Compulsory Computer Science: Specialisation II. Mathematics and Engineering Science: Elective Compulsory Data Science: Core Qualification: Compulsory Electrical Engineering: Core Qualification: Elective Compulsory Engineering Science: Core Qualification: Compulsory Engineering Science: Core Qualification: Compulsory
	General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Aircraft Syst Engineering: Elective Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Mechatronics: Electompulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Energy Syste Elective Compulsory General Engineering Science (German program, 7 semester): Specialisation Advanced Materials: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Material Engineering Sciences: Compulsory Bioprocess Engineering: Specialisation A - General Bioprocess Engineering: Elective Compulsory Computer Science: Specialisation II. Mathematics and Engineering Science: Elective Compulsory Data Science: Core Qualification: Compulsory Electrical Engineering: Core Qualification: Elective Compulsory Engineering Science: Core Qualification: Compulsory Engineering Science: Core Qualification: Compulsory Computer Science in Engineering: Core Qualification: Compulsory
	General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Aircraft Syst Engineering: Elective Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Mechatronics: Electompulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Energy Syste Elective Compulsory General Engineering Science (German program, 7 semester): Specialisation Advanced Materials: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Material Engineering Sciences: Compulsory Bioprocess Engineering: Specialisation A - General Bioprocess Engineering: Elective Compulsory Computer Science: Specialisation II. Mathematics and Engineering Science: Elective Compulsory Data Science: Core Qualification: Compulsory Electrical Engineering: Core Qualification: Elective Compulsory Engineering Science: Core Qualification: Compulsory Engineering Science: Core Qualification: Compulsory Computer Science in Engineering: Core Qualification: Compulsory Mechanical Engineering: Specialisation Theoretical Mechanical Engineering: Compulsory
	General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Aircraft Syst Engineering: Elective Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Mechatronics: Electompulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Energy Syste Elective Compulsory General Engineering Science (German program, 7 semester): Specialisation Advanced Materials: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Material Engineering Sciences: Compulsory Bioprocess Engineering: Specialisation A - General Bioprocess Engineering: Elective Compulsory Computer Science: Specialisation II. Mathematics and Engineering Science: Elective Compulsory Data Science: Core Qualification: Compulsory Electrical Engineering: Core Qualification: Elective Compulsory Engineering Science: Core Qualification: Compulsory Engineering Science: Core Qualification: Compulsory Computer Science in Engineering: Core Qualification: Compulsory

Process Engineering: Specialisation Process Engineering: Elective Compulsory

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

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

Module M0684: Heat	Transfer	
Courses		
Title	Typ Hrs/wk CP	
Heat Transfer (L0458)	Lecture 3 4	
Heat Transfer (L0459)	Recitation Section (large) 2 2	
Module Responsible	Dr. Andreas Moschallski	
Admission Requirements	None	
	Technical Thermodynamics I, II and Fluid Dynamics	
Knowledge		
	After taking part successfully, students have reached the following learning results	
Professional Competence		
Knowledge	The students can	
	- explain the technical terms,	
	classify the various physical processes of heat transfer in terms of conduction based and radiation based mechanisms	
	- classify the various physical processes of heat transfer in terms of conduction-based and radiation-based mechanisms,	
	- simplify and critically analyze complex heat transfer processes using models,	
	- methodically develop solutions to tasks.	
Skills	The students are able to	
	- describe the physics of the different Heat Transfer mechanism,	
	- simplifywith models, calculate and evaluate complex Heat Transfer processes,	
	- critically question and answer statements on heat transfer,	
	- solve excersises self-consistent and in small groups.	
Personal Competence		
Social Competence	In lectures and exercises, the students can use many examples and experiments to discuss in small groups in a goal-orie	nted
	manner, develop a solution and present it. Within the exercises, the students can independently develop further questions	and
	work out targeted solutions.	
Autonomy	The students can check their level of knowledge by means of repetition questions at the beginning of the lectures and describe	
	discuss answers in exchange with the other students. In the exercises, the students work in small groups on the methods taug the lectures in complex tasks and critically analyze the results in the auditorium.	nt in
	the feetures in complex tasks and children analyze the results in the additionalin.	
Workload in Hours	Independent Study Time 110, Study Time in Lecture 70	
Credit points		
Course achievement		
Examination	Written exam	
Examination duration and		
scale		
Assignment for the	General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Energy Syst	ems:
Following Curricula		
	General Engineering Science (German program, 7 semester): Specialisation Biomedical Engineering: Compulsory	
	General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Theoretical Mecha	nical
	Engineering: Compulsory	
	Energy Systems: Technical Complementary Course Core Studies: Elective Compulsory	
	Integrated Building Technology: Core Qualification: Compulsory	
	Mechanical Engineering: Specialisation Energy Systems: Compulsory	
	Mechanical Engineering: Specialisation Theoretical Mechanical Engineering: Elective Compulsory	

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

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

Module M0725: Produ	iction Engineering			
Courses				
Title		Тур	Hrs/wk	СР
Production Engineering I (L0608)		Lecture	2	2
Production Engineering I (L0612)		Recitation Section (large)	1	1
Production Engineering II (L0610)		Lecture	2	2
Production Engineering II (L0611)		Recitation Section (large)	1	1
Module Responsible	Prof. Wolfgang Hintze			
Admission Requirements	None			
	no course assessments required			
Knowledge	internship recommended			
Educational Objectives	After taking part successfully, students have reached th	o following loarning results		
Professional Competence	Arter taking part successiony, students have reached th	e following learning results		
•	Students are able to			
Knowieuge	Students are able to			
	<ul> <li>name basic criteria for the selection of manufactu</li> </ul>	ring processes.		
	<ul> <li>name the main groups of Manufacturing Technology</li> </ul>	gy.		
	<ul> <li>name the application areas of different manufact</li> </ul>	uring processes.		
	<ul> <li>name boundaries, advantages and disadvantages</li> </ul>	of the different manufacturing proces	SS.	
	<ul> <li>describe elements, geometric properties and kine</li> </ul>	matic variables and requirements for	tools, workpiece	and process.
	<ul> <li>explain the essential models of manufacturing ter</li> </ul>	chnology.		
Skills	Students are able to			
	<ul> <li>select manufacturing processes in accordance wi</li> </ul>	th the requirements		
	design manufacturing processes for simple tasks		component to h	e produced
	assess components in terms of their production-or		. component to b	e produced.
	assess components in terms of their production-c	mented construction.		
Personal Competence				
	Students are able to			
30ciai competence	Students are able to			
	<ul> <li>develop solutions in a production environment wi</li> </ul>	th qualified personnel at technical leve	el and represent	decisions.
Autonomy	Students are able to			
	<ul> <li>interpret independently the manufacturing proce</li> </ul>	Te.		
	assess own strengths and weaknesses in general			
	assess their learning progress and define gaps to			
	<ul> <li>assess their rearring progress and define gaps to</li> <li>assess possible consequences of their actions.</li> </ul>	be improved.		
	ussess possible consequences of their actions.			
Workload in Hours	Independent Study Time 96, Study Time in Lecture 84			
<u></u>				
Credit points  Course achievement				
	Written exam			
Examination Examination and				
scale	120 11111			
Assignment for the	General Engineering Science (German program, 7 sem	ester): Specialisation Mechanical Engi	neering, Focus P	roduct Developme
-	and Production: Compulsory	, -p		
<del></del>	General Engineering Science (German program, 7 seme	ster): Specialisation Mechanical Engin	eering, Focus Th	eoretical Mechanic
	Engineering: Elective Compulsory	, English Recharded English		
	Digital Mechanical Engineering: Core Qualification: Com	pulsory		
	Engineering Science: Specialisation Mechanical Enginee	•		
	General Engineering Science (English program, 7 semes		ering: Compulsor	v
	Green Technologies: Energy, Water, Climate: Specialisa	· ·		J
	Logistics and Mobility: Specialisation Production Manage		- G1501 y	
	Logistics and Mobility: Specialisation Engineering Science			
	Mechanical Engineering: Core Qualification: Compulsory			
	Mechatronics: Core Qualification: Compulsory			
	Engineering and Management - Major in Logistics and M	obility: Specialisation Production Mana	agement and Pro	cesses: Compulsor
	Engineering and management - major in Logistics and M	obiney. Specialisation Froduction Malla	agement and F100	coscs. Compuisory

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

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

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

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

Module M0730: Comp	outer Engineering			
Courses				
Title		Тур	Hrs/wk	СР
Computer Engineering (L0321)		Lecture	3	4
Computer Engineering (L0324)		Recitation Section (small)	1	2
Module Responsible	Prof. Heiko Falk			
Admission Requirements	None			
Recommended Previous	Basic knowledge in electrical engineering			
Knowledge				
Educational Objectives	After taking part successfully, students have reached the follow	ving learning results		
Professional Competence				
Knowledge	This module deals with the foundations of the functionality of	f computing systems. It covers	the layers from	the assembly-level
	programming down to gates. The module includes the following	g topics:		
	Introduction			
	Combinational logic: Gates, Boolean algebra, Boolean fu		nbinational netv	vorks
	Sequential logic: Flip-flops, automata, systematic hardw  Task polarical foundations	are design		
	Technological foundations     Computer arithmetics Integer addition, subtraction, multi-	inlication and division		
	Computer arithmetic: Integer addition, subtraction, mult     Resign of computer architecture: Programming models.		nolining	
	<ul> <li>Basics of computer architecture: Programming models,</li> <li>Memories: Memory hierarchies, SRAM, DRAM, caches</li> </ul>	viir 3 sirigie-cycle arcilitecture, pr	penning	
	Input/output: I/O from the perspective of the CPU, princi	oles of passing data point-to-poi	nt connections	husses
	impulyoutput. No from the perspective of the cro, princi	oles of passing data, point-to-por	nic connections,	busses
Skills	The students perceive computer systems from the architect's p	perspective, i.e., they identify the	e internal struct	ure and the physical
	composition of computer systems. The students can analyze, h	now highly specific and individua	l computers can	be built based on a
	collection of few and simple components. They are able to di	stinguish between and to explain	n the different a	abstraction layers of
	today's computing systems - from gates and circuits up to com	plete processors.		
	After successful completion of the module, the students are	able to judge the interdenender	ncies hetween ;	a physical computer
	system and the software executed on it. In particular, they should be software executed on it.			
	on the hardware-centric abstraction layers from the assembly			
	the impact that these low abstraction levels have on an entire			
	·			
Personal Competence				
Social Competence	Students are able to solve similar problems alone or in a group	and to present the results accor	dingly.	
Autonomy	Students are able to acquire new knowledge from specific liter	ature and to associate this knowl	edge with other	classes.
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56			
Credit points	6			
Course achievement	Compulsory Bonus Form Description Yes 10 % Excercises			
Examination	Written exam			
_	90 minutes, contents of course and labs			
Scale	Conoral Engineering Science (Corman program, 7 comector), S	nocialization Computer Science	Compulsory	
Assignment for the Following Curricula	General Engineering Science (German program, 7 semester): S General Engineering Science (German program, 7 semest			ocus Mechatronics
rollowing curricula	Compulsory	er). Specialisation Mechanical	Liigineeriiig, i	ocus Mechalionics.
	General Engineering Science (German program, 7 semeste	r): Specialisation Mechanical Er	naineerina Foc	us Aircraft Systems
	Engineering: Compulsory	7. Specialisation recitation 2.	iginicaling, 1 de	as / iii ci ai c Systems
	General Engineering Science (German program, 7 semester): 9	Specialisation Mechanical Engine	ering, Focus Th	eoretical Mechanical
	Engineering: Compulsory		3.	
	General Engineering Science (German program, 7 semes	ter): Specialisation Mechanical	Engineering,	Focus Materials in
	Engineering Sciences: Compulsory			
	General Engineering Science (German program, 7 semester):	Specialisation Mechanical Engin	eering, Focus P	roduct Development
	and Production: Compulsory			
	General Engineering Science (German program, 7 semester	:): Specialisation Mechanical En	igineering, Foci	us Energy Systems:
	Compulsory			
	General Engineering Science (German program, 7 semest	er): Specialisation Mechanical	Engineering, Fo	ocus Biomechanics:
	Compulsory			
	General Engineering Science (German program, 7 semester): S			
	General Engineering Science (German program, 7 semester): S	pecialisation Green Technologies	s, Focus Renewa	able Energy: Elective
	Compulsory			
	Computer Science: Core Qualification: Compulsory			
	Data Science: Core Qualification: Elective Compulsory	51 ··· 0		
	Data Science: Specialisation I. Mathematics/Computer Science:	Elective Compulsory		
	Electrical Engineering: Core Qualification: Compulsory			
	Computer Science in Engineering: Core Qualification: Compulsi			
	Integrated Building Technology: Core Qualification: Elective Co			
	Technomathematics: Specialisation II. Informatics: Elective Cor	iipui50ry		

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

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

Module M0610: Electr	ical Machines and Actuators			
Courses				
Title		Тур	Hrs/wk	СР
Electrical Machines and Actuators (		Lecture	3	4
Electrical Machines and Actuators (	L0294)	Recitation Section (large)	2	2
Module Responsible	Prof. Thorsten Kern			
Admission Requirements	None			
Recommended Previous	Basics of mathematics, in particular complexe num	bers, integrals, differentials		
Knowledge	Basics of electrical engineering and mechanical eng	gineering		
<b>Educational Objectives</b>	After taking part successfully, students have reache	ed the following learning results		
Professional Competence				
Knowledge	Students can to draw and explain the basic principl	es of electric and magnetic fields.		
J				
	They can describe the function of the standard			
	characteristic curves. For typically used drives they	can explain the major parameters of the	energy efficiency	of the whole systen
	from the power grid to the driven engine.			
Skills	Students are able to calculate two-dimensional elethis they apply the usual methods of the design aut		rromagnetic circ	uits with air gap. Fo
	They can calulate the operational performance of and characteristic curves. They apply the usual equ		cteristic data an	d selected quantities
Personal Competence				
Social Competence	none			
•	Students are able independently to calculate election	ric and magnatic fields for applications. Th	nev are able to a	nalyse independently
,	the operational performance of electric machines			
	and characteristic curves.			, , , , , , , , , , , , , , , , , , , ,
Workload in Hours	Independent Study Time 110, Study Time in Lectur	e 70		
Credit points	6			
Course achievement	None			
Examination	Subject theoretical and practical work			
Examination duration and	Design of four machines and actuators, review of d	esign files		
scale				
Assignment for the	General Engineering Science (German program, 7 s	semester): Specialisation Electrical Engine	ering: Elective Co	ompulsory
Following Curricula	General Engineering Science (German program,	7 semester): Specialisation Mechanical	Engineering, Foo	cus Energy Systems
	Compulsory			
	General Engineering Science (German program,	, 7 semester): Specialisation Mechanica	al Engineering,	Focus Mechatronics
	Compulsory			
	General Engineering Science (German program, 7 s	semester): Specialisation Mechanical Engi	neering, Focus Tl	neoretical Mechanica
	Engineering: Elective Compulsory			
	Digital Mechanical Engineering: Core Qualification:	Compulsory		
	Electrical Engineering: Core Qualification: Elective (	Compulsory		
	Engineering Science: Specialisation Electrical Engin	eering: Elective Compulsory		
	Green Technologies: Energy, Water, Climate: Speci	**	pulsory	
	Logistics and Mobility: Specialisation Engineering S	• •		
	Logistics and Mobility: Specialisation Traffic Plannin			
	Logistics and Mobility: Specialisation Production Ma	,	ilsory	
	Mechanical Engineering: Core Qualification: Elective	e Compulsory		
	Mechatronics: Core Qualification: Compulsory			
	Technomathematics: Specialisation III. Engineering	• •		
	Engineering and Management - Major in Logistics a		-	
	Engineering and Management - Major in Logistics	and Mobility: Specialisation Production	Management and	d Processes: Electiv
	Compulsory			

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

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

Module M1573: Mode	ling, Simulation and Optimization (EN	)		
Courses				
Title		Тур	Hrs/wk	СР
Modeling, Simulation and Optimizat	ion (EN) (L2446)	Integrated Lecture	4	6
Module Responsible	Prof. Benedikt Kriegesmann			
Admission Requirements	None			
Recommended Previous	Sound knowledge of engineering mathematics, engineer	ring mechanics and fluid mechanic	s	
Knowledge				
Educational Objectives	After taking part successfully, students have reached the	e following learning results		
Professional Competence				
Knowledge	Students will have an overview of various technical pr	oblems and the differential equati	ons, which describe	them. Students will
	gave an overview of different solution approaches and $\boldsymbol{f}$	or which kind of problems they car	be used for.	
Skills	Students are able to solve different technical problems	with the introduced discretization r	nethods	
Personal Competence				
Social Competence	The students are able to discuss problems and jointly de	evelop solution strategies.		
Autonomy	The students are able to develop solution strategies for	complex problems self-consistent	and critically analyse	results.
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56			
Credit points	6			
Course achievement	None			
Examination	Oral exam			
Examination duration and	30 min			
scale				
Assignment for the	General Engineering Science (German program, 7 seme	ester): Specialisation Mechanical Er	ngineering, Focus Th	eoretical Mechanical
Following Curricula	Engineering: Compulsory			
	General Engineering Science (German program, 7 seme	•		
	General Engineering Science (German program, 7 se	emester): Specialisation Mechanic	al Engineering, Foc	us Aircraft Systems
	Engineering: Elective Compulsory			
	Engineering Science: Core Qualification: Compulsory			
	Mechanical Engineering: Specialisation Theoretical Engineering: Specialisation Theoretical Engineering: Specialisation Theoretical Engineering: Specialisation Engin			
	Technomathematics: Specialisation III. Engineering Scie	nce: Elective Compulsory		

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

Module M1595: Mach	ine Learning I			
Courses				
Title		Тур	Hrs/wk	СР
Machine Learning I (L2432)		Lecture	2	3
Machine Learning I (L2433)		Recitation Section (small)	2	3
Module Responsible	Prof. Nihat Ay			
Admission Requirements	None			
Recommended Previous	Linear Algebra, Analysis, Basic Programming Course			
Knowledge				
<b>Educational Objectives</b>	After taking part successfully, students have reached	the following learning results		
<b>Professional Competence</b>				
Knowledge	The students know			
	a gaparal principles of machine learning lea	rning, cuporticed/uncuporticed learni	na annorativo/o	loccrintivo locrning
	general principles of machine learning lea	rning: supervised/urisupervised learni	ng, generative/c	iescriptive learning,
	<ul><li>parametric/non-parametric learning</li><li>different learning methods: neural networks, su</li></ul>	inport vector machines, clustering, dime	ncionality roduct	ion kornal mathads
	fundamentals of statistical learning theory	pport vector machines, clustering, dime	ensionality reduct	ion, kerner methods
	advanced techniques such as transfer learning	ag roinforcement learning generative	advorcarial not	works and adaptive
	control	ig, removement learning, generative	adversariar riet	works and adaptive
	control			
Skills	The students can			
	<ul> <li>apply machine learning methods to concrete pr</li> </ul>	ohlems		
	select and evaluate suitable methods for specific			
	evaluate the quality of a trained data-driven me	·		
	work with known software frameworks for mach			
	adapt the architecture and cost function of neural networks to specific problems			
	show the limits of machine learning methods			
Personal Competence				
Social Competence	····	idently and in teams. They can exchang	je ideas with eacl	n other and use their
	individual strengths to solve the problem.			
Autonomy	Students are able to independently investigate a com	plex problem and assess which compete	encies are require	ed to solve it.
Workload in Hours	Independent Study Time 124, Study Time in Lecture 5	6		
Credit points	6			
Course achievement		scription		
	No 20 % Excercises			
Examination				
Examination duration and	90 min			
scale				
	General Engineering Science (German program, 7 ser	nester): Specialisation Mechanical Engir	neering, Focus Th	eoretical Mechanica
Following Curricula	Engineering: Elective Compulsory			
	Computer Science: Specialisation I. Computer and Sof	tware Engineering: Elective Compulsory	,	
	Data Science: Core Qualification: Compulsory	la Flactiva Cananala		
	Engineering Science: Specialisation Advanced Materia	, ,		
	Engineering Science: Specialisation Mechanical Engine			
	Engineering Science: Specialisation Mechatronics: Elec			
	Logistics and Mobility: Specialisation Information Tech			
	Mechanical Engineering: Specialisation Theoretical Me		ory	
	Technomathematics: Specialisation II. Informatics: Ele	, ,	barden Elect	C
	Engineering and Management - Major in Logistics and	Modility: Specialisation Information Tec	nnology: Elective	Compulsory

