# **Module Manual**

Bachelor of Science (B.Sc.)

# General Engineering Science (English program, 7 semester)

Cohort: Winter Term 2019

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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  $1^{st}$  and the  $2^{nd}$  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

- Collaborate with both English and German speaking specialists in other disciplines
- 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 M070	1: Chemistry (GES)				
Courses					
<b>Title</b> Chemistry (GES) I (L04	67)	<b>Typ</b> Lecture	Hrs,	/wk	<b>CP</b> 2
Chemistry (GES) I (L04	78)	Recitation (large)	Section 1		1
Chemistry (GES) II (L04	469)	Lecture	2		2
Chemistry (GES) II (L04	Recitation Section				1
Module Responsible	Dr. Dorothea Rechtenbach	· · · · · ·			
Admission Requirements	None				
Recommended Previous Knowledge	None				
Educational Objectives		nts have reached t	he following	learni	ng results
Professional Competence					
Knowledge	The students are able to name and to describe basic principles and applications of general chemistry (structure of matter, periodic table, chemical bonds), physical chemistry (aggregate states, separating processes, thermodynamics, kinetics), increasing chemistry (assidiance physical colleges colleges and processes), and				
Skills	After successful completion of this module students are able to describe substance groups and chemical compounds. On this basis, they are capable of explaining, choosing and applying specific methods and various reaction mechanisms.				
Personal Competence					
Social Competence	Students are able to take part in discussions on chemical issues and problems as a member of an interdisciplinary team. They can contribute to those discussion by their own statements.				
Autonomy	After successful completion of this module students are able to solve chemical problems independently by defending proposed approaches with arguments. They can also document their approaches.				
<b>Workload in Hours</b>	Independent Study Time 96, Study T	ime in Lecture 84			
Credit points	6				
Course achievement	None				
Examination	Written exam				
Examination duration and scale					
Assignment for the Following Curricula	Compulsory	lish program, 7 s	emester): C	ore q	ualification:
.————	1				

Typ Lecture  Hrs/wk 2  CP 2  Workload in Hours Independent Study Time 32, Study Time in Lecture 28  Lecturer Dr. Holger Gulyas  Language EN  Cycle WiSe  - Structure of matter - Periodic table - Electronegativity - Chemical bonds - Solid compounds and solutions - Chemistry of water	
Workload in Hours Independent Study Time 32, Study Time in Lecture 28  Lecturer Dr. Holger Gulyas  Language EN  Cycle WiSe  - Structure of matter - Periodic table - Electronegativity - Chemical bonds  Content  Content	
Workload in Hours  Lecturer Dr. Holger Gulyas  Language EN  Cycle WiSe  - Structure of matter  - Periodic table  - Electronegativity  - Chemical bonds  Content  Content	
in Hours  Lecturer Dr. Holger Gulyas  Language EN  Cycle WiSe  - Structure of matter  - Periodic table  - Electronegativity  - Chemical bonds  - Solid compounds and solutions	
Language EN  Cycle WiSe  - Structure of matter - Periodic table - Electronegativity - Chemical bonds - Solid compounds and solutions	
Cycle WiSe  - Structure of matter  - Periodic table  - Electronegativity  - Chemical bonds  Content  - Solid compounds and solutions	
- Structure of matter - Periodic table - Electronegativity - Chemical bonds - Solid compounds and solutions	
- Periodic table - Electronegativity - Chemical bonds - Solid compounds and solutions	
- Electronegativity - Chemical bonds  Content - Solid compounds and solutions	
- Chemical bonds  Content - Solid compounds and solutions	
Content - Solid compounds and solutions	
Content	
- Chemistry of water	
- Chemical reactions and equilibria	
- Acid-base reactions	
- Redox reactions	
- Gallagher, Ingram: Complete Chemistry (Oxford University Pres	5)
Literature - Corwin: Introductory Chemistry (Pearson)	
- Burrows, Parsons, Price, Holman: Chemistry3 (Oxford University	

Course L0478: Chemistry (GES) I		
Тур	Recitation Section (large)	
Hrs/wk	1	
СР	1	
<b>Workload in Hours</b>	Independent Study Time 16, Study Time in Lecture 14	
Lecturer	Dr. Holger Gulyas	
Language	EN	
Cycle	WiSe	
Content	See interlocking course	
Literature	See interlocking course	