Course L2432: Machine Lear	ning I
Тур	Lecture
Hrs/wk	2
СР	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Prof. Nihat Ay
Language	DE/EN
Cycle	SoSe
Content	<ul> <li>History of neuroscience and machine learning (in particular, the age of deep learning)</li> <li>McCulloch-Pitts neurons and binary Artificial Neural Networks</li> <li>Boolean and threshold functions</li> <li>Universality of McCulloch-Pitts neural networks</li> <li>Learning and the perceptron convergence theorem</li> <li>Support vector machines</li> <li>Harmonic analysis of Boolean functions</li> <li>Continuous Artificial Neural Networks</li> <li>Kolmogorov's superposition theorem</li> <li>Universal approximation with continuous neural networks</li> <li>Approximation error and the gradient decent method: the general idea</li> <li>The stochastic gradient decent method (Robbins-Monro and Kiefer-Wolfowitz cases)</li> <li>Multilayer networks and the backpropagation algorithm</li> <li>Statistical Learning Theory</li> </ul>
Literature	<ul> <li>Martin Anthony and Peter L. Bartlett. Neural Network Learning: Theoretical Foundations. Cambridge University Press, 1999.</li> <li>Martin Anthony. Discrete Mathematics of Neural Networks: Selected Topics. SIAM Monographs on Discrete Mathematics &amp; Applications, 1987.</li> <li>Mehryar Mohri, Afshin Rostamizadeh and Ameet Talwalkar. Foundations of Machine Learning, Second Edition. MIT Press, 2018.</li> <li>Christopher M. Bishop. Pattern Recognition and Machine Learning. Information Science and Statistics. Springer-Verlag, 2008.</li> <li>Bernhard Schölkopf, Alexander Smola. Learning with Kernels: Support Vector Machines, Regularization, Optimization, and Beyond. Adaptive Computation and Machine Learning series. MIT Press, Cambridge, MA, 2002.</li> <li>Luc Devroye, László Györfi, Gábor Lugosi. A Probabilistic Theory of Pattern Recognition. Springer, 1996.</li> <li>Vladimir Vapnik. The Nature of Statistical Learning Theory. Springer-Verlag: New York, Berlin, Heidelberg, 1995.</li> </ul>

Course L2433: Machine Learning I	
Тур	Recitation Section (small)
Hrs/wk	2
СР	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Prof. Nihat Ay
Language	DE/EN
Cycle	SoSe
Content	See interlocking course
Literature	See interlocking course

Module M0854: Mathe	ematics IV			
Courses				
Title Typ Differential Equations 2 (Partial Differential Equations) (L1043) Lecture			Hrs/wk	<b>CP</b>
Differential Equations 2 (Partial Diff Differential Equations 2 (Partial Diff		Recitation Section (small) 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
	Prof. Anusch Taraz			
Admission Requirements  Recommended Previous	None Mathematics I - III			
Knowledge	Matternatics 1 - III			
Educational Objectives	After taking part successfully, students have reached	the following learning results		
Professional Competence				
Knowledge	<ul> <li>Students can name the basic concepts in Mathe</li> <li>Students can discuss logical connections between the help of examples.</li> <li>They know proof strategies and can reproduce</li> </ul>	een these concepts. They are capable		*
Skills	<ul> <li>Students can model problems in Mathematics capable of solving them by applying establisher</li> <li>Students are able to discover and verify further</li> <li>For a given problem, the students can develor results.</li> </ul>	d methods. logical connections between the conce	pts studied in the	e course.
Personal Competence Social Competence	Students are able to work together in teams. The In doing so, they can communicate new concept design examples to check and deepen the under the Indian Communication.	ots according to the needs of their coop		-
Autonomy	<ul> <li>Students are capable of checking their underst precisely and know where to get help in solving</li> <li>Students have developed sufficient persistence problems.</li> </ul>	them.		
Workload in Hours	Independent Study Time 68, Study Time in Lecture 11	2		
Credit points				
Course achievement	None			
Examination	Written exam			
Examination duration and	60 min (Complex Functions) + 60 min (Differential Eq	uations 2)		
Scale Assignment for the	General Engineering Science (German program, 7 sen	postor): Specialisation Floctrical Enginee	ring: Compulsor	,
Following Curricula	General Engineering Science (German program, 7 sen			,
-	Compulsory		-	
	General Engineering Science (German program, 7 sen	•		
	General Engineering Science (German program, 7 ser Engineering: Elective Compulsory	nester): Specialisation Mechanical Engir	neering, Focus Th	neoretical Mechanical
	Electrical Engineering: Core Qualification: Compulsory			
	General Engineering Science (English program, 7 sem		ring: Compulsory	,
	Computer Science in Engineering: Specialisation II. Ma	thematics & Engineering Science: Elect	ive Compulsory	
	Mechanical Engineering: Specialisation Mechatronics:			
	Mechanical Engineering: Specialisation Theoretical Me	chanical Engineering: Elective Compuls	ory	
	Mechatronics: Core Qualification: Compulsory  Naval Architecture: Core Qualification: Compulsory			
	Theoretical Mechanical Engineering: Technical Comple	ementary Course Core Studies: Elective	Compulsory	

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

Course L1044: Differential Ed	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 Ed	Course L1045: Differential Equations 2 (Partial Differential Equations)	
Тур	Recitation Section (large)	
Hrs/wk	1	
СР	1	
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14	
Lecturer	Dozenten des Fachbereiches Mathematik der UHH	
Language	DE	
Cycle	SoSe	
Content	See interlocking course	
Literature	See interlocking course	

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

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

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

## **Specialization Biomedical Engineering**

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

Module M0933: Funda	amentals of Materials Science			
Courses				
<b>Title</b> Fundamentals of Materials Science Fundamentals of Materials Science Physical and Chemical Basics of Ma	II (Advanced Ceramic Materials, Polymers and Composites) (L0506)	Typ Lecture Lecture Lecture	Hrs/wk 2 2 2	CP 2 2 2
Module Responsible				
Admission Requirements	None			
Recommended Previous	Highschool-level physics, chemistry und mathematics			
Knowledge				
<b>Educational Objectives</b>	After taking part successfully, students have reached the follow	ving learning results		
<b>Professional Competence</b>				
Knowledge	comprehensively. Fundamental knowledge here means specific phase transformations, corrosion and mechanical properties. T for materials and can identify relevant approaches for chaphenomena back to the underlying physical and chemical laws	cally the issues of ator he students know abo aracterizing specific p of nature.	nic structure, microstructuut the key aspects of char oroperties. They are able	ure, phase diagrams, racterization methods e to trace materials
<i>3.1.1.2</i>	The students are able to trace materials phenomena back to the underlying physical and chemical laws of nature. Materials phenomena here refers to mechanical properties such as strength, ductility, and stiffness, chemical properties such as corrosion resistance, and to phase transformations such as solidification, precipitation, or melting. The students can explain the relation between processing conditions and the materials microstructure, and they can account for the impact of microstructure on the material's behavior.			
Personal Competence				
Social Competence	-			
Autonomy	-			
Workload in Hours	Independent Study Time 96, Study Time in Lecture 84			
Credit points	6			
Course achievement	None			
Examination	Written exam			
Examination duration and	180 min			
scale				
Assignment for the	General Engineering Science (German program, 7 semester): S	pecialisation Mechani	cal Engineering: Compulso	ory
Following Curricula	General Engineering Science (German program, 7 semester): S	pecialisation Biomedic	cal Engineering: Compulso	ory
	General Engineering Science (German program, 7 semester): S	pecialisation Naval Ar	chitecture: Compulsory	
	Data Science: Specialisation Materials Science: Compulsory			
	Digital Mechanical Engineering: Core Qualification: Compulsory			
	Energy and Environmental Engineering: Core Qualification: Cor		tiva Camanulaanu	
	Green Technologies: Energy, Water, Climate: Specialisation En- Logistics and Mobility: Specialisation Engineering Science: Elec		tive Compulsory	
	Logistics and Mobility: Specialisation Engineering Science. Elec- Logistics and Mobility: Specialisation Production Management a		e Compulsory	
	Mechanical Engineering: Core Qualification: Compulsory		pa.oo.y	
	Mechatronics: Core Qualification: Compulsory			
	Naval Architecture: Core Qualification: Compulsory			
	Technomathematics: Specialisation III. Engineering Science: Ele	ective Compulsory		
	Engineering and Management - Major in Logistics and Mobili Compulsory	ty: Specialisation Prod	duction Management and	Processes: Elective

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

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

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

Courses	T	Hen hade	СР
Title Computer Engineering (L0321)	<b>Typ</b> Lecture	Hrs/wk 3	4
omputer Engineering (L0324)	Recitation Section (small)	1	2
Module Responsible	Prof. Heiko Falk		
Admission Requirements	None		
Recommended Previous	Basic knowledge in electrical engineering		
Knowledge	After heling your grossefully attribute hours you shad the following learning you the		
Educational Objectives Professional Competence	After taking part successfully, students have reached the following learning results		
•	This module deals with the foundations of the functionality of computing systems. It covers programming down to gates. The module includes the following topics:  • Introduction	the layers fron	n the assembly-lev
	<ul> <li>Combinational logic: Gates, Boolean algebra, Boolean functions, hardware synthesis, co</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, p</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-points</li> </ul>	pipelining	
Skills	The students perceive computer systems from the architect's perspective, i.e., they identify the composition of computer systems. The students can analyze, how highly specific and individual collection of few and simple components. They are able to distinguish between and to explait today's computing systems - from gates and circuits up to complete processors.  After successful completion of the module, the students are able to judge the interdependence system and the software executed on it. In particular, they shall understand the consequence on the hardware-centric abstraction layers from the assembly language down to gates. This was the impact that these low abstraction levels have on an entire system's performance and to provide the composition of the students.	al computers can bin the different encies between es that the execu	n be built based on abstraction layers a physical comput ution of software h enabled to evalua
Personal Competence Social Competence	Students are able to solve similar problems alone or in a group and to present the results according	ordingly.	
Autonomy	Students are able to acquire new knowledge from specific literature and to associate this know	vledge with othe	r classes.
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56		
Credit points	6		
Course achievement	Compulsory Bonus Form Description		
Post of the section o	Yes 10 % Excercises		
Examination	90 minutes, contents of course and labs		
scale	30 minutes, contents of course and labs		
Assignment for the	General Engineering Science (German program, 7 semester): Specialisation Computer Science	: Compulsory	
	General Engineering Science (German program, 7 semester): Specialisation Process Engineeri General Engineering Science (German program, 7 semester): Specialisation Mechanical Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering Sciences: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineerial Engineering Science (German program, 7 semester): Specialisation Mechanical Engineerial Engineering Science (German program, 7 semester): Specialisation Mechanical Engineerial Engineering Science (German program, 7 semester): Specialisation Mechanical Engineerial Engineering Science (German program, 7 semester): Specialisation Mechanical Engineerial Engineering Science (German program, 7 semester): Specialisation Mechanical	I Engineering, I Engineering, Focus Th Beering, Focus Th Beering, Focus P Engineering, Focus P	us Aircraft System eoretical Mechanic Focus Materials roduct Developme us Energy System
	Compulsory  General Engineering Science (German program, 7 semester): Specialisation Naval Architecture General Engineering Science (German program, 7 semester): Specialisation Biomedical Engine General Engineering Science (German program, 7 semester): Specialisation Bioprocess Engine General Engineering Science (German program, 7 semester): Specialisation Electrical Enginee General Engineering Science (German program, 7 semester): Specialisation Green Technologic Compulsory Computer Science: Core Qualification: Compulsory Data Science: Core Qualification: Elective Compulsory Electrical Engineering: Core Qualification: Compulsory	e: Compulsory eering: Compulso eering: Compulsory ring: Compulsory	ory ry

Technomathematics: Specialisation II. Informatics: Elective Compulsory

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

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

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

Module M0680: Fluid	Dynamics			
Courses				
Title		Тур	Hrs/wk	СР
Fluid Mechanics (L0454)		Lecture	3	4
Fluid Mechanics (L0455)		Recitation Section (large)	2	2
Module Responsible	Prof. Thomas Rung			
Admission Requirements	None			
Recommended Previous	Sound knowledge of engineering mathematics, engineer	ring mechanics and thermodynamics.		
Knowledge				
<b>Educational Objectives</b>	After taking part successfully, students have reached the	e following learning results		
<b>Professional Competence</b>				
Knowledge	Students will have the required sound knowledge to Students can scientifically outline the rationale of flow			
	performance analysis and the prediciton of fluid engine			nan meanous for ane
Skills	Students are able to apply fluid-engineering principles			-
	enables the student to carry out all necessary theore scientific level.	ical calculations for the fluid dynami	design of engir	neering devices on a
Personal Competence				
Social Competence	The students are able to discuss problems and jointly d	evelop solution strategies.		
Autonomy	The students are able to develop solution strategies for	complex problems self-consistent and	crtically analyse	results.
Workload in Hours	Independent Study Time 110, Study Time in Lecture 70			
Credit points	6			
Course achievement	None			
Examination	Written exam			
Examination duration and	180 min			
scale				
Assignment for the	General Engineering Science (German program, 7 seme	ester): Specialisation Mechanical Engin	eering: Compulso	ory
Following Curricula	General Engineering Science (German program, 7 seme	ester): Specialisation Biomedical Engin	eering: Compulso	ory
	General Engineering Science (German program, 7 seme	ester): Specialisation Naval Architectur	e: Compulsory	
	Mechanical Engineering: Core Qualification: Compulsory	•		
	Naval Architecture: Core Qualification: Compulsory			
	Technomathematics: Specialisation III. Engineering Scientific Scientific Specialisation III.	nce: Elective Compulsory		

Course L0454: Fluid Mechani	ics
Тур	Lecture
Hrs/wk	3
CP	4
Workload in Hours	Independent Study Time 78, Study Time in Lecture 42
Lecturer	Prof. Thomas Rung
Language	DE/EN
Cycle	SoSe
Content	<ul> <li>continuum physics definition of fluids, difference to solids/structures and material properties of fluids</li> <li>dimensional analysis and similitude</li> <li>fluid forces and fluid statics</li> <li>transport and conservation of mass, momentum &amp; energy</li> <li>fluid kinematics</li> <li>technically relevant flow models for incompressible fluids         <ul> <li>control volume &amp; stream tube analysis</li> <li>vortical flow models</li> <li>potential flows</li> <li>boundary layer flows</li> <li>different types of conservation equations and their realm</li></ul></li></ul>
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 Mechan	Course L0455: Fluid Mechanics	
Тур	Recitation Section (large)	
Hrs/wk	2	
СР	2	
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28	
Lecturer	Prof. Thomas Rung	
Language	DE/EN	
Cycle	SoSe	
Content	See interlocking course	
Literature	See interlocking course	

Module M0960: Mecha	anics IV (Oscillations, Analytical Mecha	anics, Multibody Systems	, Numerica	Mechanics)
Courses				
-	al Mechanics, Numerical Mechanics) (L1137)	Typ Lecture	Hrs/wk 3 2	<b>CP</b> 3 2
-	al Mechanics, Numerical Mechanics) (L1138) al Mechanics, Numerical Mechanics) (L1139)	Recitation Section (small)  Recitation Section (large)	1	1
Module Responsible		Recitation Section (large)		1
Admission Requirements	None			
Recommended Previous	Mathematics I-III and Mechanics I-III			
Knowledge				
Educational Objectives	After taking part successfully, students have reached the	e following learning results		
Professional Competence				
Knowledge	The students can			
Skills	<ul> <li>describe the axiomatic procedure used in mechan</li> <li>explain important steps in model design;</li> <li>present technical knowledge.</li> </ul> The students can	ical contexts;		
	<ul> <li>explain the important elements of mathematical their own problems;</li> <li>apply basic methods to engineering problems;</li> <li>estimate the reach and boundaries of the method</li> </ul>	·		
Personal Competence				
Social Competence	The students can work in groups and support each other	to overcome difficulties.		
Autonomy	Students are capable of determining their own strengths	and weaknesses and to organize the	eir time and learn	ing based on those.
Workload in Hours	Independent Study Time 96, Study Time in Lecture 84			
Credit points	6			
Course achievement	None			
Examination	Written exam			
Examination duration and	120 min			
scale				
Assignment for the	General Engineering Science (German program, 7 semes			-
Following Curricula	General Engineering Science (German program, 7 semes General Engineering Science (German program, 7 semes	- · ·		ory
	Energy Systems: Technical Complementary Course Core	•	c. compaisory	
	Mechanical Engineering: Core Qualification: Compulsory			
	Mechatronics: Core Qualification: Compulsory			
	Naval Architecture: Core Qualification: Compulsory			
	Technomathematics: Specialisation III. Engineering Scien	nce: Elective Compulsory		
	Theoretical Mechanical Engineering: Technical Complem	entary Course Core Studies: Elective	Compulsory	

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

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

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

Module M1277: MED I	l: Introduction to Anatomy	
Courses		
Title	Typ Hrs/wk	СР
Introduction to Anatomy (L0384)	Lecture 2	3
Module Responsible	Prof. Udo Schumacher	
Admission Requirements	None	
Recommended Previous	None	
Knowledge		
Educational Objectives	After taking part successfully, students have reached the following learning results	
Professional Competence		
Knowledge	The students can describe basal structures and functions of internal organs and the musculoskeletal system	1.
	The students can describe the basic macroscopy and microscopy of those systems.	
Ckilla	The students can recognize the relationship hetures given engaged facts and the development of some	annon diagona, thau
SKIIIS	The students can recognize the relationship between given anatomical facts and the development of some can explain the relevance of structures and their functions in the context of widespread diseases.	common diseases; they
	tan explain the relevance of structures and their functions in the context of widespread diseases.	
Personal Competence		
Social Competence	The students can participate in current discussions in biomedical research and medicine on a professional le	evel.
Autonomy	The students are able to access anatomical knowledge by themselves, can participate in conversations or	n the tenic and acquire
Autonomy	the relevant knowledge themselves.	i the topic and acquire
	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 program, 7 semester): Specialisation Biomedical Engineering: Compu	ilsory
Following Curricula	General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering,	Focus Biomechanics:
	Compulsory	
	Data Science: Specialisation Medicine: Compulsory	
	Electrical Engineering: Specialisation Medical Technology: Elective Compulsory	
	Engineering Science: Specialisation Biomedical Engineering: Compulsory	
	General Engineering Science (English program, 7 semester): Specialisation Biomedical Engineering: Compul	sory
	Mechanical Engineering: Specialisation Biomechanics: Compulsory	
	Biomedical Engineering: Specialisation Medical Technology and Control Theory: Elective Compulsory	
	Biomedical Engineering: Specialisation Management and Business Administration: Elective Compulsory	
	Biomedical Engineering: Specialisation Artificial Organs and Regenerative Medicine: Elective Compulsory	
	Biomedical Engineering: Specialisation Implants and Endoprostheses: Elective Compulsory	
	Technomathematics: Specialisation III. Engineering Science: Elective Compulsory	

Course L0384: Introduction t	o Anatomy		
Тур	Lecture	Lecture	
Hrs/wk	2		
СР	3		
Workload in Hours	Independent Study	Time 62, Study Time in Lecture 28	
	Prof. Tobias Lange		
Language			
Cycle			
Content	General Anatomy	y	
	1 <sup>st</sup> week:	The Eucaryote Cell	
	2 <sup>nd</sup> week:	The Tissues	
	2 week:	The fissues	
	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/Michae	el Schünke, Der Körper des Menschen, 17. Auflage, Thieme Verlag Stuttgart, 2016	

urses			
e		Тур	Hrs/wk CP
oduction to Radiology and Radi		Lecture	2 3
Module Responsible  Admission Requirements			
Recommended Previous			
Knowledge			
<b>Educational Objectives</b>	After taking part successfully, students have reac	thed the following learning results	
Professional Competence	<b>Th</b> and the		
Knowledge	<b>Therapy</b> The students can distinguish different types of cu	rrently used equipment with respect	to its use in radiation therapy.
	The students can explain treatment plans used in	radiation therapy in interdisciplinary	contexts (e.g. surgery, internal medicine)
	The students can describe the patients' pass	sage from their initial admittance	e through to follow-up care.
	Diagnostics		
	The students can illustrate the technical base cowell as sectional imaging techniques (CT, MRT, US		cluding angiography and mammography,
	The students can explain the diagnostic as well a techniques.	as therapeutic use of imaging technic	ques, as well as the technical basis for the
	·	had depending on the particular (P. C.	al history and needs
	The students can choose the right treatment met	nou depending on the patient's clinic	ai ilistory and needs.
	The student can explain the influence of technica	I errors on the imaging techniques.	
	The student can draw the right conclusions based	d on the images' diagnostic findings o	r the error protocol.
Skills	<b>Therapy</b> The students can distinguish curative and palliative	ve situations and motivate why they	came to that conclusion.
	The students can develop adequate therapy conc	ents and relate it to the radiation his	logical aspects
			logical aspects.
	The students can use the therapeutic principle (et	ffects vs adverse effects)	
	The students can distinguish different kinds of tumor) and choose the energy needed in that situ		depending on the situation (location of
	The student can assess what an individual psy- groups, self-help groups, social services, psycho-o		e.g. follow-up treatment, sports, social h
	Diagnostics		
	The students can suggest solutions for repairs of	imaging instrumentation after having	done error analyses
	,	3 3	,
	The students can classify results of imaging tec anatomy, pathology and pathophysiology.	chniques according to different group	ps of diseases based on their knowledge
Personal Competence			
Social Competence	The students can assess the special social situation.  The students are aware of the special, often the measures and can meet them appropriately.	·	
Autonomy	The students can apply their new knowledge and	skills to a concrete therapy case.	
	The students can introduce younger students to t	the clinical daily routine.	
	The students are able to access anatomical know	wledge by themselves, can participat	e competently in conversations on the to
	and acquire the relevant knowledge themselves.		
Workload in Hours	Independent Study Time 62, Study Time in Lectur	re 28	
Credit points			
Course achievement	None		
Examination			
xamination duration and scale	90 minutes		
Assignment for the	General Engineering Science (German program, 7	7 semester): Specialisation Biomedica	al Engineering: Compulsory
Following Curricula	General Engineering Science (German program	m, 7 semester): Specialisation Med	chanical Engineering, Focus Biomechan
	Compulsory		
	Data Science: Specialisation Medicine: Compulsor Electrical Engineering: Specialisation Medical Tecl		
	Engineering Science: Specialisation Biomedical Er		
	General Engineering Science (English program, 7		Engineering: Compulsory
	1	-1 C	
	Mechanical Engineering: Specialisation Biomecha		
	Biomedical Engineering: Specialisation Medical Te	echnology and Control Theory: Electiv	, .
	- · ·	echnology and Control Theory: Electivent and Business Administration: Elec	ctive Compulsory

Technomathematics: Specialisation iii. Engineering Science: Elective Compulsory

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

Module M0684: Heat	Transfer
Courses	
Title	Typ Hrs/wk CP
Heat Transfer (L0458)	Lecture 3 4
Heat Transfer (L0459)	Recitation Section (large) 2 2
Module Responsible	Dr. Andreas Moschallski
Admission Requirements	None
Recommended Previous	Technical Thermodynamics I, II and Fluid Dynamics
Knowledge	After the literature of the state that the fall with a large transfer of the
Educational Objectives Professional Competence	After taking part successfully, students have reached the following learning results
•	The students can
	- explain the technical terms,
	- classify the various physical processes of heat transfer in terms of conduction-based and radiation-based mechanisms,
	- simplify and critically analyze complex heat transfer processes using models,
	- methodically develop solutions to tasks.
Skills	The students are able to
Skins	
	- describe the physics of the different Heat Transfer mechanism,
	- simplifywith models, calculate and evaluate complex Heat Transfer processes,
	- critically question and answer statements on heat transfer,
	- solve excersises self-consistent and in small groups.
	3 · · · · · · · · · · · · · · · · · · ·
Personal Competence	
Social Competence	In lectures and exercises, the students can use many examples and experiments to discuss in small groups in a goal-oriented manner, develop a solution and present it. Within the exercises, the students can independently develop further questions and
	work out targeted solutions.
Autonomy	The students can check their level of knowledge by means of repetition questions at the beginning of the lectures and describe and
	discuss answers in exchange with the other students. In the exercises, the students work in small groups on the methods taught in
	the lectures in complex tasks and critically analyze the results in the auditorium.
Workload in Hours	Independent Study Time 110, Study Time in Lecture 70
Credit points	
Course achievement	
Examination	Written exam
Examination duration and	
scale	
Assignment for the	General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Energy Systems
Following Curricula	
	General Engineering Science (German program, 7 semester): Specialisation Biomedical Engineering: Compulsory  General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Theoretical Mechanica
	Engineering: Compulsory
	Energy Systems: Technical Complementary Course Core Studies: Elective Compulsory
	Integrated Building Technology: Core Qualification: Compulsory
	Mechanical Engineering: Specialisation Energy Systems: Compulsory
	Mechanical Engineering: Specialisation Theoretical Mechanical Engineering: Elective Compulsory

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

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

Module M0956: Meas	urement Technology for Med	chanical Engine	ers		
Courses					
Title			Тур	Hrs/wk	СР
Practical Course: Measurement and	Control Systems (L1119)		Practical Course	2	2
Measurement Technology for Mech			Lecture	2	3
Measurement Technology for Mech	anical Engineering (L1118)		Recitation Section (large)	1	1
Module Responsible	Prof. Thorsten Kern				
Admission Requirements	None				
<b>Recommended Previous</b>	Basic knowledge of physics, chemistry a	nd electrical engineering	I		
Knowledge					
<b>Educational Objectives</b>	After taking part successfully, students h	nave reached the following	ng learning results		
<b>Professional Competence</b>					
Knowledge	Students are able to name the most im	portant fundmentals of	the Measurement Technological	ogy (Quantities and	d Units, Uncertainty,
	Calibration, Static and Dynamic Properti	ies of Sensors and Syste	ms).		
	They can outline the most important m	accuring motheds for d	ifferent kinds of quantities	to be massured (	Floatrical Quantities
	They can outline the most important m		merent kinds of quantities	to be maesured (	Electrical Quantities,
	Temperature, mechanical quantities, Flo	ow, fillie, Frequency).			
	They can describe important methods of	chemical Analysis (Gas	Sensors, Spectroscopy, Ga	s Chromatography)	
Skills	Students can select suitable measuring r	methods to given proble	ms and can use refering m	easurement device	s in practice.
	The students are able to orally explain in		a of measurement technol	ogy and solution a	pproacnes as well as
	place the issues into the right context an	nd application area.			
Personal Competence					
Social Competence	Students can arrive at work results in gro	oups and document ther	n in a common report.		
Autonomy	Students are able to familiarize themselv	ves with new measureme	ent technologies.		
Workload in Hours	Independent Study Time 110, Study Time	e in Lecture 70			
Credit points					
Course achievement	Compulsory Bonus Form	Description			
	Yes None Subject theoret	tical and			
	practical work				
	Subject theoretical and practical work				
Examination duration and	105 minutes				
scale					
	General Engineering Science (German pr				
Following Curricula	General Engineering Science (German pr				
	General Engineering Science (German pr			rials: Elective Com	pulsory
	Digital Mechanical Engineering: Core Qua				
	Energy and Environmental Engineering:		oulsory		
	Engineering Science: Specialisation Mech				
	Engineering Science: Specialisation Mech				
	Engineering Science: Specialisation Biom				
	Engineering Science: Specialisation Adva				
	General Engineering Science (English pro				m.,
	General Engineering Science (English pro				
	General Engineering Science (English pro				ompuisory
	Logistics and Mobility: Specialisation Pro	3	u Processes: Elective Comp	ouisory	
	Mechanical Engineering: Core Qualification				
	Mechatronics: Core Qualification: Compu	,	Constallerable B. J. C.		D
	Engineering and Management - Major i	n Logistics and Mobility	: Specialisation Production	ı Management and	rrocesses: Elective
	Compulsory				

Course L1119: Practical Cou	rse: Measurement and Control Systems
Тур	Practical Course
Hrs/wk	2
СР	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Prof. Thorsten Kern
Language	DE
Cycle	WiSe/SoSe
Content	Experiment 1: Emission and immission measurement of gaseous pollutants: different technologies to determine different gaseous pollutants in automotive exhaust are used.
	Experiment 2: Simulation and measurement of asynchrone engine and rotary pump: the dynamic behaviour of e pump engine will be investigated. The starting will be simulated on a PC and compared with measurement.
	Experiment 3: Michelson interferometer and fiber optic: fundamental optical phenonema will be understood and applications with Michelson interferometer and optical fibers demonstrated.
	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</li> <li>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> </ul>
	Versuch 2:  Grundlagen über elektrische Maschinen, speziell: Asynchronmotoren  Simulationsmethoden, speziell: Verwendung von Blockschaltbildern  Betriebsverhalten von Kreispumpen, speziell: Kennlinien, Ähnlichkeitsgesetze  Versuch 3:  Unger, HG.: Optische Nachrichtentechnik, Teil 1: Optische Wellenleiter. Hüthing Verlag, Heidelberg, 1984  Dakin, J., Cushaw, B.: Optical Fibre Sensors: Principles and Components. Artech House Boston, 1988  Culshaw, B., Dakin, J.: Optical Fibre Sensors: Systems and Application. Artech House Boston, 1989  Versuch 4:  Leonhard: Einführung in die Regelungstechnik. Vieweg Verlag, Braunschweig-Wiesbaden  Jan Lunze: Systemtheoretische Grundlagen, Analyse und Entwurf einschleifiger Regelungen

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

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

Module M0662: Nume	erical Mathematics I
Courses	
Title	Typ Hrs/wk CP
Numerical Mathematics I (L0417)	Lecture 2 3
Numerical Mathematics I (L0418)	Recitation Section (small) 2 3
Module Responsible	Prof. Sabine Le Borne
-	
Admission Requirements	
Recommended Previous	<ul> <li>Mathematik I + II for Engineering Students (german or english) or Analysis &amp; Linear Algebra I + II for Technomathematicians</li> </ul>
Knowledge	basic MATLAB/Python knowledge
Educational Objectives	After taking part successfully, students have reached the following learning results
Professional Competence	
Knowledge	Students are able to
	name numerical methods for interpolation, integration, least squares problems, eigenvalue problems, nonlinear root finding
	problems and to explain their core ideas,
	repeat convergence statements for the numerical methods,
	<ul> <li>explain aspects for the practical execution of numerical methods with respect to computational and storage complexitx.</li> </ul>
Skills	Students are able to
	in the second se
	implement, apply and compare numerical methods using MATLAB/Python,     institute the appropriate the description of a provided provided and the provided provid
	• justify the convergence behaviour of numerical methods with respect to the problem and solution algorithm,
	select and execute a suitable solution approach for a given problem.
Personal Competence	
· ·	Students are able to
	work together in heterogeneously composed teams (i.e., teams from different study programs and background knowledge),
	explain theoretical foundations and support each other with practical aspects regarding the implementation of algorithms.
4	Production and the second seco
Autonomy	Students are capable
	to assess whether the supporting theoretical and practical excercises are better solved individually or in a team,
	to assess their individual progess and, if necessary, to ask questions and seek help.
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56
Credit points	6
Course achievement	None
Examination	Written exam
Examination duration and	90 minutes
scale	
Assignment for the	General Engineering Science (German program, 7 semester): Specialisation Computer Science: Compulsory
	General Engineering Science (German program, 7 semester): Specialisation Biomedical Engineering: Compulsory
	General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Biomechanics:
	Compulsory
	General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Theoretical Mechanical
	Engineering: Compulsory
	General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Aircraft Systems
	Engineering: Elective Compulsory
	General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Mechatronics: Elective
	Compulsory
	General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Energy Systems:
	Elective Compulsory
	General Engineering Science (German program, 7 semester): Specialisation Advanced Materials: Compulsory
	General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Materials in
	Engineering Science (German program, 7 Semester). Specialisation Mechanical Engineering, Focus Materials in
	Bioprocess Engineering: Specialisation A - General Bioprocess Engineering: Elective Compulsory
	Computer Science: Specialisation II. Mathematics and Engineering Science: Elective Compulsory  Data Science: Care Qualification: Compulsory
	Data Science: Core Qualification: Compulsory
	Electrical Engineering: Core Qualification: Elective Compulsory
	Engineering Science: Core Qualification: Compulsory
	Engineering Science: Core Qualification: Compulsory
	Computer Science in Engineering: Core Qualification: Compulsory
	Mechanical Engineering: Specialisation Theoretical Mechanical Engineering: Compulsory
	Mechanical Engineering: Specialisation Energy Systems: 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	Finite precision arithmetic, error analysis, conditioning and stability					
	Finite precision arithmetic, error analysis, conditioning and stability     Linear systems of equations: LU and Cholesky factorization, condition					
	Interpolation: polynomial, spline and trigonometric interpolation					
	Nonlinear equations: fixed point iteration, root finding algorithms, Newton's method					
	5. Linear and nonlinear least squares problems: normal equations, Gram Schmidt and Householder orthogonalization, sing					
	value decomposition, regularizatio, Gauss-Newton and Levenberg-Marquardt methods					
	6. Eigenvalue problems: power iteration, inverse iteration, QR algorithm					
	7. Numerical differentiation					
	8. Numerical integration: Newton-Cotes rules, error estimates, Gauss quadrature, adaptive quadrature					
Literature	Gander/Gander/Kwok: Scientific Computing: An introduction using Maple and MATLAB, Springer (2014)					
	Stoer/Bulirsch: Numerische Mathematik 1, Springer					
	Dahmen, Reusken: Numerik für Ingenieure und Naturwissenschaftler, Springer					
	,					

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

Module M1279: MED	II: Introduction to Biochemist	ry and Molecular Biology		
Courses				
Title		Тур	Hrs/wk	СР
Introduction to Biochemistry and M	olecular Biology (L0386)	Lecture	2	3
Module Responsible	Prof. Hans-Jürgen Kreienkamp			
Admission Requirements	None			
Recommended Previous	None			
Knowledge				
	After taking part successfully, students have	ve reached the following learning results		
Professional Competence				
Knowledge	The students can			
	<ul> <li>describe basic biomolecules;</li> </ul>			
	<ul> <li>explain how genetic information is contact.</li> </ul>	oded in the DNA;		
	<ul> <li>explain the connection between DNA</li> </ul>	A and proteins;		
Skills	The students can			
	<ul> <li>recognize the importance of molecul</li> </ul>	lar parameters for the course of a disease;		
	<ul> <li>describe selected molecular-diagnos</li> </ul>	tic procedures;		
	<ul> <li>explain the relevance of these proce</li> </ul>	dures for some diseases		
Personal Competence				
	The students can participate in discussions	in research and medicine on a technical leve	el.	
	Students will have an improved understar	nding of current medical problems (e.g. Cor	ona pandemic)and will	be able to explain
	these issues to others.			
Autonomy	The students can develop an understanding	g of topics from the course, using technical lit	terature, by themselves	
	Students will be better equipped to recogni	ize fake news in the media regarding medical	research topics.	
Workload in Hours	Independent Study Time 62, Study Time in	Lecture 28		
Credit points	3			
Course achievement	None			
Examination	Written exam			
Examination duration and	60 minutes			
scale				
Assignment for the		gram, 7 semester): Specialisation Biomedical		
Following Curricula		orogram, 7 semester): Specialisation Mech	anical Engineering, Fo	ocus Biomechanics:
	Compulsory	and Taraharaharaharaharah		
	Electrical Engineering: Specialisation Medic Engineering Science: Specialisation Biomed	. ,		
		ram, 7 semester): Specialisation Biomedical E	ngineering: Compulsor	/
	Mechanical Engineering: Specialisation Bior	•	J	•
	·	nagement and Business Administration: Electi	ve Compulsory	
	Biomedical Engineering: Specialisation Arti	ficial Organs and Regenerative Medicine: Elec	ctive Compulsory	
	Biomedical Engineering: Specialisation Med	lical Technology and Control Theory: Elective	Compulsory	
	Biomedical Engineering: Specialisation Imp	lants and Endoprostheses: Elective Compulso	ory	
	Technomathematics: Specialisation III. Engi	ineering Science: Elective Compulsory		

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

Module M1333: BIO I:	Implants and Fracture Healing					
Courses						
Title	Typ Hrs/wk CP					
Implants and Fracture Healing (L03						
Module Responsible	Prof. Michael Morlock					
Admission Requirements	None					
Recommended Previous	It is recommended to participate in "Introduction into Anatomie" before attending "Implants and Fracture Healing".					
Knowledge						
Educational Objectives	After taking part successfully, students have reached the following learning results					
Professional Competence						
Knowledge	The students can describe the different ways how bones heal, and the requirements for their existence.					
	The students can name different treatments for the spine and hollow bones under given fracture morphologies.					
Skills	The students can determine the forces acting within the human body under quasi-static situations under specific assumptions	5.				
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						
-	General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Biomecha	anics:				
Following Curricula						
	General Engineering Science (German program, 7 semester): Specialisation Biomedical Engineering: Compulsory					
	Engineering Science: Specialisation Biomedical Engineering: Compulsory					
	General Engineering Science (English program, 7 semester): Specialisation Biomedical Engineering: Compulsory					
	Mechanical Engineering: Specialisation Biomechanics: Compulsory  Biomedical Engineering: Specialisation Implants and Endoprostheses: Elective Compulsory					
	Biomedical Engineering: Specialisation Artificial Organs and Regenerative Medicine: Elective Compulsory					
	Biomedical Engineering: Specialisation Management and Business Administration: Elective Compulsory					
	Biomedical Engineering: Specialisation Medical Technology and Control Theory: Elective Compulsory					
	Orientation Studies: Core Qualification: Elective Compulsory					
	Technomathematics: Specialisation III. Engineering Science: Elective Compulsory					

Typ Lecture  His/Mix  CP  3  Workload in Hours  Lecturer  Prof. Michael Morfock  Language  Cycle  Wife  Content  1. Introduction (history, definitions, background importance)  2. Bone (anatomy, properties, biology, adaptations in femur, tibia, humerus, radius)  3. Spine (anatomy, properties, biology, adaptations in femur, tibia, humerus, radius)  3. Spine (anatomy, bomerchanics, function, vertebral bodies, interversebral disc, ligaments)  3.1 The spine in its entirety  3.2 Cervical spine  3.3 Thoracic spine  3.3 Injuries and diseases  4. Pelvis (anatomy, biomechanics, fracture treatment)  5 Fracture Healling  5.1. Basics and biology of fracture repair  5.2 Clinical principals and terminology of fracture treatment  3.3 Biomechanics of fracture treatment  5.3.1 Screws  5.3.2 Plates  5.3.3 Nalis  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 Orthopadic Biomechanics  Write A.A., Ponjabi M.M.: Clinical biomechanics of the spine  Nigg. B.: Biomechanics of the musculo-skeletal system  Schiebler T.H., Schmidt W.: Anatomie  Platzer: dtv-Attas der Anatomie, Band 1 Bewegungsapparat	Course L0376: Implants and	Fracture Healing				
Workload in Mours  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, properties, biology, adaptations in femur, tibia, humerus, radius)  3. 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 Pibtes  5.3.3 Nails  5.3.4 External fixation devices  5.3.5 Spine implants  6.0 New implants  Literature  Cochran V.B.: Orthopaddische Biomechaniks  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	Тур	Lecture				
Lecture   Prof. Michael Morlock		2				
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 Naiis 5.3.4 External fixation devices 5.3.5 Spine implants 6.0 New Implants Literature Cochran V.B.: Orthopadische 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						
Content   Content						
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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  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		3.2 Cervical spine				
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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.: Orthopādische 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		3.4 Lumbar spine				
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		3.5 Injuries and diseases				
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		4. Pelvis (anatomy, biomechanics, fracture treatment)				
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 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		5 Fracture Healing				
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		Basics and biology of fracture repair				
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		5.2 Clinical principals and terminology of fracture treatment				
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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		5.3.2 Plates				
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		5.3.3 Nails				
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		.3.4 External fixation devices				
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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		6.0 New Implants				
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						
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	Literature	Cochran V.B.: Orthopädische Biomechanik				
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Schiebler T.H., Schmidt W.: Anatomie		White A.A., Panjabi M.M.: Clinical biomechanics of the spine				
		Nigg, B.: Biomechanics of the musculo-skeletal system				
Platzer: dtv-Atlas der Anatomie, Band 1 Bewegungsapparat		Schiebler T.H., Schmidt W.: Anatomie				
		Platzer: dtv-Atlas der Anatomie, Band 1 Bewegungsapparat				