Course L0	Course L0469: Chemistry (GES) II				
Тур	Lecture				
Hrs/wk	2				
СР	2				
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28				
Lecturer	Dr. Holger Gulyas				
Language	∍ EN				
Cycle	WiSe				
Content	<ul> <li>Simple compounds of carbon, aliphatic hydrocarbons, aromatic hydrocarbons,</li> <li>Alkohols, phenols, ether, aldehydes, ketones, carbonic acids, ester, amines, amino acids, fats, sugars</li> <li>Reaction mechanisms, radical reactions, nucleophilic substitution, elimination reactions, addition reaction</li> <li>Practical apllications and examples</li> </ul>				
Literature	<ul> <li>Gallagher, Ingram: Complete Chemistry (Oxford University Press)</li> <li>Corwin: Introductory Chemistry (Pearson)</li> <li>Burrows, Parsons, Price, Holman: Chemistry3 (Oxford University Press)</li> </ul>				

Course L0479: Chemistry (GES) II		
Тур	Recitation Section (large)	
Hrs/wk	1	
СР	1	
<b>Workload in Hours</b>	Independent Study Time 16, Study Time in Lecture 14	
Lecturer	Dr. Holger Gulyas	
Language	EN	
Cycle	WiSe	
Content	See interlocking course	
Literature	See interlocking course	

Module M112	L: Programming in C			
Courses				
<b>Title</b> Programming in C (L00) Programming in C (L14)		<b>Typ</b> Lecture Practical Course	Hrs/wk 1 1	<b>CP</b> 1 1
Module Responsible	Prof. Siegfried Rump			
Admission Requirements	None			
	Elementary PC handling skills			
Previous Knowledge	Elementary mathematical skills			
Educational Objectives	After taking part successfully, students have reached the following learning results			
Professional Competence				
	The students know by heart the b meaning, intent and purpose.		-	
	They know the fundamental compo programming based on C programming and can ex		f elementary	/ procedura
Knowledge	<ul> <li>basic data types (integers, floating</li> <li>advanced data types (pointers, conversion)</li> <li>operators (arithmetical operations,</li> <li>control flow (choice, loops, jumps,</li> <li>functions and macros</li> <li>important standard libraries and fu</li> <li>recursion</li> <li>linked lists</li> </ul>	arrays, strings, complogical operations, bit conditional compilation	oosed data operations)	types, type
	The students are prepared for contin	nuing programming lect	tures like obj	ect oriented
	The students know how to use an programming on a PC so that they can write, store, compile	-		ment for C
	Using their knowledge they are able	to read and understand	d given C Pro	grams.
Skills	They can solve simple algorithmic program their solutions in C language.	problems on their or	wn and can	model and
	The students are able to solve select mathematics, mechanics, electrical engineering o projects numerically.			-
Personal Competence				
Social Competence	The students are able to work in sma and analyze programming errors and to present t	_	weekly task	s, to identify
	They are able to explain simple phen	omena to each other d	irectly at the	PC.
!	· [11]			

Autonomy	The students prepare themselves using the given teaching material and solve the given programming exercises on their own.  Additionally, they write small C programs to understand and check addressed issues and also to gain a certain programming experience.  For details beyond the scope of the lecture the students inform themselves using the stated literature and / or by supplementary own research.		
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28		
Credit points			
Course achievement			
Examination	Written elaboration		
Examination duration and scale	1-2 coding tasks weekly		
Assignment for the Following Curricula	Compulsory  General Engineering Science (English program, 7 semester): Core qualification:		

Course L0083: Programming in C				
Typ Lecture				
Hrs/wk 1				
СР	<b>CP</b> 1			
Workload in Hours Independent Study Time 16, Study Time in Lecture 14				
Lecturer	rer Prof. Siegfried Rump, Weitere Mitarbeiter			
Language	je 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)			
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  Literature  Kaiser, Ulrich (Kecher, Christoph.;) C/C++: Von den Grundlagen zur professionellen Programmierung ISBN: 9783898428392 Bonn: Galileo Press, 2010  Wolf, Jürgen C von A bis Z: das umfassende Handbuch ISBN: 3836214113 Bonn: Galileo Press, 2009				