Module M0598: Mech	anical Engineering:	Design				
Courses						
Title			Тур	)	Hrs/wk	СР
Embodiment Design and 3D-CAD (	_0268)		Lec	ture	2	1
Mechanical Design Project I (L0695			-	ect-/problem-based Learning	3	2
Mechanical Design Project II (L059)				ect-/problem-based Learning	3	2
Team Project Design Methodology			Proj	ect-/problem-based Learning	2	1
Module Responsible						
Admission Requirements	None					
Recommended Previous	Fundamentals of Med	hanical Engineering	a Desian			
Knowledge	Mechanics	, , , , , , , , , , , , , , , , , , ,	5 5			
	<ul> <li>Fundamentals of Mat</li> </ul>	erials Science				
	Production Engineerii	ng				
	-					
Educational Objectives	After taking part successful	ly, students have re	eached the following le	earning results		
Professional Competence						
Knowledge	After passing the module, st	tudents are able to:	:			
	explain design guidel	lines for machinery	parts e.a. considering	load situation, materials an	d manufactur	ing requirements
	describe basics of 3D	•	p	,		9
	explain basics metho		lesigning.			
	·					
Skills	After passing the module, st	tudents are able to:	:			
	<ul> <li>independently create</li> </ul>	sketches, technica	al drawings and docum	entations e.g. using 3D CAD	),	
	design components b		-			
	dimension (calculate)					
	<ul> <li>use methods to design</li> </ul>	n and solve engine	ering design tasks sys	stamtically and solution-orie	nted,	
	<ul> <li>apply creativity techn</li> </ul>	niques in teams.				
Personal Competence						
Social Competence	After passing the module, si	tudents are able to:				
	<ul> <li>develop and evaluate</li> </ul>	solutions in groups	s including making and	d documenting decisions,		
	moderate the use of	scientific methods,				
	<ul> <li>present and discuss solutions and technical drawings within groups,</li> </ul>					
	<ul> <li>reflect the own result</li> </ul>	ts in the work group	os of the course.			
Autonomy	Students are able					
Autonomy	Students are able					
	<ul> <li>to estimate their level</li> </ul>	el of knowledge usi	ng activating method	s within the lectures (e.g. w	ith clickers),	
	<ul> <li>To solve engineering</li> </ul>	design tasks syster	matically.			
Waydaad in Harry	Indonesia dest Ctudu Time 40	Chudu Timo in Loca	turno 140			
Credit points	Independent Study Time 40	, study Time in Leci	ture 140			
Course achievement	Compulsory Bonus Form		Description			
		ten elaboration	3D-CAD-Praktikur	m		
	Yes None Writt	ten elaboration	Teamprojekt Kons	struktionsmethodik		
	Yes None Writt	ten elaboration	Konstruktionsproj			
	Yes None Writt	ten elaboration	Konstruktionsproj	ekt 2		
Examination	Written exam					
Examination duration and	180					
scale						
Assignment for the	General Engineering Science	e (German program	n, 7 semester): Special	isation Mechanical Engineer	ing: Compuls	ory
Following Curricula				-		-
	General Engineering Science (German program, 7 semester): Specialisation Biomedical Engineering: Compulsory					
	Digital Mechanical Engineer	-				
	Engineering Science: Specia					
	Engineering Science: Specialisation Mechanical Engineering: Compulsory					
	Engineering Science: Specialisation Biomedical Engineering: Compulsory					
	Green Technologies: Energy			echnology: Elective Compul	sory	
	Mechanical Engineering: Core Qualification: Compulsory					
	Mechatronics: Core Qualification: Compulsory					
	Naval Architecture: Core Qualification: Compulsory					

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

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

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

Course L0267: Team Project	Design Methodology				
Тур	Project-/problem-based Learning				
Hrs/wk					
СР	1				
Workload in Hours	Independent Study Time 2, Study Time in Lecture 28				
Lecturer	Prof. Dieter Krause				
Language	DE				
Cycle	SoSe				
Content	Introduction to engineering designing methodology  Team Project Design Methodology  Creating requirement lists  Problem formulation  Creating functional structures  Finding solutions  Evaluation of the found concepts  Documentation of the taken methodological steps and the concepts using presentation slides				
Literature	<ul> <li>Dubbel, Taschenbuch für den Maschinenbau; Grote, KH., Feldhusen, J.(Hrsg.); Springer-Verlag, aktuelle Auflage.</li> <li>Maschinenelemente, Band I-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 M0634: Introd	luction into Me	dical Technolo	gy and Systen	ns				
Courses								
Title Introduction into Medical Technolog	gy and Systems (L0342)			<b>Typ</b> Lecture	Hrs/wk	<b>CP</b> 3		
Introduction into Medical Technolog	gy and Systems (L0343)			Project Seminar	2	2		
Introduction into Medical Technolog	y and Systems (L1876)			Recitation Section (large)	1	1		
Module Responsible	Prof. Alexander Schlae	efer						
Admission Requirements	None							
Recommended Previous	principles of math (alg	gebra, analysis/calcul	us)					
Knowledge	principles of stochast	ics						
	principles of programi	ning, R/Matlab						
Educational Objectives	After taking part succ	essfully, students hav	ve reached the followi	ing learning results				
Professional Competence								
Knowledge	The students can ex	plain principles of m	nedical technology, ir	ncluding imaging systems,	computer aided s	urgery, and medical		
	information systems.	They are able to give	an overview of regul	atory affairs and standards	in medical technolo	gy.		
Skills	The students are able	to evaluate systems	and medical devices	in the context of clinical app	plications.			
Personal Competence								
-	The students describe	a problem in medica	al technology as a pro	ject, and define tasks that a	ere solved in a joint	effort		
30ciai competence		•		and make constructive sugg	-			
	The students can criti	cally reflect on the re	suits of other groups	and make constructive sugg	gestions for improv	ement.		
Autonomo	The students can as	and their level of l		and their work requite. T	hav san seitiaally	avalvata tha vaculta		
Autonomy	achieved and present		-	nent their work results. T	ney can critically	evaluate the results		
	acilieved and present	пент ні ан арргорна	ate manner.					
Workload in Hours	Independent Study Ti	me 110, Study Time	in Lecture 70					
Credit points								
Course achievement	Compulsory Bonus	Form	Description					
	Yes 10 %	Presentation						
	Yes 10 %	Written elaboration						
Examination	Written exam							
Examination duration and	90 minutes							
scale								
Assignment for the				pecialisation Biomedical Eng		ry		
Following Curricula			_	ng Science: Elective Compul	Isory			
	Data Science: Special							
	Data Science: Core Qualification: Elective Compulsory							
	Electrical Engineering: Core Qualification: Elective Compulsory							
		Engineering Science: Specialisation Biomedical Engineering: Compulsory  General Engineering Science (English program, 7 semester): Specialisation Biomedical Engineering: Compulsory						
						у		
	7			& Engineering Science: Ele				
	-			enerative Medicine: Elective	compulsory			
	-			eses: Elective Compulsory				
	-			Control Theory: Elective Cor				
	Biomedical Engineering: Specialisation Management and Business Administration: Elective Compulsory  Technomathematics: Specialisation III. Engineering Science: Elective Compulsory							
	recrinomatnematics:	อมู่อนเสเเรลต์ได้ที่ III. Eng	inleering Science: Elec	Luve Compuisory				

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

Course L0343: Introduction i	urse L0343: Introduction into Medical Technology and Systems		
Тур	Project Seminar		
Hrs/wk	2		
СР	2		
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28		
Lecturer	Prof. Alexander Schlaefer		
Language	DE		
Cycle	SoSe		
Content	See interlocking course		
Literature	See interlocking course		

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

Module M1280: MED I	II: Introduction to Physiology
Courses	
Title	Typ Hrs/wk CP
Introduction to Physiology (L0385)	Lecture 2 3
Module Responsible	Dr. Roger Zimmermann
Admission Requirements	None
Recommended Previous	None
Knowledge	
Educational Objectives	After taking part successfully, students have reached the following learning results
Professional Competence	
Knowledge	The students can
	describe the basics of the energy metabolism;
	describe physiological relations in selected fields of muscle, heart/circulation, neuro- and sensory physiology.
Skills	The students can describe the effects of basic bodily functions (sensory, transmission and processing of information, development of favors and vital functions) and value them to similar tradesical systems.
Davisanal Commetence	of forces and vital functions) and relate them to similar technical systems.
Personal Competence	The students can conduct discussions in research and medicine on a technical level.
Social Competence	The students can find solutions to problems in the field of physiology, both analytical and metrological.
	The students can find solutions to problems in the field of physiology, both analytical and methological.
Autonomy	The students can derive answers to questions arising in the course and other physiological areas, using technical literature, b
	themselves.
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Credit points	3
Course achievement	None
Examination	Written exam
Examination duration and	60 minutes
scale	
Assignment for the	General Engineering Science (German program, 7 semester): Specialisation Biomedical Engineering: Compulsory
Following Curricula	General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Biomechanics
	Compulsory
	Data Science: Specialisation Medicine: Compulsory
	Electrical Engineering: Specialisation Medical Technology: Elective Compulsory
	Engineering Science: Specialisation Biomedical Engineering: Elective Compulsory  General Engineering Science (English program, 7 semester): Specialisation Biomedical Engineering: Elective Compulsory
	Mechanical Engineering: Specialisation Biomechanics: Compulsory
	Biomedical Engineering: Specialisation Medical Technology and Control Theory: Elective Compulsory
	Biomedical Engineering: Specialisation Management and Business Administration: Elective Compulsory
	Biomedical Engineering: Specialisation Artificial Organs and Regenerative Medicine: Elective Compulsory
	Biomedical Engineering: Specialisation Implants and Endoprostheses: Elective Compulsory
	Technomathematics: Specialisation III. Engineering Science: Elective Compulsory

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

Module M1332: BIO I:	Experimental Methods in Biomechanics			
Courses				
Title		Тур	Hrs/wk	СР
Experimental Methods in Biomecha	nics (L0377)	Lecture	2	3
Module Responsible	Prof. Michael Morlock			
Admission Requirements	None			
Recommended Previous	It is recommended to participate in "Implantate und Fraktu	rheilung" before attending "	Experimentelle Methode	en".
Knowledge				
<b>Educational Objectives</b>	After taking part successfully, students have reached the f	ollowing learning results		
Professional Competence				
Knowledge	The course deals with common experimental methods use knowledge is provided.	d in biomechanics. For each	n topic an overview and	some basic practical
	1. Tribology			
	2. Optical Methods			
	3. Motion Analysis			
	4. Pressure Distribution			
	5. Strain Gauges			
	6. Pre-clinical testing			
	7. Specimen Preparation and Storage			
	The students can describe the different ways how bones h	eal, and the requirements fo	r their existence.	
	The students can name different treatments for the spine a	and hollow bones under give	n fracture morphologies	
	The students can describe different measurement technique given task.	ies for forces and movemen	its, and choose the adeq	uate technique for a
Skills	The students can describe the basic handling of several ex	perimental techniques used	in biomechanics.	
Personal Competence				
Social Competence	Students are able to organize themselves as a group to so tasks must be organized during the experiment as wel knowledge acquired must be available to all participants quickly because fundamentally different measurement prin	as during the short written of the group afterwards. The	en elaboration, but on the challenge here is that	the other hand, the the topics change
Autonomy	Students perform simple experimental tasks in small grouserves as a basis for these experiments. As preparation or the experimental result. In particular, independent transfershow deviations from the theoretical values and how these	follow-up, the theoretical kn performance is necessary t	nowledge has to be work to clarify why experimen	ed up and related to
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 sen	nester): Specialisation Med	chanical Engineering, F	ocus Biomechanics:
Following Curricula	Compulsory			
	General Engineering Science (German program, 7 semeste	r): Specialisation Biomedica	l Engineering: Compulso	ry
	Engineering Science: Specialisation Biomedical Engineering	g: Elective Compulsory		
	General Engineering Science (English program, 7 semester	): Specialisation Biomedical	Engineering: Elective Co	ompulsory
	Mechanical Engineering: Specialisation Biomechanics: Com	pulsory		
	Technomathematics: Specialisation III. Engineering Science	e: 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	The course deals with common experimental methods used in biomechanics. For each topic an overview and some basic practical
	knowledge is provided.
	1. Tribology
	2. Optical Methods
	3. Motion Analysis
	4. Pressure Distribution
	5. Strain Gauges
	6. Pre-clinical testing
	7. Specimen Preparation and Storage
Literature	Hoffmann K., Eine Einführung in die Technik des Messens mit Dehnmessstreifen
	White A.A., Panjabi M.M.: Clinical biomechanics of the spine
	Nigg, B.: Biomechanics of the musculo-skeletal system
	Online Hilfe von Mathworks: https://de.mathworks.com/help/matlab/

## **Specialization Naval Architecture**

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

Module M1118: Hydro	ostatics and Body Plan			
Courses				
Title		Тур	Hrs/wk	СР
Hydrostatics (L1260)		Lecture	2	3
Hydrostatics (L1261)		Recitation Section (large)	2	1
Body Plan (L1452)		Project Seminar	2	2
Module Responsible	Prof. Stefan Krüger			
Admission Requirements	None			
Recommended Previous	Good knowledge in Mathemathics I-III and Mechan	nics I-III.		
Knowledge	It is recommended that the students are familiar	with typical design relevant drawings, e.g. B	ody Plan, GA- Pla	n, Tank Plan etc.
<b>Educational Objectives</b>	After taking part successfully, students have reac	hed the following learning results		
Professional Competence				
Knowledge	The lecture enables the student to carry out all necessary theoretical calculations for ship design on a scientific level. The lecture			
	is basic requirement for all following lectures in the subjects shipo design and safety of ships.			
Skille	The student is able to carry out hydrostatic calc	ulations to onsure that the chin has sufficie	nt stability. Ho i	s able to design bull
Skiiis	forms that are safe against capsizing or sinking.	diacions to ensure that the ship has sufficie	are stubility. The f	s able to design num
	Tornis that are sare against capsizing or sinking.			
Personal Competence				
Social Competence	The student gets access to hydrostatical problems	5.		
Autonomy				
	Independent Study Time 96, Study Time in Lectur	e 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	e: Compulsory	
Following Curricula	Naval Architecture: Core Qualification: Compulsor	у		

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

- Balance of Heeling and Righting Moments acc. to BV 1030
- Intact Stability Code (General Critaria)
- 4. Linearization of Stability Problems
- Linearization of Restoring Forces and Moments
- Correlation between Metacentric Height and Righting Lever at small heeling angles
- Computation of Path of Metacentric Height for Modern Hull Forms
- Correlation between Righting Lever and Path of Metacentric Height
- Hydrostatic Stiffness Matrix
- Definition of MCT
- Computation of Equilibrum Floating Conditions from Hydrostatic Tables
- Effect of Free Surfaces on Initial GM
- Roll Motions at Small Roll Angles
- 6. Stability in Waves
- Roll Motions at Large Amplitudes
- Pure Loss of Stability on the Wave Crest
- Principle of Parametric Excitation
- Principle of Direct Wave Moments
- Grim's Equivalent Wave Concept
- 6 Longitudinal Strength
- Longitudinal Mass Distribution, Shear Forces, Bending Moments
- Longitudinal Strength in Stability Booklet
- 7. Deadweight Survey and Inclining Experiment
- Deplacement Computations from Draft mark Readings
- Weights to go on /come from board  $% \left( 1\right) =\left( 1\right) \left( 1\right) \left($
- Inclining Experiment with Heeling Moments from Weights and Heeling Tanks
- Residual Sounding Volumes
- Determination of COG from Metacentric height and from Cross Curves
- Roll Decay Test
- 8. Launching and Docking
  - Launching Plan, Arrangement of Launching Blocks
  - Rigid Body Launching: Tilting, Dumping, Equation of Techel
  - Computation of Launching Event
  - Bottom Pressure and Longitudinal Strength
  - Linear- Elastic Effects
  - Transversal Stability on Slipway and in Dock
- 9. Grounding
- Loss of Buoynacy when Grounded
- Pointwise Grounding
- Ship Grounds on Keel
- 10. Introduction into Damage Stability Problems
  - Added Mass Method
  - Loss of Buoyant Volume Method
  - Simple Equilibrium Computations
  - Intermediate Stages of Flooding (Addes Mass Method), Cross- and Downflooding
  - Water Ingress Through Openings
- 11. Special Problems (optional and agreed upon)
- e.g. Heavy Lift Operations
- e.g. Jacking of Jackup Vessels

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

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

Course L1452: Body Plan	
Тур	Project Seminar
Hrs/wk	2
СР	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Prof. Stefan Krüger
Language	DE
Cycle	WiSe
Content	As preparation for the lecture "Hydrostatics", the students must develop a body plan of a modern twin screw vessel (cruise liner, RoPAx- feryy, RoRo) and perform elementary volumetric computations. The body plan is to be developed from a given GA or can be designed freely. All computations shall be based on graphical integration methods. The body plan consists of:  - Grid  - approx. 20 sections, 5 Waterlines, 5 Buttocks  - Computation Volume and centre of buoyancy for several drafts  - Computation of Righting Lever curve for a given displacement based on and graphical integration for several heeling angles.
Literature	1. Herner/Rusch: Die Theorie des Schiffes Fachbuchverlag Leipzig  2. Henschke Schiffstechnisches Handbuch, Band 1 VEB Technik Verlag Berlin  3. Das Skript zur Vorlesung, Anwendungsbeispiele und Klausuren sind auf unserer Homepage abrufbar.

Module M0933: Funda	amentals of Materials Science			
Courses				
Title Fundamentals of Materials Science I (L1085)		Typ Lecture	Hrs/wk	<b>CP</b> 2
Fundamentals of Materials Science II (Advanced Ceramic Materials, Polymers and Composites) (L0506)		Lecture	2	2
Physical and Chemical Basics of Ma	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				
	After taking part successfully, students have reached the follow	ring learning results		
Professional Competence				
Knowleage	The students have acquired a fundamental knowledge on r comprehensively. Fundamental knowledge here means specific phase transformations, corrosion and mechanical properties. The for materials and can identify relevant approaches for chaphenomena back to the underlying physical and chemical laws	ally the issues of atomic s ne students know about the tracterizing specific prope	structure, microstructure key aspects of char	ure, phase diagrams, acterization methods
	The students are able to trace materials phenomena back to the underlying physical and chemical laws of nature. Materials phenomena here refers to mechanical properties such as strength, ductility, and stiffness, chemical properties such as corrosion resistance, and to phase transformations such as solidification, precipitation, or melting. The students can explain the relation between processing conditions and the materials microstructure, and they can account for the impact of microstructure on the material's behavior.			
Personal Competence				
Social Competence	-			
Autonomy	-			
	Independent Study Time 96, Study Time in Lecture 84			
Credit points				
Course achievement				
Examination Examination duration and	Written exam			
scale	100 11111			
Assignment for the	General Engineering Science (German program, 7 semester): S	pecialisation Mechanical E	ingineering: Compulso	ory
Following Curricula	General Engineering Science (German program, 7 semester): S			-
	General Engineering Science (German program, 7 semester): S	pecialisation Naval Archite	ecture: Compulsory	
	Data Science: Specialisation Materials Science: Compulsory			
	Digital Mechanical Engineering: Core Qualification: Compulsory			
	Energy and Environmental Engineering: Core Qualification: Con	. ,		
	Green Technologies: Energy, Water, Climate: Specialisation Ene		Compulsory	
	Logistics and Mobility: Specialisation Engineering Science: Elect		mpulcon	
	Logistics and Mobility: Specialisation Production Management a Mechanical Engineering: Core Qualification: Compulsory	inu riocesses: Elective Co	iripuisory	
	Mechatronics: Core Qualification: Compulsory			
	Naval Architecture: Core Qualification: Compulsory			
	Technomathematics: Specialisation III. Engineering Science: Ele	ective Compulsorv		
	Engineering and Management - Major in Logistics and Mobilii Compulsory		ion Management and	Processes: Elective

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

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

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

_	outer Engineering		
Courses			
Title	Тур	Hrs/wk	CP
Computer Engineering (L0321) Computer Engineering (L0324)	Lecture Recitation Section (small	3 I) 1	4 2
Module Responsible		., -	
	<del> </del>		
Recommended Previous			
Knowledge			
Educational Objectives	After taking part successfully, students have reached the following learning results		
<b>Professional Competence</b>			
Knowledge	This module deals with the foundations of the functionality of computing systems. It programming down to gates. The module includes the following topics:  • Introduction	covers the layers from	m the assembly-lev
	Combinational logic: Gates, Boolean algebra, Boolean functions, hardware synthe Sequential logic: Flip-flops, automata, systematic hardware design Technological foundations Computer arithmetic: Integer addition, subtraction, multiplication and division Basics of computer architecture: Programming models, MIPS single-cycle architec Memories: Memory hierarchies, SRAM, DRAM, caches Input/output: I/O from the perspective of the CPU, principles of passing data, poin	ture, pipelining	
Skills	The students perceive computer systems from the architect's perspective, i.e., they idea composition of computer systems. The students can analyze, how highly specific and in collection of few and simple components. They are able to distinguish between and to today's computing systems - from gates and circuits up to complete processors.  After successful completion of the module, the students are able to judge the interdesystem and the software executed on it. In particular, they shall understand the consection the hardware-centric abstraction layers from the assembly language down to gates, the impact that these low abstraction levels have on an entire system's performance and	dividual computers ca o explain the different ependencies between quences that the exec This way, they will be	n be built based or abstraction layers a physical computution of software he e enabled to evalua
Personal Competence Social Competence	Students are able to solve similar problems alone or in a group and to present the result	ts accordingly.	
Autonomy	Students are able to acquire new knowledge from specific literature and to associate thi	s knowledge with other	er classes.
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56		
Credit points			
Course achievement			
	Yes 10 % Excercises		
Examination	Written exam		
	90 minutes, contents of course and labs		
scale	Consul Facility of the Colones (Common and Tanasakan) Considiration Common to	-i Ci	
Assignment for the			
rollowing curricula	General Engineering Science (German program, 7 semester): Specialisation Civil Engine General Engineering Science (German program, 7 semester): Specialisation Process Eng		
	General Engineering Science (German program, 7 semester): Specialisation Mech Compulsory		
	General Engineering Science (German program, 7 semester): Specialisation Mech	nanical Engineering,	Focus Mechatronio
	General Engineering Science (German program, 7 semester): Specialisation Mech Compulsory	nanical Engineering,	Focus Mechatronio
	General Engineering Science (German program, 7 semester): Specialisation Mech Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechan Engineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical	nanical Engineering,	Focus Mechatronic
	General Engineering Science (German program, 7 semester): Specialisation Mech Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechan Engineering: Compulsory	nanical Engineering, nical Engineering, Foo	Focus Mechatronic cus Aircraft Syster
	General Engineering Science (German program, 7 semester): Specialisation Mech Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechan Engineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering Sciences: Compulsory	nanical Engineering, nical Engineering, Foo Engineering, Focus Tl	Focus Mechatronic cus Aircraft Syster neoretical Mechanic Focus Materials
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	General Engineering Science (German program, 7 semester): Specialisation Mech Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechan Engineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering Sciences: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical and Production: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering Science (German program, 7 semester): Specialisation Naval Archit General Engineering Science (German program, 7 semester): Specialisation Biomedical General Engineering Science (German program, 7 semester): Specialisation Biomedical General Engineering Science (German program, 7 semester): Specialisation Bioprocess (Germal Engineering Science (German program, 7 semester): Specialisation Bioprocess (General Engineering Science (German program, 7 semester): Specialisation Electrical Engeneral Engineering Science (German program, 7 semester): Specialisation Green Technology Computer Science: Core Qualification: Compulsory Data Science: Core Qualification: Elective Compulsory	nanical Engineering, nical Engineering, Food Engineering, Focus Tichanical Engineering, all Engineering, Focus Indical Engineering, Focus Indical Engineering, Focus Indical Engineering, Intecture: Compulsory Engineering: Compulsor Engineering: Compulsor Indical Engineering: Compulsor Indicates Ind	Focus Mechatronic cus Aircraft Syster heoretical Mechanic Focus Materials Product Developme cus Energy System Focus Biomechanic ory ory y yable Energy: Electi

Technomathematics: Specialisation II. Informatics: Elective Compulsory

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

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

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

Module M0854: Matho	ematics IV			
Courses				
Title		Тур	Hrs/wk	СР
Differential Equations 2 (Partial Diff		Lecture	2	1
Differential Equations 2 (Partial Diff		Recitation Section (small)		1 1
Differential Equations 2 (Partial Diff Complex Functions (L1038)	erential Equations) (L1045)	Recitation Section (large) Lecture	2	1
Complex Functions (L1041)		Recitation Section (small		1
Complex Functions (L1042)		Recitation Section (large)	1	1
Module Responsible	Prof. Anusch Taraz			
Admission Requirements	None			
Recommended Previous	Mathematics 1 - III			
Knowledge				
Educational Objectives	After taking part successfully, students have reached the	following learning results		
Professional Competence				
Knowledge	Students can name the basic concepts in Mathema	tics IV. They are able to explain	them using appropri	ate examples.
	Students can discuss logical connections between			-
	the help of examples.			
	<ul> <li>They know proof strategies and can reproduce the</li> </ul>	n.		
Skills	Students can model problems in Mathematics IV	with the help of the concents	studied in this course	Moreover they are
	capable of solving them by applying established m	·	statica iii tiiis coarse	. Moreover, they are
	Students are able to discover and verify further log		oncepts studied in the	e course.
	<ul> <li>For a given problem, the students can develop a</li> </ul>			
	results.			-
Personal Competence				
Social Competence	• Students are able to work together in teams. They	ara canabla ta uca mathamatic	e as a sommon langu	200
	<ul> <li>Students are able to work together in teams. They</li> <li>In doing so, they can communicate new concepts</li> </ul>			-
	design examples to check and deepen the underst		cooperating partitions	. Moreover, ency cum
Autonomy				
	Students are capable of checking their understand		neir own. They can sp	ecify open questions
	<ul> <li>precisely and know where to get help in solving the</li> <li>Students have developed sufficient persistence to</li> </ul>		eriods in a goal-orien	ted manner on hard
	problems.	be able to work for longer p	erious iii a goai-orieri	ted manner on nard
	problems			
Workload in Hours	Independent Study Time 68, Study Time in Lecture 112			
Credit points	6			
Course achievement	None			
Examination	Written exam			
Examination duration and	60 min (Complex Functions) + 60 min (Differential Equati	ons 2)		
scale				
Assignment for the	General Engineering Science (German program, 7 semest	er): Specialisation Electrical En	gineering: Compulsor	y
Following Curricula	General Engineering Science (German program, 7 se	mester): Specialisation Mech	anical Engineering,	Focus Mechatronics:
	Compulsory			
	General Engineering Science (German program, 7 semest	•		popratical Mashani
	General Engineering Science (German program, 7 semest Engineering: Elective Compulsory	.e. 7. apecialisation Mechanical	Engineering, FOCUS II	ieoretical Mechanical
	Computer Science: Specialisation Computational Mathem	atics: Elective Compulsory		
	Electrical Engineering: Core Qualification: Compulsory	accor Elective compaisory		
	General Engineering Science (English program, 7 semeste	er): Specialisation Electrical Eng	ineering: Compulsory	
	General Engineering Science (English program, 7 se	mester): Specialisation Mech	anical Engineering,	Focus Mechatronics:
	Compulsory			
	General Engineering Science (English program, 7 semest	er): Specialisation Mechanical	Engineering, Focus Th	neoretical Mechanical
	Engineering: Compulsory			
	Computational Science and Engineering: Specialisation II.		ience: Elective Comp	ılsory
	Mechanical Engineering: Specialisation Mechatronics: Cor			
	Mechanical Engineering: Specialisation Theoretical Mecha	nical Engineering: Elective Con	npulsory	
	Mechatronics: Core Qualification: Compulsory			
	Naval Architecture: Core Qualification: Compulsory Theoretical Mechanical Engineering: Technical Compleme	ntary Course Core Studios: Ele-	rtive Compulsory	
	meoretical Mechanical Engineering: Technical Compleme	intary Course Core Studies: Elec	Live Compuisory	

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

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

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

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

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

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

Module M0960: Mecha	anics IV (Oscillations, Analytical Mecha	nics, Multibody Systems	s, Numerical	l Mechanics)
Courses				
	al Mechanics, Numerical Mechanics) (L1137) al Mechanics, Numerical Mechanics) (L1138)	Typ Lecture Recitation Section (small)	Hrs/wk 3 2	<b>CP</b> 3 2
-	al Mechanics, Numerical Mechanics) (L1139)	Recitation Section (large)	1	1
Module Responsible	Prof. Robert Seifried			
Admission Requirements	None			
Recommended Previous Knowledge	Mathematics I-III and Mechanics I-III			
Educational Objectives	After taking part successfully, students have reached the	following learning results		
Professional Competence				
Knowledge	The students can			
Skills	<ul> <li>describe the axiomatic procedure used in mechanical contexts;</li> <li>explain important steps in model design;</li> <li>present technical knowledge.</li> </ul> The students can <ul> <li>explain the important elements of mathematical / mechanical analysis and model formation, and apply it to the context of their own problems;</li> <li>apply basic methods to engineering problems;</li> <li>estimate the reach and boundaries of the methods and extend them to be applicable to wider problem sets.</li> </ul>			
Personal Competence				
Social Competence	The students can work in groups and support each other	to overcome difficulties.		
Autonomy	Students are capable of determining their own strengths	Students are capable of determining their own strengths and weaknesses and to organize their time and learning based on those.		ing based on those.
Workload in Hours	Independent Study Time 96, Study Time in Lecture 84			
Credit points	6			
Course achievement	None			
Examination	Written exam			
Examination duration and	120 min			
scale				
Assignment for the	General Engineering Science (German program, 7 semest			-
Following Curricula	General Engineering Science (German program, 7 semest			ory
	General Engineering Science (German program, 7 semest	•	re: Compulsory	
	Energy Systems: Technical Complementary Course Core	Studies: Elective Compulsory		
	Mechanical Engineering: Core Qualification: Compulsory Mechatronics: Core Qualification: Compulsory			
	Naval Architecture: Core Qualification: Compulsory			
	Technomathematics: Specialisation III. Engineering Science	re: Flective Compulsory		
	Theoretical Mechanical Engineering: Technical Compleme		Compulsory	
		, Transc conc staanes, Elective	pa	

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

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

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

Module M0680: Fluid	Dynamics			
Courses				
Title		Тур	Hrs/wk	СР
Fluid Mechanics (L0454)		Lecture	3	4
Fluid Mechanics (L0455)		Recitation Section (large)	2	2
Module Responsible	Prof. Thomas Rung			
Admission Requirements	None			
Recommended Previous	Sound knowledge of engineering mathematics, engineering mechanics and thermodynamics.			
Knowledge				
<b>Educational Objectives</b>	After taking part successfully, students have reached the	ne following learning results		
<b>Professional Competence</b>				
Knowledge	Students will have the required sound knowledge to	explain the general principles of flui	d engineering ar	nd physics of fluids.
	Students can scientifically outline the rationale of flow	physics using mathematical models a	nd are familiar v	vith methods for the
	performance analysis and the prediciton of fluid engine	ering devices.		
Chille	Chudanta ava abla ta anniu fluid anninagging myinginiag	and flavor physics madels for the analy	sia of tooksiaal s	waterns. The leature
	Students are able to apply fluid-engineering principles enables the student to carry out all necessary theore			-
	scientific level.	ical calculations for the hald dynamic	. design of engin	leering devices on a
	scientific level.			
Personal Competence				
Social Competence	The students are able to discuss problems and jointly develop solution strategies.			
Autonomy	The students are able to develop solution strategies for	complex problems self-consistent and	crtically analyse	results.
Workload in Hours	Independent Study Time 110, Study Time in Lecture 70			
Credit points	6			
Course achievement	None			
Examination	Written exam			
<b>Examination duration and</b>	180 min			
scale				
Assignment for the	General Engineering Science (German program, 7 seme	ester): Specialisation Mechanical Engin	eering: Compulso	ory
Following Curricula	General Engineering Science (German program, 7 seme	ster): Specialisation Biomedical Engine	eering: Compulso	ry
	General Engineering Science (German program, 7 seme	ester): Specialisation Naval Architecture	e: Compulsory	
	Mechanical Engineering: Core Qualification: Compulsory	,		
	Naval Architecture: Core Qualification: Compulsory			
	Technomathematics: Specialisation III. Engineering Scientification	nce: Elective Compulsory		

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

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

Module M0640: Stoch	astics and Ship Dynamics			
Courses				
Title		Тур	Hrs/wk	СР
Ship Dynamics (L0352)		Lecture	2	3
Ship Dynamics (L1620)	in Nevel Andribanus and Ocean Facility and (19364)	Recitation Section (small)	1	1
	in Naval Architecure and Ocean Engineering (L0364)	Lecture	2	3
Module Responsible  Admission Requirements	Prof. Moustafa Abdel-Maksoud  None			
Recommended Previous	None			
Knowledge	Technical mechanics			
-	Linear algebra, analysis, complex numbers			
	Fluid mechanics			
<b>Educational Objectives</b>	After taking part successfully, students have reached the follo	owing learning results		
<b>Professional Competence</b>				
Knowledge	<ul> <li>The students are able to give an overview over various man procedure of the manoeuvres.</li> </ul>	noeuvres. They can name applic	ation goals and t	hey can describe the
	- The students are able to give an overview over varius rudde	er types. They can name criteria	in the rudder des	ign.
	- The students can name computation methods which are use	ed to determine forces and motion	ons in waves.	
Skills	- The students can come up with the equations of motions wh	nich are used to discribe manneu	vres. The can us	e and linearise them
SKIIS	- The students are able to determine hydrodynamic coefficier			e una inicarise circini.
	- The students can explain how a rudder works and they can			
	- The students can mathematically describe waves.	, , , , , , , , , , , , , , , , , , ,		
	- The students can explain the mathematically description 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 docun	nent them.		
	- The students can discuss in groups and explain their point o	of view.		
Autonomy	- The students can assess their own strengthes and weakness	ses 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				
Examination				
Examination duration and	180 min			
scale Assignment for the	General Engineering Science (German program, 7 semester):	Specialisation Naval Architectur	e: Compulsor:	
-	Naval Architecture: Core Qualification: Compulsory	Specialisation Naval Alchitectur	e. Compulsory	
i ollowing carricula	Mayar Architecture. Core Qualification. Compaisory			

Course L0352: Ship Dynamics	S
Тур	Lecture
Hrs/wk	2
СР	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Prof. Moustafa Abdel-Maksoud
Language	DE
Cycle	SoSe
Content	Maneuverability of ships
	<ul> <li>Equations of motion</li> <li>Hydrodynamic forces and moments</li> <li>Linear equations and their solutions</li> <li>Full-scale trials for evaluating the maneuvering performance</li> <li>Regulations for maneuverability</li> <li>Rudder</li> </ul> Seakeeping <ul> <li>Representation of harmonic processes</li> <li>Motions of a rigid ship in regular waves</li> <li>Flow forces on ship cross sections</li> <li>Strip method</li> <li>Consequences induced by ship motion in regular waves</li> <li>Behavior of ships in a stationary sea state</li> <li>Long-term distribution of seaway influences</li> </ul>
Literature	<ul> <li>Abdel-Maksoud, M., Schiffsdynamik, Vorlesungsskript, Institut für Fluiddynamik und Schiffstheorie, Technische Universität Hamburg-Harburg, 2014</li> <li>Abdel-Maksoud, M., Ship Dynamics, Lecture notes, Institute for Fluid Dynamic and Ship Theory, Hamburg University of Technology, 2014</li> <li>Bertram, V., Practical Ship Design Hydrodynamics, Butterworth-Heinemann, Linacre House - Jordan Hill, Oxford, United Kingdom, 2000</li> <li>Bhattacharyya, R., Dynamics of Marine Vehicles, John Wiley &amp; Sons, Canada,1978</li> <li>Brix, J. (ed.), Manoeuvring Technical Manual, Seehafen-Verlag, Hamburg, 1993</li> <li>Claus, G., Lehmann, E., Östergaard, C). Offshore Structures, I+II, Springer-Verlag. Berlin Heidelberg, Deutschland, 1992</li> <li>Faltinsen, O. M., Sea Loads on Ships and Offshore Structures, Cambridge University Press, United Kingdom, 1990</li> <li>Handbuch der Werften, Deutschland, 1986</li> <li>Jensen, J. J., Load and Global Response of Ships, Elsevier Science, Oxford, United Kingdom, 2001</li> <li>Lewis, Edward V. (ed.), Principles of Naval Architecture - Motion in Waves and Controllability, Society of Naval Architects and Marine Engineers, Jersey City, NJ, 1989</li> <li>Lewandowski, E. M., The Dynamics of Marine Craft: Maneuvering and Seakeeping, World Scientific, USA, 2004</li> <li>Lloyd, A., Ship Behaviour in Rough Weather, Gosport, Chichester, Sussex, United Kingdom, 1998</li> </ul>

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

Course L0364: Statistics and	Stochastic Processes in Naval Architecure and Ocean Engineering
Тур	Lecture
Hrs/wk	2
СР	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Dr. Sven Wassermann
Language	DE
Cycle	WiSe
Content	<ul> <li>descriptive statistics, parameter, criteria for outliers</li> <li>sample, sample space, probability, probability space</li> <li>Bayes method, conditional probability, law of total probability</li> <li>Discrete and continuous random variables</li> <li>Probability distributions</li> <li>mixed and joint random variables and their distribution</li> <li>Characteristics of random variables (expectation, variance, skewness, kurtosis,)</li> <li>(central) limit theorem</li> <li>Stochastic processes</li> <li>Statistical description of seaway, harmonic analysis of seaway</li> <li>narrow-banded Gaussian process, seaway and its characteristics</li> <li>sea- and wind spectra</li> <li>transformation of spectra, transfer function</li> </ul>
Literature	V. Müller, Statistik und Stochastik in der Schiffs- und Meerestechnik, Vorlesungsskript, Institut für Fluiddynamik und Schiffstheorie, Technische Universität Hamburg-Harburg, 2014  W. Blendermann "Grundlagen der Wahrscheinlichkeitsrechnung", Vorlesungsskript, Arbeitsbereich Fluiddynamik und Schiffstheorie, Technische Universität Hamburg-Harburg, 2001  H. W. Coleman, W. G. Steele, Experimentation and Uncertainty Analysis for Engineers, 3 rd Edition, John Wiley & Sons, Inc., New York, NY, 2009  ITTC Recommended Procedures and Guidelines, In: Quality Systems Manual, International Towing Tank Conference (ITTC), 2011  F.M. Dekking, C. Kraaikamp, H.P. Lopuhaä, L.E. Meester, A Modern Introduction To Probability and Statistics, Springer, 2005  Springer Handbook of Engineering Statistics, H. Pham (Hrsg.), Springer, 2006  A. Klenke, Wahrscheinlichkeitstheorie, Springer, 2013