Course L1488: Programming in C			
Тур	Practical Course		
Hrs/wk	1		
СР	1		
<b>Workload in Hours</b>	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 M0736	5: Linear Algebra					
Courses						
<b>Title</b> Linear Algebra (L0642)	)	<b>Typ</b> Lecture	Hrs/wk	<b>CP</b> 4		
Linear Algebra (L0643)		Recitation (large) Recitation	Section 2	2		
Linear Algebra (L0645)		(small)	Section 2	2		
	Prof. Marko Lindner					
Admission Requirements	None					
Recommended Previous Knowledge						
Educational Objectives	After taking part successfully, students h	nave reached	the following learr	ning results		
Professional Competence						
Knowledge	<ul> <li>Students can name the basic convexplain them using appropriate explain them using appropriate explains the second capable of illustrating these connects they know proof strategies and capable of illustrating these connects.</li> </ul>	xamples. lections betwo ections with th	een these concept ne help of example	ts. They are		
Skills	<ul> <li>Students can model problems in linear algebra with the help of the concepts studied in this course. Moreover, they are capable of solving them by applying established methods.</li> <li>Students are able to discover and verify further logical connections between the concepts studied in the course.</li> <li>For a given problem, the students can develop and execute a suitable approach, and are able to critically evaluate the results.</li> </ul>					
Personal Competence						
Social Competence	- Students are able to work together (e.g. on their regular home work) in heterogeneously composed teams (i.e., teams from different study programs and background knowledge) and to present their results appropriately (e.g. during exercise class).					
	<ul> <li>Students are capable of checking their own. They can specify open questions solving them.</li> </ul>					
Autonomy	- Students can put their knowledge in re					
	<ul> <li>Students have developed sufficient periods in a goal-oriented manner on ha</li> </ul>		o be able to wo	rk for longer		
Workload in Hours	Independent Study Time 128, Study Tim	e in Lecture 1	.12			
Credit points						
Course achievement	None					

Examination	Written exam
Examination duration and scale	120
the Following	Computer Science: Core qualification: Compulsory General Engineering Science (English program, 7 semester): Core qualification: Compulsory

Course L0642: Linear Algebra					
Тур	Lecture				
Hrs/wk	4				
СР	4				
<b>Workload in Hours</b>	dependent Study Time 64, Study Time in Lecture 56				
Lecturer	Dr. Julian Großmann				
Language	EN				
Cycle	WiSe				
	Preliminaries				
	Vector spaces				
	Matrices and linear systems of equations				
	Scalar products and orthogonality				
Content	Basis transformation				
	Determinants				
	Eigen values				
_	Strang: Linear Algebra				
Literature	Beutelsbacher: Lineare Algebra				

Course L0643: Line	Course L0643: Linear Algebra			
Тур	Recitation Section (large)			
Hrs/wk	2			
СР	2			
<b>Workload in Hours</b>	Independent Study Time 32, Study Time in Lecture 28			
Lecturer	Dr. Julian Großmann, Jan Meichsner			
Language	EN			
Cycle	WiSe			
Content	See interlocking course			
Literature	See interlocking course			

Course L0645: Line	Course L0645: Linear Algebra			
Тур	Typ Recitation Section (small)			
Hrs/wk	2			
СР	2			
<b>Workload in Hours</b>	Independent Study Time 32, Study Time in Lecture 28			
Lecturer	Dr. Julian Großmann			
Language	EN			
Cycle	WiSe			
Content	See interlocking course			
Literature	See interlocking course			

Module M108	L: Mechanics I (GES)				
Courses					
Title Mechanics I (GES) (L13 Mechanics I (GES) (L13		Typ Lecture Recitation	Hrs/wl 2 Section 3	<b>CP</b> 3	
Module	Prof. Radoslaw Iwankiewicz	(large)			
Responsible Admission Requirements					
Recommended Previous Knowledge	None				
Educational Objectives		have reached	the following lea	rning results	
Professional Competence					
Knowledge	The primary purpose of the study of Statics is to develop the capacity to predict the effects of forces on rigid bodies, structural elements and simple structures, which are at rest (in equilibrium). Such a capacity is critical to the design of many structural or engineering systems. The particular objectives of this course are to:  1. Introduce the student to the basic principles required to analyse the effects of forces applied to rigid bodies, structural elements and simple structures in equilibrium;  2. Demonstrate sound techniques of constructing and solving idealised mathematical models of real engineering systems;				
Skills	<ol> <li>Promote the analytical and problem-solving skills required to solve a wide variety of real engineering problems effectively.</li> <li>At the end of this course the student is able to:         <ol> <li>Apply the properties of two- and three-dimensional force systems to the analysis of structural elements and simple structures in equilibrium.</li> <li>Isolate a body in equilibrium by drawing its free-body diagram on which all forces acting on the body are represented.</li> <li>Analyse the external effects of forces acting on a single body or a system of bodies in two- and three-dimensional equilibrium using the free-body diagram of the body or system.</li> <li>Analyse the internal forces in trusses and beams.</li> <li>Solve problems of equilibrium with account for dry friction.</li> </ol> </li> </ol>				
Personal Competence	6. Determine mass centres and cer  Students can: - work in groups and re				
Social Competence	in mixed teams and present them to their own share in it.	others, - asse	ss the team col	aboration and	
Autonomy	Students are able to: - solve the prob assess their own strengths and weakne	esses, e.g. with	the aid of the m		
	Independent Study Time 110, Study Tir	me in Lecture 7	70		
Credit points					
Course achievement	None				
Examination	Written exam				
Examination duration and	1.5 hours Statics: force systems, equilil	brium, mass ce	nter, friction, tru	sses, beams.	