Module M0664: Struc	tural Design and Construction of Ships			
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			
Recommended Previous	Mechanics I - III			
Knowledge				
	Welding Technology I			
	Fundamentals of Mechanical Design I - III			
Educational Objectives	After taking part successfully, students have reached the	following learning results		
Professional Competence				
Knowledge	Students can reproduce design and sizing as well as fabr	ication of the different areas of ship	structures and o	f different ship types
	(incl. detail design); they can describe calculation models	for complex structures.		
Skills	Students are capable to specify the requirements for di		e hull, to define d	esign criteria for the
Personal Competence	components, to select suitable calculation models and to	assess the chosen structure		
	Students are capable to present their structural design ar	nd discuss their decisions construct	ively in a group.	
·				
Autonomy	Students are capable to design independently different	structural areas of the ship hull a	and different ship	types and to define
	appropriate fabrication methods.			
Workload in Hours	Independent Study Time 172, Study Time in Lecture 98			
Credit points	9			
Course achievement	None			
Examination	Written exam			
Examination duration and	3 hours			
scale				
Assignment for the	General Engineering Science (German program, 7 semest	ter): Specialisation Naval Architectu	ire: Compulsory	
Following Curricula	Naval Architecture: Core Qualification: Compulsory			
-				

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	Dr. Rüdiger Ulrich Franz von Bock und Polach
Language	DE
Cycle	SoSe
Content	Chapters:
	1. Bulkheads and tanks 2. Structural design of forebodies 3. Structures in engine rooms 4. Aft bodies and rudders 5. Detail structural design 6. Outfitting 7. Bulk carriers 8. Tankers 9. Container ships 10. Production-kind steel structural design 11. Buckling and ultimate strength 12. Safety factors and reliability of structures
Literature	Vorlesungsskript mit weiteren Literaturangaben wird über das Internet verfügbar gemacht

Course L0415: Ship Structural Design	
Тур	Recitation Section (small)
Hrs/wk	2
СР	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Dr. Rüdiger Ulrich Franz von Bock und Polach
Language	DE
Cycle	SoSe
Content	Chapters:
Literature	1. Bulkheads and tanks 2. Structural design of forebodies 3. Structures in engine rooms 4. Aft bodies and rudders 5. Detail structural design 6. Outfitting 7. Bulk carriers 8. Tankers 9. Container ships 10. Production-kind steel structural design 11. Buckling and ultimate strength 12. Safety factors and reliability of structures
Literature	Vorlesungsskript mit weiteren Literaturangaben wird über das Internet verfügbar gemacht

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

Module M0659: Fund	amentals of Ship Structural Design	and Analysis		
Courses				
Title Fundamentals of Ship Structural Do	_	Typ Lecture	Hrs/wk	<b>CP</b> 2
Fundamentals of Ship Structural De Fundamentals of Ship Structural Ar	nalysis (L0410)	Recitation Section (small)  Lecture	1 2	2 2
Fundamentals of Ship Structural Ar  Module Responsible		Recitation Section (small)	1	2
Admission Requirements				
Recommended Previous				
	Fundamentals of Materials Science I - III			
	Welding Technology I			
	Fundamentals of Mechanical Design I - III			
Educational Objectives	After taking part successfully, students have reache	d the following learning results		
Professional Competence				
Knowledge	Students can reproduce the basic contents of the st for the calculation of deformations and stresses in b	·	/ can explain the	theory and methods
	Furthermore, they can reproduce the basis content structural design of components in the ship structure		ed products, join	ing and principles of
Skills	Students are capable of applying the methods and tools for the calculation of linear deformations and stresses in the above mentioned structures; they can choose calculation models of typical ship structures.  Furthermore, they are capable to apply the methods of drawing and sizing the ship structure; they can select suitable materials, semi-finished products and joints.			
Personal Competence Social Competence Autonomy		e real ship structures and to select suitab structural analyses.	ole methods for a	analysis of beam-like
Workload in Hours	Independent Study Time 156, Study Time in Lecture	e 84		
Credit points				
Course achievement				
Examination	Written exam			
Examination duration and scale	3 hours			
Assignment for the	General Engineering Science (German program, 7 se	emester): Specialisation Naval Architectur	e: Compulsory	
Following Curricula	Orientation Studies: Core Qualification: Elective Com Naval Architecture: Core Qualification: Compulsory	npulsory		

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

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

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

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

Module M1109: Resis	tance and Propulsion			
Courses				
Title		Тур	Hrs/wk	СР
Resistance and Propulsion (L1265)		Lecture	2	3
Resistance and Propulsion (L1266)		Recitation Section (large)	2	3
Module Responsible	Prof. Stefan Krüger			
Admission Requirements	None			
Recommended Previous	Mechanics			
Knowledge	Fluid Dynamics for Naval Architects			
	Hydrostratics			
	,			
Educational Objectives	After taking part successfully, students have reached the	e following learning results		
Professional Competence				
Knowledge	The hydrodynamic basics that are relevant for resis	stance and propulsion of ships are	discussed. The	different resistance
	phenomena and their practical applications to hullform	design as well as numerical and em	pirical prediction	methods are subject
	of the course. Furthermore, environmental additional re	esistances are dealt with. The cours	e includes model	test techniques and
	their application to full scale ships. This hold also for p		-	
	Main Focus is how hull forms can be optimized for minim	ium and sustainable fuel consumptio	n. The following t	opics are dealt with:
	- Stillwater/added resistance, Wave resistance, Minimization of wave resistance, numerical prediction methods, friction laws,			
	laminar/turbulent flow separation, Hull form design for redcude flow separation, Appendage Design and resistance, Froude's			
	resistance law,form factor method, thrust deduction, wa		-	
	propeller basics, propulsion tests, full scale speed power predictions, additional resistances (wind, steering, current, sea state),			
	EEDI, speed trials, contractual matters concerning speed	l/power, bunker claims		
Skills	The student shall learn to design competitve hull forms			
	evaluate these hulls by several progosis methods. F		the student to c	learl determine and
	minimize the required power including environmental inf	nuences.		
Personal Competence				
Social Competence	The student learns to prepare technical matters in such a way that he can compte with his building suvervision team.			
Autonomy	The student learns to prepare technical matters in such	a way that he can compte with his bu	uilding suvervision	n team.
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56			
Credit points	6			
Course achievement	None			
Examination	Written exam			
Examination duration and	180 min			
scale				
Assignment for the	General Engineering Science (German program, 7 semes	ster): Specialisation Naval Architectu	re: Compulsory	
Following Curricula	Naval Architecture: Core Qualification: Compulsory			

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

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

Module M1110: Ship	Design
Courses	
Title	Typ Hrs/wk CP
Ship Design (L1262)	Lecture 2 3
Ship Design (L1264)	Recitation Section (large) 2 3
Module Responsible	Prof. Stefan Krüger
Admission Requirements	None
Recommended Previous	Fluid Dynamics for Naval Architects, Resistance and Propulsion
Knowledge	Resistance and Propulsion, Hydrostatics
<b>Educational Objectives</b>	After taking part successfully, students have reached the following learning results
Professional Competence	
Knowledge	The lecture starts with an overview about the importance and requirements of the aerly design phase. Competitive Elements o Ship Designs are thoroughly discussed. Typical bulding contracts and the related technical risk are introduced. The most importan main parameters of a ship are introduced and their influence on the competitiveness of a design. The lecture focusses on the
	influence of alternated main parameters on the total performance of a ship design and the consecutive process elements. In this lecture, the design changes are dealt with by simple models or formulae. The student shall further learn to model complex systems properly so that the relavent technical conclusions can be drawn.
	The lecture continues with an introduction into the different phases of design project, from the initial design phase to a building
	contract. Further, methods are introduced to generate bulding specfication relevant information at different levens of granularity during the different design stages. In detail, the following topics are adressed:
	- Structure of a building specification
	- Determination of Light Ship Weight and Deadweight
	Components
	- Design of main section and hull form
	- Design of aftbody lines and manoevering devices
	- Design of main propulsion plant - Design of subdivision
	- Determination of limiting GMrequ- Curves
	- Scantlings of most improtant structural members
	- Longitudinal strength
	- Outfitting Components
	- Relevant rules and regulations
Skills	The student is made familiar with the basic design principles of seagoing mearchant ships. The goal of the lecture is that the
	student shall be able to carry out a concept design based on a vessel of comparison fulfilling typical contract requirements within the Marine Environment. The lecture deals with the basic design methods to determine the fundamental technical characteristics of a ship design with respect to fulfillment procedures of the contract values. Based on the lecture "Principles of Ship Design" the
	relevant methods to determine and judge uopn the performance of a ship design are treated.
Personal Competence	
Social Competence	The students learns to prepare technical matters in such a way the he can persuade his potantial customer against his competitors.
Autonomy	The students learns to prepare technical matters in such a way the he can persuade his potantial customer against his
	competitors.
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56
Credit points	6
Course achievement	None
Examination	Written exam
Examination duration and	180 min
scale	
Assignment for the	
Following Curricula	Naval Architecture: Core Qualification: Compulsory

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

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

## **Specialization Process Engineering**

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

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

Module M0886: Funda	amentals of Process Engineer	ing and Material Engineering		
Courses				
Title		Тур	Hrs/wk	СР
	ng/Bioprocess Engineering (L0829)	Lecture	2	1
Fundamentals of material engineer		Lecture	2	2
Module Responsible	Prof. Michael Schlüter			
Admission Requirements	None			
Recommended Previous	none			
Knowledge				
Educational Objectives	After taking part successfully, students have	ve reached the following learning results		
Professional Competence				
Knowledge	After passing this module the students hav	e the ability to:		
	give an overview of the most import	ant fields on process and bioprocess enginee	ering,	
	<ul> <li>explain some working methods for d</li> </ul>	lifferent fields in process engineering.		
Skills	After passing this module the students sho	uld have the ability to:		
	list and outline the most important fi	ields of process engineering		
		pproaches or methods of the different fields (	of process engineering	
	read and prepare an engineering dra		or process engineering,	
		ogies for wastewater and exhaust air treatme	nt	
		hnological processes independently with the		
			·	
Personal Competence				
Social Competence	The students are able to			
	work out results in groups and docur	ment them,		
	provide appropriate feedback and ha	andle feedback on their own performance co	nstructively.	
Autonomy	The students are able to estimate their pro-	rogress of learning by themselves and to de	liborato thoir lack of k	roudedge in Presess
Autonomy	Engineering and Bioprocess Engineering.	rogress of learning by themselves and to de	siberate their lack of k	inowieuge in Frocess
	Engineering and bioprocess Engineering.			
Workload in Hours	Independent Study Time 34, Study Time in	Lecture 56		
Credit points	3			
Course achievement		Description		
	No 5 % Written elaboration			
Examination	Written exam			
Examination duration and	90 min			
scale				
Assignment for the		gram, 7 semester): Specialisation Process Eng		
Following Curricula		gram, 7 semester): Specialisation Bioprocess	Engineering: Compulso	ory
	Bioprocess Engineering: Core Qualification:	• •		
	Orientation Studies: Core Qualification: Elec			
	Process Engineering: Core Qualification: Co	ompulsory		

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

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

20111000			
Courses			- CD
<b>Fitle</b> Computer Engineering (L0321)	•••	<b>Hrs/wk</b> 3	<b>CP</b> 4
Computer Engineering (L0324)	Recitation Section (small)	1	2
Module Responsible	Prof. Heiko Falk		
Admission Requirements	None		
Recommended Previous			
Knowledge			
Educational Objectives Professional Competence			
•	This module deals with the foundations of the functionality of computing systems. It covers the programming down to gates. The module includes the following topics:  • Introduction	: layers from	the assembly-lev
	<ul> <li>Combinational logic: Gates, Boolean algebra, Boolean functions, hardware synthesis, combined 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, pipel</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 of</li> </ul>	ining	
Skills	The students perceive computer systems from the architect's perspective, i.e., they identify the in composition of computer systems. The students can analyze, how highly specific and individual co-collection of few and simple components. They are able to distinguish between and to explain the today's computing systems - from gates and circuits up to complete processors.  After successful completion of the module, the students are able to judge the interdependencie system and the software executed on it. In particular, they shall understand the consequences they on the hardware-centric abstraction layers from the assembly language down to gates. This way, the impact that these low abstraction levels have on an entire system's performance and to propose	omputers can ne different a es between a at the execut they will be o	be built based on bstraction layers physical comput tion of software h enabled to evalua
Personal Competence Social Competence	Students are able to solve similar problems alone or in a group and to present the results according	gly.	
Autonomy	Students are able to acquire new knowledge from specific literature and to associate this knowledge	ge with other	classes.
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56		
Credit points	6		
Course achievement			
Evamination	Yes 10 % Excercises Written exam		
	90 minutes, contents of course and labs		
scale			
Assignment for the	General Engineering Science (German program, 7 semester): Specialisation Computer Science: Co	mpulsory	
	General Engineering Science (German program, 7 semester): Specialisation Process Engineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Encompulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering Sciences: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering Production: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering	gineering, Focus The ngineering, Focus The ngineering, ing, Focus Preering, Focus Proceering, Focus Proceeding, Focus Pr	us Aircraft System coretical Mechanic Focus Materials oduct Developme is Energy System
	General Engineering Science (German program, 7 semester): Specialisation Naval Architecture: Co General Engineering Science (German program, 7 semester): Specialisation Biomedical Engineerin General Engineering Science (German program, 7 semester): Specialisation Bioprocess Engineerin General Engineering Science (German program, 7 semester): Specialisation Electrical Engineering: General Engineering Science (German program, 7 semester): Specialisation Green Technologies, F Compulsory  Computer Science: Core Qualification: Compulsory	g: Compulsor g: Compulsor Compulsory	у

Technomathematics: Specialisation II. Informatics: Elective Compulsory

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

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

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

Module M0536: Funda	amentals of Fluid Mechanics			
Courses				
Title		Тур	Hrs/wk	СР
Fundamentals of Fluid Mechanics (	L0091)	Lecture	2	4
Fluid Mechanics for Process Engine	ering (L0092)	Recitation Section (large)	2	2
Module Responsible	Prof. Michael Schlüter			
Admission Requirements	None			
Recommended Previous	Mathematics I+II+III			
Knowledge	Technical Mechanics I+II			
	<ul> <li>Technical Thermodynamics I+II</li> </ul>			
	Working with force balances			
	Simplification and solving of partial difference	ential equations		
	Integration			
Educational Objectives	After taking part successfully, students have rea	ched the following learning results		
Professional Competence				
Knowledge	Students are able to:			
	explain the difference between different t	whee of flow		
		s of the Reynolds Transport-Theorem in proce	ss engineering	
		and Navier-Stokes-Equation by using physical		ions
CL III				
SKIIIS	The students are able to			
	describe and model incompressible flows	mathematically		
		nechanics by simplifications to archive quantit	ative solutions e	.g. by integration
	notice the dependency between theory are	• •		
	use the learned basics for fluid dynamical	applications in fields of process engineering		
Personal Competence				
Social Competence	The students			
	are capable to gather information from significant series.	ubject related, professional publications and	relate that inforr	mation to the context
	of the lecture and	,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,		
	<ul> <li>able to work together on subject related</li> </ul>	tasks in small groups. They are able to pres	ent their results	effectively in English
	(e.g. during small group exercises)			
	are able to work out solutions for exercise	es by themselves, to discuss the solutions ora	lly and to presen	t the results.
Autonomy	The students are able to			
·				
	·	d to expand their knowledge with this literatu to evaluate their actual knowledge with the fe		
	work on their exercises by their own and	to evaluate their actual knowledge with the re	ecuback.	
Workload in Hours	Independent Study Time 124, Study Time in Lec	ture 56		
Credit points				
Course achievement	Compulsory Bonus Form Yes 5 % Midterm	Description		
Eyamination	Written exam			
Examination duration and				
scale				
Assignment for the	General Engineering Science (German program,	7 semester): Specialisation Process Engineer	ing: Compulsory	
Following Curricula	General Engineering Science (German program,	7 semester): Specialisation Bioprocess Engine	eering: Compuls	ory
	General Engineering Science (German program,	7 semester): Specialisation Green Technolog	ies: Compulsory	
	Bioprocess Engineering: Core Qualification: Com	•		
	Energy and Environmental Engineering: Core Qu			
	Green Technologies: Energy, Water, Climate: Co			
	Logistics and Mobility: Specialisation Traffic Plan			
	Technomathematics: Specialisation III. Engineering: Core Qualification: Comput			
	Process Engineering: Core Qualification: Compul Engineering and Management - Major in Logistic		and Systems: FI	ective Compulsory
			Systems. Li	y

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

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, th 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 solution are presented on the chalk board. At the end of each exercise-lecture, the correct solution is presented on the chalk board. Paralle to the exercise-lecture tutorials are held where the student solve exam questions under a set time-frame in small groups and discuss the solutions afterwards.
Literature	<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 Strömunger Springer Verlag, Berlin, Heidelberg, New York, 2006</li> <li>Herwig, H.: Strömungsmechanik: Einführung in die Physik von technischen Strömungen: Vieweg+Teubner Verlag / GWFachverlage GmbH, Wiesbaden, 2008</li> <li>Kuhlmann, H.C.: Strömungsmechanik: Grundlagen, Grundgleichungen, Lösungsmethoden, Softwarebeispiele. Vieweg+ Teubne Verlag / GWV Fachverlage GmbH, Wiesbaden, 2009</li> <li>Schade, H.; Kunz, E.: Strömungslehre. Verlag de Gruyter, Berlin, New York, 2007</li> <li>Truckenbrodt, E.: Fluidmechanik 1: Grundlagen und elementare Strömungsvorgänge dichtebeständiger Fluide. Springer Verlag, Berlin, Heidelberg, 2008</li> <li>Schlichting, H.: Grenzschicht-Theorie. Springer-Verlag, Berlin, 2006</li> <li>van Dyke, M.: An Album of Fluid Motion. The Parabolic Press, Stanford California, 1882.</li> <li>White, F.: Fluid Mechanics, Mcgraw-Hill, ISBN-10: 0071311211, ISBN-13: 978-0071311212, 2011</li> </ol>