scale									
Assignment for the Following Curricula	General Compuls	Engineering sory	Science	(English	program,	7	semester):	Core	qualification:

Course L1373: Med	hanics I (GES)
Тур	Lecture
Hrs/wk	2
СР	3
<b>Workload in Hours</b>	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Prof. Radoslaw Iwankiewicz
Language	EN
Cycle	WiSe
Content	<ol> <li>Simple structures: frames and machines.</li> <li>Mass centers and centroids of lines, areas and volumes.</li> <li>Friction: dry friction, types of friction problems.</li> <li>Beams: internal effects- internal forces. Internal forces in curved-in-plane members.</li> <li>* Flexible cables.</li> <li>* Virtual work principle.</li> <li>* Denotes an additional topic.</li> </ol>
Literature	<ol> <li>J.L. Meriam and L.G, Kraige, Engineering Mechanics, Vol. 1, Statics, John Wiley &amp; Sons, SI Version, 4<sup>th</sup> Edition.</li> <li>R.C. Hibbeler, Engineering Mechanics, Statics, Pearson, Prentice Hall, SI, 3<sup>rd</sup> Edition.</li> </ol>

Course L1374: Med	hanics I (GES)
Тур	Recitation Section (large)
Hrs/wk	3
СР	3
<b>Workload in Hours</b>	Independent Study Time 48, Study Time in Lecture 42
Lecturer	Prof. Radoslaw Iwankiewicz
Language	EN
Cycle	WiSe
Content	<ol> <li>Two-dimensional (2D) force systems.: moment of a force about a point, reduction of a system of forces, resultant.</li> <li>Three-dimensional (3D) force systems; moment of a force about a point and about an axis, reduction of a system of forces, resultant, wrench.</li> <li>Supports and bearings, constraints, reactive forces, mechanical system isolation, free-body diagram. Systems with complete and incomplete fixity.</li> <li>Equilibrium in two and three dimensions. Equations of equilibrium.</li> <li>Plane trusses: forces in members, the method of joints and the method of sections. Space trusses.</li> <li>Simple structures: frames and machines.</li> <li>Mass centers and centroids of lines, areas and volumes.</li> <li>Friction: dry friction, types of friction problems.</li> <li>Beams: internal effects- internal forces. Internal forces in curved-in-plane members.</li> <li>* Flexible cables.</li> <li>* Virtual work principle.</li> <li>* Denotes an additional topic.</li> </ol>
Literature	<ol> <li>J.L. Meriam and L.G, Kraige, Engineering Mechanics, Vol. 1, Statics, John Wiley &amp; Sons, SI Version, 4<sup>th</sup> Edition.</li> <li>R.C. Hibbeler, Engineering Mechanics, Statics, Pearson, Prentice Hall, SI, 3<sup>rd</sup> Edition.</li> </ol>

Module M1139	9: Physics	for Engine	ers (GE	S)			
Courses							
<b>Title</b> Physics for Engineers (	GES) (L0557)			<b>Typ</b> Lecture		Hrs/wk 2	<b>CP</b> 3
Physics for Engineers (	GES) (L0560) Recitation Section 1 1 (small)						1
Module Responsible	Dr. Alexander I	Petrov					
Admission Requirements	None						
Recommended Previous Knowledge	<ul><li>Physics</li></ul>	and linear alg on high school		h school level			
Educational Objectives	After taking pa	rt successfully	, students h	ave reached	the follo	wing learr	ing results
Professional Competence							
Knowledge	Students can explain fundamental topics and laws of physics such as in the areas of mechanics, oscillations, waves, and optics.						
Skills	Students can relate physics topics to technical problems.  Students can describe physical problems mathematically and solve such problems within the framework of their acquired mathematical expertise.						
Personal Competence							
Social Competence	Students can j their results eff within the fram	fectively	-	·	in grou	ps. They	can present
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 S	tudy Time 78,	Study Time	in Lecture 42			
Credit points	4						
Course achievement	None						
Examination	Written exam						
Examination duration and scale	120 Minutes, 1	0 tasks with pa	arts a) and b	o)			
Assignment for the Following Curricula	General Engin Compulsory	eering Scienc	e (English <sub>I</sub>	program, 7 s	semeste	r): Core (	qualification

Course L0557: Phys	sics for Engineers (GES)
Тур	Lecture
Hrs/wk	2
СР	3
<b>Workload in Hours</b>	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Dr. Alexander Petrov
Language	EN
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>D. Halliday, R. Resnick and J. Walker ("HRW-7"), Fundamentals of Physics – Extended Edition, 7<sup>th</sup> ed., (Wiley 2005); available in the TUHH Library 'Lehrbuchsammlung'.</li> <li>K. Cummings, P. Laws, E. Redish, and P. Cooney ("CLRC"), Understanding Physics, (Wiley 2004); available in the TUHH Library 'Lehrbuchsammlung'.</li> <li>Other books that cover similar topics are, e.g., Physics by Fishbane, Gasiorowicz and Thornton and Physics by Tipler and Mosca.</li> </ul>

Course L0560: Physics for Engineers (GES)		
Тур	Recitation Section (small)	
Hrs/wk	1	
СР	1	
<b>Workload in Hours</b>	Independent Study Time 16, Study Time in Lecture 14	
Lecturer	Dr. Alexander Petrov	
Language	EN	
Cycle	WiSe	
Content	See interlocking course	
Literature	See interlocking course	

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

#### 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**

#### Knowledge

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-oriented way.

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

### The Competence Level

of the courses offered in this area is different as regards the basic training objective

in the Bachelor's and Master's fields. 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.

#### **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

Skills

#### Personal Competences (Social Skills)

Students will be able

- to learn to collaborate in different manner,
- to present and analyze problems in the abovementioned fields in a partner or group situation in a manner appropriate to the addressees,
- to express themselves competently, in a culturally appropriate and gendersensitive manner in the language of the country (as far as this study-focus would be chosen).
- to explain nontechnical items to auditorium with technical background knowledge.

#### Personal Competences (Self-reliance)

Students are able in selected areas

- to reflect on their own profession and professionalism in the context of reallife fields of application
- to organize themselves and their own learning processes

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- 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 verbalv
- to organize themselves as an entrepreneurial subject country (as far as this study-focus would be chosen)

Autonomy

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 M0745	5: Electrical Eng	ineering I			
Courses					
<b>Title</b> Electrical Engineering	I (L0677)		Typ Lecture	Hrs/wk 3	<b>CP</b> 5
Electrical Engineering	I (L0679)		Recitation (small)	Section 2	1
Module Responsible	Prof. Manfred Kasper				
Admission Requirements	None				
Recommended Previous Knowledge	None				
Educational Objectives	After taking part succe	ssfully, students h	ave reached t	he following learn	ing results
Professional					
Competence	The students know t	he hasis thoons	relations and	d methods of dis	act current
Knowledge	<ul> <li>Ohm's law,</li> <li>methods to simp</li> <li>description of elements</li> <li>Basic material reference</li> <li>Gauss's law,</li> <li>Ampère's law,</li> <li>induction law,</li> </ul>	ge and current law plify and analyze dectric and magnet elations, ion in the integral inition of resistance	irect current r ic fields by us form, ee, capacitance	networks, e of vectorial field e and inductance.	
Skills	direct current network Student know to apply able to derive and ev	s and to apply th the fundamental aluate relations b	ese to calculates of electrices of electrices of the electricas of the electricas of the electricas of the electrices of the electricas of	ate and dimensio c and magnetic fi	n networks. elds and are
Personal					
Competence					
Social Competence	Students are able to so results accordingly. Students and deepen their	udents can explai			
Autonomy	Students are able to a process, to integrate, students develop perse	present and asso	ciate this kno	wledge with othe	r fields. The
<b>Workload in Hours</b>	Independent Study Tim	ne 110, Study Time	e in Lecture 70	0	
Credit points	6				
Course achievement	CompulsorBonus No 10 %	<b>Form</b> Excercises	D	escription	
Examination	Written exam				
Examination duration and scale					
Assignment for		[25]			

the Following General Engineering Science (English program, 7 semester): Core qualification: Curricula Compulsory