Module M0544: Phase	e Equilibria Thermodynamics			
Courses				
Title		Тур	Hrs/wk	СР
Phase Equilibria Thermodynamics	(L0114)	Lecture	2	2
Phase Equilibria Thermodynamics	(L0140)	Recitation Section (small)	1	2
Phase Equilibria Thermodynamics	(L0142)	Recitation Section (large)	1	2
Module Responsible	Prof. Irina Smirnova			
Admission Requirements	None			
Recommended Previous	Mathematics, Physical Chemistry, Thermodynamics	I and II		
Knowledge				
Educational Objectives	After taking part successfully, students have reache	d the following learning results		
Professional Competence		a the following learning results		
Knowledge				
Knowledge	Starting from the very basics of thermodyna	amics, the students learn the mathemat	cal tools to desc	cribe thermodynamic
	equilibria.			
	They learn how state variables are influence	d by the mixing of compounds and lear	n concepts to qu	antitatively describe
	these properties.			
	Moreover, the students learn how phase equ	uilibria can be described mathematically	and which pher	omena may occur if
	different phases (vapor, liquid, solid) coexist i	n equilibrium. Furthermore the fundamen	tals of reaction e	quilibria are taught.
	For different phase equilibria, several exam	ples relevant for different kinds of proc	esses are show	n and the necessary
	knowledge for plotting and interpreting the ed	quilibria are taught.		
Skills				
	Applying their knowledge, the students are		the determination	on of the equilibrium
	state and know how to simplify these equatio			
	The students know models which can be use		em in the equili	orium state and they
	are able to solve the resulting mathematical i			
	For specific applications, they are able to sell	f-reliantly find necessary physico-chemica	Il properties of c	ompounds as well as
	model parameters in literature sources.			
	Beside pure compound properties the student			
	The students know how to visualize phase eq			
	Based on their knowledge, the students a		ncepts that are	the basis for many
	separation and reaction processes in chemica	l engineering.		
Personal Competence				
Social Competence	The students are able to work in small groups, to s	olve the corresponding problems and to	present them or	aly to the tutors and
	other students			
Autonomy	The students are able to find necessary inforr	nation self religably in literature sources	nd to judgo their	quality
	•	·		
	During the semester the students are able  knowledge the students can adopt their learn		iluousiy iii exer	cises. based on this
	knowledge the students can adept their learn	וווא אוטנכסס.		
		<u></u>		
Workload in Hours	Independent Study Time 124, Study Time in Lecture	56		
Credit points	6			
Course achievement	None			
Examination	Written exam			
	120 minutes; theoretical questions and calculations			
scale	'			
Assignment for the		emester): Specialisation Process Engineer	ing: Compulsory	
Following Curricula				orv
. onowing curricula	General Engineering Science (German program, 7 se			*
		anester). Specialisation dreen rechnolog	es, i ocus Kenew	able Lifetgy. Elective
	Compulsory	omostor), Enocialization Caran Tarks	oc Forms Dem	able Engrava Election
	General Engineering Science (German program, 7 se	ernester): specialisation Green Technolog	es, rocus Kenew	able Ellergy: Elective
	Compulsory			
	Bioprocess Engineering: Core Qualification: Compuls		C	
	Green Technologies: Energy, Water, Climate: Specia			
	Green Technologies: Energy, Water, Climate: Specia		sory	
	Process Engineering: Core Qualification: Compulsory	,		

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

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

Module M0938: Biopr	ocess Engineering - Fundamental	ls		
Courses				
Title Bioprocess Engineering - Fundamentals (L0841)		<b>Typ</b> Lecture	Hrs/wk	<b>CP</b> 3
Bioprocess Engineering- Fundamen	tals (L0842)	Recitation Section (large)	2	1
Bioprocess Engineering - Fundamer	ntal Practical Course (L0843)	Practical Course	2	2
Module Responsible	Prof. Andreas Liese			
Admission Requirements	None			
Recommended Previous	none, module "organic chemistry", module "fund	lamentals for process engineering"		
Knowledge				
<b>Educational Objectives</b>	After taking part successfully, students have rea	ched the following learning results		
Professional Competence				
	Students are able to describe the basic concepts enzymes and microorganisms, as well as to or rheology can be named and mass transport p fundamental bioprocess management, sterilization of this module, students and the successful completion of this module, students are also successful completion of this module, students are also successful completion of this module, students are able to describe the basic concepts and successful as the successful completion of this module, students are also successful completion of this module.	differentiate different types of inhibition. rocesses in bioreactors can be explained on technology and downstream processing	The parameters . The students ar	of stoichiometry and
	describe different kinetic approaches for g     predict qualitatively the influence of ene fermentation process     analyze bioprocesses on basis of stoichior     distinguish between scale-up criteria for g     to compare them as well as to apply them     propose solutions to complicated biotechr     to explore new knowledge resources and g     identify scientific problems with concrete     to document and discuss their procedures	ergy generation, regeneration of redox equators and to set up / solve metabolic flux edifferent bioreactors and bioprocesses (analytic to current biotechnical problem hological problems and to deduce the correct apply the newly gained contents industrial use and to formulate solutions.	uivalents and gro quations erobic, aerobic as	wth inhibition on the
	After completion of this module participants sho take position to their own opinions and increase  After completion of this module participants will	their capacity for teamwork in engineering	and scientific env	ironments.
	workflow and to present their results in a plenur	n.		
Workload in Hours	Independent Study Time 96, Study Time in Lectu	ire 84		
Credit points				
Course achievement	Compulsory Bonus Form	<b>Description</b> and		
Examination	·			
Examination duration and scale				
Assignment for the	General Engineering Science (German program,	7 semester): Specialisation Process Engine	ering: Compulsory	
Following Curricula	General Engineering Science (German program,	7 semester): Specialisation Bioprocess Eng	ineering: Compuls	ory
	Bioprocess Engineering: Core Qualification: Com	pulsory		
	Green Technologies: Energy, Water, Climate: Spe			
	Biomedical Engineering: Specialisation Artificial (	· ·	Isory	
	Biomedical Engineering: Specialisation Implants			
	Biomedical Engineering: Specialisation Medical T			
	Biomedical Engineering: Specialisation Managem		Compulsory	
	Technomathematics: Specialisation III. Engineeri	- · · · ·		
	Process Engineering: Core Qualification: Compuls	sory		

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

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

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

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Courses				
litle		Тур	Hrs/wk	CP
Power Industry (L0316)	0.//.0215\	Lecture Lecture	1 2	1 2
Energy Systems and Energy Indust Renewable Energy (L0313)	y (L0313)	Lecture	2	2
Renewable Energy (L1434)		Recitation Section (small)	1	1
	Prof. Martin Kaltschmitt			
Admission Requirements	None			
Recommended Previous	none			
Knowledge				
Educational Objectives	After taking part successfully, students have reach	ned the following learning results		
Professional Competence	, , , , , , , , , , , , , , , , , , ,	3		
Knowledge	With completion of this module, the students car efficiency. They can explain the issues occurring in distribution and power trading wih regard to s applicable to many energy systems in general, e the students can explain the environmental benef	n this context. Furthermore, they can expla subject-related contexts. The students ca specially for renewable energy systems ar	n details of pown	er generation, power aspects, which a
Skills	Students are able to apply methodologies for detailed determination of energy demand or energy production for various types or energy systems. Furthermore, they can evaluate energy systems technically, environmentally and economically and design then under certain given conditions. Therefore, they can choose the necessary subject-specific calculation rules, also for no standardized solutions of a problem.  The students are able to explain questions and possible approaches to its processing from the field of renewable energies orally			
Barranal Garranaharan	and to put them them into the right context.			
Personal Competence Social Competence	The students are able to analyze suitable technical alternatives and to assess them with technical, economical and ecological criteria under sustainability aspects. This allows them to make an effective contribuition to a more sustainable power supply.			
Autonomy	Students can independently exploit sources , acquire the particular knowledge about the subject area and transform it to new questions.			
Workload in Hours	Independent Study Time 96, Study Time in Lecture	2 84		
Credit points	6			
Course achievement				
Examination				
Examination duration and	3 hours written exam			
scale				
Assignment for the	General Engineering Science (German program, 7	semester): Specialisation Process Engineer	ina: Compulsory	
Following Curricula				
	General Engineering Science (German program,			
	Elective Compulsory			
	Civil- and Environmental Engineering: Specialisation	on Civil Engineering: Elective Compulsory		
	Civil- and Environmental Engineering: Specialisation	on Traffic and Mobility: Elective Compulsory		
	Civil- and Environmental Engineering: Specialisation	on Water and Environment: Elective Compu	Isory	
	Energy and Environmental Engineering: Core Qual	ification: Compulsory		
	General Engineering Science (English program,	7 semester): Specialisation Mechanical	Engineering, Foo	cus Energy System
	Elective Compulsory			
	Process Engineering: Core Qualification: Compulso	ry		

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

Course L0315: Energy Systems and Energy Industry		
Тур	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	nergy
Тур	Lecture
Hrs/wk	2
СР	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Prof. Martin Kaltschmitt
Language	DE/EN
Cycle	SoSe
Content	<ul> <li>introduction</li> <li>solar energy for heat and power generation</li> <li>wind power for electricity generation</li> <li>hydropower for electricity generation</li> <li>ocean energy for electricity generation</li> <li>geothermal energy for heat and electricity generation</li> </ul>
Literature	<ul> <li>Kaltschmitt, M.; Streicher, W.; Wiese, A. (Hrsg.): Erneuerbare Energien - Systemtechnik, Wirtschaftlichkeit, Umweltaspekte; Springer, Berlin, Heidelberg, 2006, 4. Auflage</li> <li>Kaltschmitt, M.; Streicher, W.; Wiese, A. (Hrsg.): Renewable Energy - Technology, Economics and Environment; Springer, Berlin, Heidelberg, 2007</li> </ul>

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

Module M0892: Chem	ical Reaction Engineering			
Courses				
Title		Тур	Hrs/wk	СР
Chemical Reaction Engineering (Fu	ndamentals) (L0204)	Lecture	2	2
Chemical Reaction Engineering (Fu	ndamentals) (L0244)	Recitation Section (large)	2	2
Experimental Course Chemical Eng	ineering (Fundamentals) (L0221)	Practical Course	2	2
Module Responsible	Prof. Raimund Horn			
Admission Requirements	None			
Recommended Previous	Contents of the previous modules mathematics I-III, ph	nysical chemistry, technical thermody	namics I+II as w	vell as computational
Knowledge	methods for engineers.			
Educational Objectives	After taking part successfully, students have reached th	e following learning results		
Professional Competence				
Knowledge	The students are able to explain basic concepts of cher	mical reaction engineering. They are a	able to point out	differences between
	thermodynamical and kinetical processes. The student	ts have a strong ability to outline par	rts of isotherma	l and non-isothermal
	ideal reactors and to describe their properties.			
Skills	After successful completion of the module, students are	able to:		
	- apply different computational methods to dimension isothermal and non-isothermal ideal reactors,			
	- determine and compute stable operation points for these reactors ,			
	- conduct experiments on a lab-scale pilot plants and do	- conduct experiments on a lab-scale pilot plants and document these according to scientific guidelines.		
Personal Competence				
Social Competence	After successful completition of the lab-course the stud	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 students	issues in chemical reaction engineering. The students can discuss their subject related knowledge among each other and with		
	their teachers.			
Autonomy	The students are able to obtain further information	n and assess their relevance auton	omously. Stude	nts can apply their
	knowldege discretely to plan, prepare and conduct expe	eriments.		
Workload in Hours	Independent Study Time 96, Study Time in Lecture 84			
Credit points	6			
Course achievement	Compulsory Bonus Form Descri	ription		
	Yes None Subject theoretical and			
	practical work			
Examination	Written exam			
Examination duration and	120 min			
scale				
Assignment for the	General Engineering Science (German program, 7 seme	ster): Specialisation Bioprocess Engine	eering: Compulso	ory
Following Curricula	General Engineering Science (German program, 7 semester): Specialisation Process Engineering: Compulsory			
	General Engineering Science (German program, 7 semester): Specialisation Chemical and Bioengineering: Compulsory			
	Bioprocess Engineering: Core Qualification: Compulsory			
	Chemical and Bioprocess Engineering: Core Qualification: Compulsory			
	Green Technologies: Energy, Water, Climate: Specialisa	tion Bioresource Technology: Elective	Compulsory	
	Process Engineering: Core Qualification: Compulsory			

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

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

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

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

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

## Literature

lecture notes Raimund Horn

skript Frerich Keil

Books:

- M. Baerns, A. Behr, A. Brehm, J. Gmehling, H. Hofmann, U. Onken, A. Renken, Technische Chemie, Wiley-VCH
- G. Emig, E. Klemm, Technische Chemie, Springer
- A. Behr, D. W. Agar, J. Jörissen, Einführung in die Technische Chemie
- E. Müller-Erlwein, Chemische Reaktionstechnik 2012, 2. Auflage, Teubner Verlag
- J. Hagen, Chemiereaktoren: Auslegung und Simulation, 2004, Wiley-VCH
- H. S. Fogler, Elements of Chemical Reaction Engineering, Prentice Hall B
- H. S. Fogler, Essentials of Chemical Reaction Engineering, Prentice Hall
- O. Levenspiel, Chemical Reaction Engineering, John Wiley & Sons, 1998
- L. D. Schmidt, The Engineering of Chemical Reactions, Oxford Univ. Press, 2009
- J. B. Butt, Reaction Kinetics and Reactor Design, 2000, Marcel Dekker
- R. Aris, Elementary Chemical Reactor Analysis, Dover Pubn. Inc., 2000
- M. E. Davis, R. J. Davis, Fundamentals of Chemical Reaction Engineering, McGraw Hill
- G. F. Froment, K. B. Bischoff, J. De Wilde, Chemical Reactor Analysis and Design, John Wiley & Sons, 2010
- A. Jess, P. Wasserscheid, Chemical Technology An Integrated Textbook, WILEY-VCH

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

enthalpy, calorimeter, heat of reaction, standard heat of formation, Hess law, heat capacity, Kirchhoff law, standard heat of reaction, pressure dependence of the heat of reaction, second law of thermodynamics, reversible and irreversible processes, entropy, Clausius inequality, free energy, Gibbs Energy, chemical potential, chemical equilibrium, activity, van't Hoff law, calculation of chemical equilibrium, principle of Le Chatelier and Braun, equilibrium calculations in multiple reaction systems, Lagrange Multipliers)

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

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

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

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

## Literature

lecture notes Raimund Horn

skript Frerich Keil

Books

- M. Baerns, A. Behr, A. Brehm, J. Gmehling, H. Hofmann, U. Onken, A. Renken, Technische Chemie, Wiley-VCH
- G. Emig, E. Klemm, Technische Chemie, Springer
- A. Behr, D. W. Agar, J. Jörissen, Einführung in die Technische Chemie
- E. Müller-Erlwein, Chemische Reaktionstechnik 2012, 2. Auflage, Teubner Verlag
- J. Hagen, Chemiereaktoren: Auslegung und Simulation, 2004, Wiley-VCH
- H. S. Fogler, Elements of Chemical Reaction Engineering, Prentice Hall B
- $\hbox{H. S. Fogler, Essentials of Chemical Reaction Engineering, Prentice Hall}\\$
- O. Levenspiel, Chemical Reaction Engineering, John Wiley & Sons, 1998
- L. D. Schmidt, The Engineering of Chemical Reactions, Oxford Univ. Press, 2009
- J. B. Butt, Reaction Kinetics and Reactor Design, 2000, Marcel Dekker
- R. Aris, Elementary Chemical Reactor Analysis, Dover Pubn. Inc., 2000
- M. E. Davis, R. J. Davis, Fundamentals of Chemical Reaction Engineering, McGraw Hill
- G. F. Froment, K. B. Bischoff, J. De Wilde, Chemical Reactor Analysis and Design, John Wiley & Sons, 2010
- A. Jess, P. Wasserscheid, Chemical Technology An Integrated Textbook, WILEY-VCH

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

Module M1275: Enviro	onmental Techn	ology				
Courses						
Title				Тур	Hrs/wk	СР
Practical Exercise Environmental Te	echnology (L1387)			Practical Course	1	1
Environmental Technologie (L0326	)			Lecture	2	2
Module Responsible	Prof. Martin Kaltschmit	t				
Admission Requirements	None					
Recommended Previous	Fundamentals of inorg	anic/organic chemistry a	and biology			
Knowledge						
<b>Educational Objectives</b>	After taking part succe	essfully, students have re	eached the followi	ng learning results		
Professional Competence						
Knowledge	With the completion of	f this modul the students	obtain profound	knowledge of environme	ntal technology. They	are able to describe
	the behaviour of chem	nicals in the environmen	t. Students can g	ive an overview of scien	tific disciplines involve	ed. They can explain
	terms and allocate the	m to related methods.				
Skills	l .		-	itigation measures for e	•	-
	_	•	·	l of pollutants to migrat		
		•		gy contributes to sustai	nable development, a	nd they can present
	and defend these opin	ons in front of and again	st the group.			
Personal Competence						
Social Competence	The students are able	to discuss the various te	chnical and scient	tific tasks, both subject-s	pecific and multidiscip	olinary. They are able
·	The students are able to discuss the various technical and scientific tasks, both subject-specific and multidisciplinary. They are able to develop different approaches to the task as a group as well as to discuss their theoretical or practical implementation.					
Autonomy	Students can independ	dently exploit sources ab	out of the subject	, acquire the particular k	nowledge and tranfer	it to new problems.
Workload in Hours	Independent Study Tin	ne 48, Study Time in Lec	ture 42			
Credit points	3	•				
Course achievement	Compulsory Bonus	Form	Description			
	Yes None	Subject theoretical	and			
		practical work				
Examination	Written exam					
Examination duration and	1 hour					
scale						
Assignment for the	General Engineering S	cience (German progran	n, 7 semester): Sp	ecialisation Bioprocess E	ngineering: Elective C	ompulsory
_				ecialisation Process Engi	-	
_		g: Core Qualification: Ele		-	-	· •
	Energy and Environmental Engineering: Core Qualification: Compulsory					
		Core Qualification: Electiv		· •		

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

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

Module M1497: Meas	urement Technol	ogy for Cher	mical and Biop	rocess Engineer	ing	
Courses						
Title				Тур	Hrs/wk	СР
Practical Course Measurement Tecl	nnology (L2270)			Practical Course	2	2
Measurement Technology (L2268)				Lecture	2	2
Physical Fundamentals of Measurer	ment Technology (L2269)			Lecture	2	2
Module Responsible	Prof. Alexander Penn					
Admission Requirements	None					
Recommended Previous	Technical interest, logic	al skills, integral-	and differential calcu	llus, basic physical cond	cepts such as temperat	ure, mass, velocity,
Knowledge	etc					
Educational Objectives	After taking part succes	sfully, students ha	ive reached the follow	ring learning results		
Professional Competence						
Knowledge	Physical basics: kinem magnetism, basics of hy				odies, energy and mor	mentum, electricity,
	Metrology: SI units, me measurement, pressure			-		ciples, temperature
	Practical course: Pressu mass transfer, capacitiv				asurement, concentratio alculation, chromatograp	
Skills	Literature research, cat programming with Mat calculations.	-		•		
Personal Competence						
	Arrangement and divisi experimental stand in experiment, tolerance o	groups, consultat	_		ent of own level of known, presentation of the	-
Autonomy	Time management of the protective equipment of formulation of enquiries	and work clothing	g, practice of preser		, personal responsibility roup, active participat	
Workload in Hours	Independent Study Time	96, Study Time ir	n Lecture 84			
Credit points	6					
Course achievement		orm Excercises	<b>Description</b> Popup-Quizz	zes währen der Vorlesun	ng	
Examination	Written exam					
Examination duration and scale	120 min					
Assignment for the	General Engineering Sci	ence (German pro	gram, 7 semester): S	pecialisation Process En	gineering: Compulsory	
Following Curricula	General Engineering Sci	ence (German pro	gram, 7 semester): S	pecialisation Green Tech	nnologies: Compulsory	
	General Engineering Sci	ence (German pro	gram, 7 semester): S	pecialisation Chemical a	and Bioengineering: Com	pulsory
	Bioprocess Engineering:	Core Qualification	n: Compulsory			
	Chemical and Bioproces			•		
	Green Technologies: En			: Compulsory		
	Orientation Studies: Cor					
	Process Engineering: Co	re Qualification: Co	Compulsory			

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

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

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

Module M0546: Therr	nal Separation Processes			
Courses				
Title		Тур	Hrs/wk	СР
Thermal Separation Processes (L03 Thermal Separation Processes (L03		Lecture Recitation Section (small)	2	2
Thermal Separation Processes (L01		Recitation Section (Small)	1	1
Separation Processes (L1159)		Practical Course	1	1
Module Responsible	Prof. Irina Smirnova			
Admission Requirements	None			
Recommended Previous Knowledge	Recommended requirements: Thermodynamics III			
Educational Objectives	After taking part successfully, students have reached	d the following learning results		
Professional Competence				
Knowledge	The students can distinguish and describe adsorption The students develop an understanding for the energy demand of a process, the possibilities They have good knowledge of designing meth	he course of concentration during a sep of energy saving, and the selection of s	paration process, eparation systems	the estimation of the
Skills	Using the gained knowledge the students can close the associated energy and material bala. The students can use different graphical methoretical stages required They can select and design a basic type of disadvantages of the process The students are capable to obtain independentables) They can calculate continuous and discontinuous The students are able to prove their theoretical The students are able to discuss the theoretical colloquium. The students are capable of linking their gained know technical problems. Other lectures such as thermody	ethods for the designing of a separation thermal separation process for a given ently the needed material properties from the separation processes at knowledge in the experimental lab work at labeling many the content of the separation of the sep	on process and on case based on om appropriate so ork.  experimental work is and use it toget.	lefine the amount of the advantages and ources (diagrams and
Personal Competence Social Competence Autonomy	The students can work technical assignments  The students are able to carry out practical them. They are able to discuss their results are	lab work in small groups and organize nd to document them scientifically in a r d information from suitable sources by t	a functional divis eport. hemselves and as	ion of labor between
Workload in Hours	Independent Study Time 96, Study Time in Lecture 8	M.		
Credit points		•		
Course achievement				
Examination	Written exam			
Examination duration and scale	120 minutes; theoretical questions and calculations			
Assignment for the Following Curricula		rester): Specialisation Green Tec emester): Specialisation Bioprocess Engine emester): Specialisation Process Enginee emester): Specialisation Chemical and Biory ation: Compulsory cation: Elective Compulsory lisation Energy Systems: Elective Compulsory	chnologies, Focus neering: Compulsory ering: Compulsory ioengineering: Con	Renewable Energy:
	Process Engineering: Core Qualification: Compulsory		. ,	

irse L0118: Thermal Sepa	
	Lecture
Hrs/wk	
СР	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Prof. Irina Smirnova
Language	DE
Cycle	WiSe
Content	<ul> <li>Introduction in the thermal process engineering and to the main features of separation processes</li> <li>Simple equilibrium processes, several steps processes</li> <li>Distillation of binary mixtures, enthalpy-concentration diagrams</li> <li>Extractive and azeotrope distillation, water vapor distillation, stepwise distillation</li> <li>Extraction: separation ternary systems, ternary diagram</li> <li>Multiphase separation including complex mixtures</li> <li>Designing of separation devices without discrete stages</li> <li>Drying</li> <li>Chromatographic separation processes</li> <li>Membrane separation</li> <li>Energy demand of separation processes</li> <li>Advance overview of separation processes</li> <li>Selection of separation processes</li> </ul>
Literature	<ul> <li>G. Brunner: Skriptum Thermische Verfahrenstechnik</li> <li>J. King: Separation Processes, McGraw-Hill, 2. Aufl. 1980</li> <li>Sattler: Thermische Trennverfahren, VCH, Weinheim 1995</li> <li>J.D. Seader, E.J. Henley: Separation Process Principles, Wiley, New York, 1998.</li> <li>Mersmann: Thermische Verfahrenstechnik, Springer, 1980</li> <li>Grassmann, Widmer, Sinn: Einführung in die Thermische Verfahrenstechnik, 3. Aufl., Walter de Gruyter, Berlin 1997</li> <li>Brunner, G.: Gas extraction. An introduction to fundamentals of supercritical fluids and the application to separation processes. Steinkopff, Darmstadt; Springer, New York; 1994. ISBN 3-7985-0944-1; ISBN 0-387-91477-3.</li> <li>R. Goedecke (Hrsg.): Fluid-Verfahrenstechnik, Wiley-VCH Verlag, Weinheim, 2006.</li> <li>Perry"s Chemical Engineers" Handbook, R.H. Perry, D.W. Green, J.O. Maloney (Hrsg.), 6th ed., McGraw-Hill, New York 1984 Ullmann"s Enzyklopädie der Technischen Chemie</li> </ul>

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

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

Course L1159: Separation Pr	ocesses
Тур	Practical Course
Hrs/wk	1
СР	1
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14
Lecturer	Prof. Irina Smirnova
Language	DE/EN
Cycle	WiSe
Content	The students work on eight different experiments in this practical course. For every one of the eight experiments, a colloquium takes place in which the students explain and discuss the theoretical background and its translation into practice with staff and fellow students.
	The students work small groups with a high degree of division of labor. For every experiment, the students write a report. They receive instructions in terms of scientific writing as well as feedback on their own reports and level of scientific writing so they can increase their capabilities in this area.
	Topics of the practical course:  Introduction in the thermal process engineering and to the main features of separation processes  Simple equilibrium processes, several steps processes  Distillation of binary mixtures, enthalpy-concentration diagrams  Extractive and azeotrope distillation, water vapor distillation, stepwise distillation  Extraction: separation ternary systems, ternary diagram  Multiphase separation including complex mixtures  Designing of separation devices without discrete stages  Drying  Chromatographic separation processes  Membrane separation  Energy demand of separation processes  Advance overview of separation processes  Selection of separation processes
Literature	<ul> <li>G. Brunner: Skriptum Thermische Verfahrenstechnik</li> <li>J. King: Separation Processes, McGraw-Hill, 2. Aufl. 1980</li> <li>Sattler: Thermische Trennverfahren, VCH, Weinheim 1995</li> <li>J.D. Seader, E.J. Henley: Separation Process Principles, Wiley, New York, 1998.</li> <li>Mersmann: Thermische Verfahrenstechnik, Springer, 1980</li> <li>Grassmann, Widmer, Sinn: Einführung in die Thermische Verfahrenstechnik, 3. Aufl., Walter de Gruyter, Berlin 1997</li> <li>Brunner, G.: Gas extraction. An introduction to fundamentals of supercritical fluids and the application to separation processes. Steinkopff, Darmstadt; Springer, New York; 1994. ISBN 3-7985-0944-1; ISBN 0-387-91477-3.</li> <li>R. Goedecke (Hrsg.): Fluid-Verfahrenstechnik, Wiley-VCH Verlag, Weinheim, 2006.</li> <li>Perry"s Chemical Engineers" Handbook, R.H. Perry, D.W. Green, J.O. Maloney (Hrsg.), 6th ed., McGraw-Hill, New York 1984 Ullmann"s Enzyklopädie der Technischen Chemie</li> </ul>

Module M1274: Envir	onmental Technology			
Courses				
Title		Тур	Hrs/wk	СР
Case studies project assessment (L	.1054)	Recitation Section (small)	1	1
Environmental Assessment (L0860		Lecture	2	2
Module Responsible	Prof. Martin Kaltschmitt			
Admission Requirements	None			
Recommended Previous	Fundamentals of inorganic/organic chemistry and biology			
Knowledge				
	After taking part successfully, students have reached the follo	wing learning results		
Professional Competence				
Knowledge	With the completion of this module the students acquire	, -		
	environmental problems which might occur from production about the methodological diversity and are competent in deal			
	impacts. Besides the students are able to estimate the comp	-		
	difficulties with their measurement.	lexity of these environmental pro	ocesses as well	as uncertainties and
Skills	The students are able to select a suitable method for the res	pective case from the variety of	assessment me	thods. Thereby they
	can develop suitable solutions for managing and mitigating e			
	out Life Cycle Impact Assessments independently and can a	pply the software programs Ope	enLCA and the	database Ecolnvent.
	After finishing the course the students have the competer	ence to critically judge researc	h results or ot	her publications on
	environmental impacts.			
Personal Competence				
· -	The students are able to discuss the various technical and science	entific tasks, both subject-specific	and multidiscip	linary. They are able
	to develop jointly different solutions and to discuss their th	eoretical or practical implemen	tation. Due to t	the selected lecture
	topics, the students receive insights into the multi-layered iss	ues of the environment protection	on and the conc	ept of sustainability.
	Their sensitivity and consciousness towards these subjects	are raised and which helps to ra	aise their aware	ness of their future
	social responsibilities in their role as engineers.			
Autonomy	The students learn to research, process and present a scie			
	scientific work. They can solve an environmental problem in a	business context and are able to	Juage results of	other publications.
Workload in Hours	Independent Study Time 48, Study Time in Lecture 42			
Credit points				
Course achievement				
Examination	Written exam			
Examination duration and				
scale				
Assignment for the	General Engineering Science (German program, 7 semester):	Specialisation Bioprocess Engine	ering: Elective C	ompulsory
Following Curricula	General Engineering Science (German program, 7 semester):	Specialisation Process Engineerin	g: Elective Com	pulsory
	Bioprocess Engineering: Core Qualification: Elective Compulso	•		
	Energy and Environmental Engineering: Core Qualification: Co	mpulsory		
	Process Engineering: Core Qualification: Elective Compulsory			

Course L1054: Case studies	project assessment
Тур	Recitation Section (small)
Hrs/wk	1
СР	1
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14
Lecturer	Prof. Martin Kaltschmitt, Weitere Mitarbeiter
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

ture
ependent Study Time 32, Study Time in Lecture 28
Anne Rödl, Dr. Christoph Hagen Balzer
EN
е
ataminants: Impact- and Risk Assessment
rironmental damage & precautionary principle: Environmental Risk Assessment (ERA)
source and water consumption: Material flow analysis
ergy consumption: Cumulated energy demand (CED), cost analysis
e cycle concept: Life cycle assessment (LCA)
tainability: Comprehensive product system assessment , SEE-Balance
nagement: Environmental and Sustainability management (EMAS)
nplex systems: MCDA and scenario method
ensätze der Vorlesung
die: Instrumente zur Nachhaltigkeitsbewertung - Eine Synopse (Forschungszentrum Jülich GmbH)
Antinia

Module M0538: Heat	and Mass Transfer			
Courses				
Title		Тур	Hrs/wk	СР
Heat and Mass Transfer (L0101)		Lecture	2	2
Heat and Mass Transfer (L0102)		Recitation Section (small)	1	2
Heat and Mass Transfer (L1868)		Recitation Section (large)	1	2
Module Responsible	Prof. Irina Smirnova			
Admission Requirements	None			
Recommended Previous	Basic knowledge: Technical Thermodynamics			
Knowledge				
Educational Objectives	After taking part successfully, students have reached th	e following learning results		
Professional Competence				
Knowledge	The students are capable of explaining qualitativ	e and determining quantitative heal	transfer in proces	dural annaratus (e. d
	heat exchanger, chemical reactors).	e and determining quantitative near	transier in proces	durar apparatus (e. g.
	They are capable of distinguish and characterize	different kinds of heat transfer med	hanisms namely h	neat conduction, heat
	transfer and thermal radiation.		,	
	The students have the ability to explain the p	hysical basis for mass transfer in	detail and to de	scribe mass transfer
	qualitative and quantitative by using suitable ma			
	They are able to depict the analogy between hea	t- and mass transfer and to describe	complex linked p	rocesses in detail.
CL III				
Skills	The students are able to set reasonable system	boundaries for a given transport p	roblem by using tl	ne gained knowledge
	and to balance the corresponding energy and ma	ss flow, respectively.		
	They are capable to solve specific heat transfer	problems (e.g. heated chemical rea	actors, temperatur	e alteration in fluids)
	and to calculate the corresponding heat flows.			
	<ul> <li>Using dimensionless quantities, the students can</li> </ul>	execute scaling up of technical prod	esses or apparatu	S.
	<ul> <li>They are able to distinguish between diffusion, c</li> </ul>	onvective mass transition and mass	transfer. They can	n use this knowledge
	for the description and design of apparatus (e.g.	extraction column, rectification colu	mn).	
	<ul> <li>In this context, the students are capable to choos</li> </ul>		heat and mass ex	changer for a specific
	application considering their advantages and disa			
	In addition, they can calculate both, steady-state			
	The students are capable to connect their kn			
	particular the courses thermodynamics, fluid m	echanics and chemical process en	gineering) to solv	e concrete technical
	problems.			
Barranal Carrenatoria				
Personal Competence				
Social Competence	<ul> <li>The students are capable to work on subject-specified.</li> </ul>	ecific challenges in teams and to pro	esent the results o	orally in a reasonable
	manner to tutors and other students.			
Autonomy	<ul> <li>The students are able to find and evaluate necess</li> </ul>	sary information from suitable source	es	
	They are able to prove their level of knowledge	•		continuously (clicker-
	system, exam-like assignments) and on this basis	-		continuously (ellene)
		,		
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56			
Credit points				
Course achievement				
Examination	Written exam			
	120 minutes; theoretical questions and calculations			
scale	•			
Assignment for the	General Engineering Science (German program, 7 seme	ster): Specialisation Green Technolo	gies: Compulsorv	
Following Curricula		•		ory
	General Engineering Science (German program, 7 seme			•
	General Engineering Science (German program, 7 seme			
	Bioprocess Engineering: Core Qualification: Compulsory	•	-	
	Chemical and Bioprocess Engineering: Core Qualification	n: Compulsory		
	Energy and Environmental Engineering: Core Qualificati	on: Compulsory		
	Green Technologies: Energy, Water, Climate: Core Quali	fication: Compulsory		
	Technomathematics: Specialisation III. Engineering Scie			
	Process Engineering: Core Qualification: Compulsory			

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

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

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

Module M0670: Partic	le Technology	and Solids Proces	s Engineering		
Courses					
Title			Тур	Hrs/wk	СР
Particle Technology I (L0434)			Lecture	2	3
Particle Technology I (L0435)			Recitation Section (	small) 1	1
Particle Technology I (L0440)			Practical Course	2	2
Module Responsible	Prof. Stefan Heinrich				
Admission Requirements	None				
Recommended Previous	keine				
Knowledge					
<b>Educational Objectives</b>	After taking part succ	cessfully, students have re	ached the following learning results		
<b>Professional Competence</b>					
Knowledge	After successful com	pletion of the module stude	ents are able to		
	• name and eve	lain processes and unit or	erations of solids process engineeri	na	
			ns and to discuss their bulk properti	-	
	• characterize p	articles, particle distribution	ns and to discuss their balk properti	103	
Skille	Students are able to				
Skills	Students are able to				
	<ul> <li>choose and de</li> </ul>	sign apparatuses and proc	esses for solids processing accordin	g to the desired solids pro	operties of the product
	<ul> <li>asses solids w</li> </ul>	ith respect to their behavio	r in solids processing steps		
	<ul> <li>document the</li> </ul>	r work scientifically.			
Personal Competence					
•	The students are ah	le to discuss scientific to	pics orally with other students or s	scientific personal and to	develop solutions for
social competence	technical-scientific is		nes crany man caner stadents or s	verentine personal and to	develop solutions to
Autonomy			s regarding solid particles independ	dently.	
,					
Workload in Hours	Independent Study T	ime 110, Study Time in Le	cture 70		
Credit points	6				
Course achievement	Compulsory Bonus	Form	Description	D : 11) \ 5 10 0 !!	
	Yes None	Written elaboration	sechs Berichte (pro Versuch ein	Bericht) a 5-10 Seiten	
Examination	Written exam				
Examination duration and	90 minutes				
scale					
Assignment for the			, 7 semester): Specialisation Green	Technologies, Focus Wat	er and Environmental
Following Curricula	Engineering: Elective	•	7t-a) Consistination Discussion	Fii GI	
			7 semester): Specialisation Bioproc		
			, 7 semester): Specialisation Process		
		science (German program ng: Core Qualification: Con	, 7 semester): Specialisation Chemic	ai and bioengineering: Co	ompuisory
		cess Engineering: Core Qua	•		
			ualification: Compulsory		
			pecialisation Water: Elective Compul	Isory	
	_	Core Qualification: Compu		301 y	
	1 Tocess Engineering.	core quanneation. Compa	1501 y		

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

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

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

Module M0539: Proce	ss and Plant Engi	neering I				
Courses						
Title Process and Plant Engineering I (L0095) Process and Plant Engineering I (L0096)				Typ Lecture Recitation Section (large)	Hrs/wk 2 1	<b>CP</b> 4 1
Process and Plant Engineering I (L1				Recitation Section (small)	1	1
Module Responsible	Prof. Mirko Skiborowski					
Admission Requirements	None					
Recommended Previous	unit operation of thermal	an dmechanical sepa	ration processes			
Knowledge	chemical reactor eingine	ering				
<b>Educational Objectives</b>	After taking part success	fully, students have re	eached the following	ig learning results		
<b>Professional Competence</b>						
Knowledge	students can:					
	classify and formulate blo	obal balance equation	s of chemical proc	esses		
	specify linear component	equations of complex	chemical process	es		
	explain linear regression	and data reconcilliation	on problems			
	explain pfd-diagrams					
Skills	students are capable of					
	- formulation of mass and	d energy balance equa	ations and estimati	on of product streams		
	- estimation of componer	nt streams of chemica	l plants using linea	r component balance mode	els	
	- solution of data reconci	lliation tasks				
	- conduction of process s	ynthesis				
	- economic evaluation of	processes and the es	timation of product	cion costs		
Personal Competence						
Social Competence						
Autonomy						
Workload in Hours	Independent Study Time	124, Study Time in Le	ecture 56			
Credit points	6					
Course achievement		orm ubject theoretical	<b>Description</b> and			
		ractical work				
Examination	Written exam					
Examination duration and	120 Min. lectures notes a	nd books				
scale						
Assignment for the	General Engineering Scie	nce (German progran	n, 7 semester): Spe	ecialisation Bioprocess Engir	neering: Compulso	ory
Following Curricula				ecialisation Process Enginee		
				ecialisation Chemical and Bi	oengineering: Con	npulsory
	Bioprocess Engineering:					
	Chemical and Bioprocess			•	Compulsor	
	Process Engineering: Cor			source Technology: Elective	Compulsory	
	1 100ess Engineering: Cor	e Quanneadon. Comp	u1301 y			

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

Decision levels Experimental process development Reactor synthesis Synthesis of separation processes (process alternatives and criteria for selection) Integration of reaction systems/separation systems (interactions, recycle streams) 4. Process safety 5. Cost estimation of production plants Production costs, capital costs, economic evaluation Literature 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, Chem. -Ing.-Tech. 72(2000)Nr. 10, S.1157 E. Blass, Entwicklung verfahrenstechnischer Prozesse, Springer-Verlag, 2. Auflage 1997 M. H. Bauer, J. Stichlmair, Chem.-Ing.-Tech., 68(1996), Nr. 8, 911-916 R. Dittmeyer, W. Keim, G. Kreysa, A. Oberholz, Chemische Technik. Prozesse und Produkte, Band 2, Neue Technologien, 5. Auflage, Wiley-VCH GmbH&Co.KGaA, Weinheim, 2004 J.M. Douglas, Conceptual Design of Chemical Processes, Mc Graw-Hill, NY, 1988 G. Fieg, Inz. Chem. Proc., 5(1979), S.15-19 G. Fieg, G. Wozny, L. Jeromin, Chem. Eng. Technol. 17(1994),5, 301-306 G. Fieg, Heat and Mass Transfer 32(1996), S. 205-213 G. Fieg, Chem. Eng. Processing, Vol. 41/2(2001), S. 123-133 U.H. Felcht, Chemie eine reife Industrie oder weiterhin Innovationsmotor, Universitätsbuchhandlung Blazek und Bergamann, J.P. van Gigch, Systems Design, Modeling and Metamodeling, Plenum Press, New York, 1991 T.F. Edgar, D.M. Himmelblau, L.S. Lasdon, Optimization of Chemical Processes, McGraw-Hill, 2001 G. Gruhn, Vorlesungsmanuskript "Prozess- und Anlagentechnik, TU Hamburg-Harburg D. Hairston, Chemical Engineering, October 2001, S. 31-37 J.L.A. Koolen, Design of Simple and Robust Process Plants, Wiley-VCH, Weinheim, 2002 J. Krekel, G. Siekmann, Chem. -Ing.-Tech. 57(1985)Nr. 6, S. 511 K. Machej, G. Fieg, J. Wojcik, Inz. Chem. Proc., 2(1981), S.815-824 S. Meier, G. Kaibel, Chem. -Ing.-Tech. 62(1990)Nr. 13, S.169 J. Mittelstraß, Chem. -Ing.-Tech. 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, Chem.-Ing.-Tech. 61 (1989), Nr. 2, S. 104-112 G. Kaibel, Chem. Eng. Technol., 10(1987), Nr. 2, S. 92-98 H.J. Lang, Chem. Eng. 54(10),117, 1947 H.J. Lang, Chem. Eng. 55(6), 112, 1948 F. Lestak, C. Collins, Chemical Engineering, July 1997, S. 72-76

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

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

## **Thesis**

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

Engineering and Management - Major in Logistics and Mobility: Thesis: Compulsory