Course L0677: Electrical Engineering I		
Тур	Lecture	
Hrs/wk	3	
СР	5	
<b>Workload in Hours</b>	Independent Study Time 108, Study Time in Lecture 42	
Lecturer	Prof. Manfred Kasper	
Language	EN	
Cycle	WiSe	
Content	<ol> <li>Basics of Resistive Circuits</li> <li>Simplifying Resistive Circuits</li> <li>Network Analysis</li> <li>The Electrostatic Field</li> <li>Stationary Currents in Conductive Media</li> <li>Electrostatic Field in Non-Conductive Media</li> <li>Static Magnetic Field</li> <li>Induction and Time-Dependent Fields</li> </ol>	
Literature	<ol> <li>M. Kasper, Lecture Notes Electrical Engineering Fundamentals 1, 2013</li> <li>A. R. Hambley: Electrical Engineering, Principles and Applications, Pearson Education, 2008</li> <li>P. M. Fishbane: Physics for Scientists and Engineers, Prentice Hall, 1996</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> </ol>	

Course L0679: Electrical Engineering I		
Тур	Recitation Section (small)	
Hrs/wk	2	
СР	1	
<b>Workload in Hours</b>	Independent Study Time 2, Study Time in Lecture 28	
Lecturer	Prof. Manfred Kasper	
Language	EN	
Cycle	WiSe	
Content	See interlocking course	
Literature	See interlocking course	

Courses				
Title		Тур	Hrs/wk	СР
Technical Thermodyna	amics I (L0437)	Lecture	2	4
Technical Thermodyna	amics I (L0439)	Recitation (large)	Section 1	1
Technical Thermodyna	amics I (L0441)	Recitation (small)	Section 1	1
Module Responsible	Prof. Gerhard Schmitz			
Admission Requirements	None			
Recommended		tics and Mechanics	5	
Knowledge				
Educational Objectives	LATTER TAKING NART SLICCESSTILLIV STLIGE	ents have reached	the following learr	ing results
Professional Competence				
Knowledge	Students are familiar with the laws of Thermodynamics. They know the relation of the kinds of energy according to 1 <sup>st</sup> law of Thermodynamics and are aware about the limits of energy conversions according to 2 <sup>nd</sup> law of Thermodynamics. They are able to distinguish between state variables and process variables and know the meaning of different state variables like temperature, enthalpy, entropy and also the meaning of exergy and anergy. They are able to draw the Carnot cycle in a Thermodynamics related diagram. They know the physical difference between a ideal and a real gas and are able to use the related equations of state. They know the meaning of a fundamental state of equation and know the basics of two phase Thermodynamics.			
Skills	Students are able to calculate the i potential energy as well as work a this calculations for the Carnot cyc an ideal and for a real gas from mea	nd heat for simple le. They are able	e change of states to calculate state	and to us
Personal Competence				
-	The students are able to discuss in :	small groups and o	develop an approa	ch.
Autonomy	Students are able to define inde existing knowledge as well as to fin			
Workload in Hours	I Independent Study Time 124, Study	/ Time in Lecture 5	 56	
Credit points				
Course achievement	INODE			
	Written exam			
Examination duration and scale	90 min			
	General Engineering Science (Ger Compulsory Bioprocess Engineering: Core qualif Energy and Environmental Engineer	ication: Compulsor	ry	qualificatio

	General Engineering Science (English program, 7 semester): Core qualification:			
Assignment for	Compulsory			
the Following	Computational Science and Engineering: Specialisation Engineering Sciences:			
Curricula	Compulsory  Computational Science and Engineering: Specialisation Engineering Sciences:  Elective Compulsory  Mechanical Engineering: Core qualification: Compulsory			
Curricula	Mechanical Engineering: Core qualification: Compulsory			
	Mechatronics: Core qualification: Compulsory			
	Orientierungsstudium: Core qualification: Elective Compulsory			
	Naval Architecture: Core qualification: Compulsory			
	Technomathematics: Specialisation III. Engineering Science: Elective Compulsory			
	Process Engineering: Core qualification: Compulsory			

Course L0437: Tecl	nnical Thermodynamics I
Тур	Lecture
Hrs/wk	2
СР	4
<b>Workload in Hours</b>	Independent Study Time 92, Study Time in Lecture 28
Lecturer	Prof. Gerhard Schmitz
Language	DE
Cycle	SoSe
Content	<ol> <li>Introduction</li> <li>Fundamental terms</li> <li>Thermal Equilibrium and temperature         3.1 Thermal equation of state</li> <li>First law         4.1 Heat and work         4.2 First law for closed systems         4.3 First law for open systems         4.4 Examples</li> <li>Equations of state and changes of state         5.1 Changes of state         5.2 Cycle processes</li> <li>Second law         6.1 Carnot process         6.2 Entropy         6.3 Examples         6.4 Exergy</li> <li>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.)</li> </ol>
Literature	<ul> <li>Schmitz, G.: Technische Thermodynamik, TuTech Verlag, Hamburg, 2009</li> <li>Baehr, H.D.; Kabelac, S.: Thermodynamik, 15. Auflage, Springer Verlag, Berlin 2012</li> <li>Potter, M.; Somerton, C.: Thermodynamics for Engineers, Mc GrawHill, 1993</li> </ul>

Course L0439: Technical Thermodynamics I		
Тур	Recitation Section (large)	
Hrs/wk	1	
СР	1	
<b>Workload in Hours</b>	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	
<b>Workload in Hours</b>	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	

Courses				
<b>Title</b> Electrical Engineering	II (L0747)	<b>Typ</b> Lecture	Hrs/wk	<b>CP</b> 5
Electrical Engineering	II (L0748)	Recitation (small)	Section 2	1
Module Responsible	Prof. Manfred Kasper			
Admission Requirements	None			
Recommended Previous Knowledge	Content of the Lecture "Electrica	al Engineering I (Elekt	rotechnik I)"	
Educational Objectives	After taking part successfully, st	udents have reached	the following lear	ning results
Professional Competence				
Knowledge Skills	<ul> <li>complex power and 3-phase systems,</li> <li>transformers,</li> <li>transfer function and filters,</li> <li>the concept of resonance,</li> <li>diodes and rectifiers,</li> <li>bipolar transistors and operational amplifiers</li> </ul> The students are able to establish relations between time dependent currents and voltages in linear networks. The students know how to apply network theory to			
Personal	networks. The students know t diodes, bipolar transistors, and o			
Social Competence	Students are able to solve speci results accordingly. Students ca and exercises, verify and deepe	an explain concepts a	and, on the basis	
Autonomy	Students are able to acquire pa process, to integrate, present, students develop persistency to	and associate this kn	lowledge with oth	er fields. Th
Workload in Hours	Independent Study Time 110, St	tudy Time in Lecture	70	
Credit points	6			
Course achievement				
Examination	Written exam			
Examination duration and scale				

# Curricula Compulsory

Course L0747: Electrical Engineering II		
Тур	Lecture	
Hrs/wk	3	
СР	5	
Workload in Hours	Independent Study Time 108, Study Time in Lecture 42	
Lecturer	Prof. Manfred Kasper	
Language	EN	
Cycle	SoSe	
Content	<ul> <li>Transients</li> <li>Periodic and sinusoidal signals</li> <li>Power in AC circuits</li> <li>Three-phase systems</li> <li>Transformers</li> <li>Harmonic analysis, transfer functions, filters, locus curve, and Bode plot</li> <li>Resonant circuits</li> <li>Diodes and nonlinear circuits</li> <li>Bipolar transistor and operational amplifier</li> </ul>	
Literature	<ul> <li>A.R. Hambley: "Electrical Engineering", 5th ed., (Pearson, 2011)</li> <li>M. Albach: "Elektrotechnik", (Pearson, 2011).</li> </ul>	

Course L0748: Electrical Engineering II		
Тур	Recitation Section (small)	
Hrs/wk	2	
СР	1	
<b>Workload in Hours</b>	Independent Study Time 2, Study Time in Lecture 28	
Lecturer	Prof. Manfred Kasper	
Language	EN	
Cycle	SoSe	
Content	See interlocking course	
Literature	See interlocking course	

Module M1103	3: Mechanics II (GES)				
Courses					
Title Mechanics II (GES) (L1- Mechanics II (GES) (L1-	417) Le 418) R	<b>yp</b> ecture ecitation arge)	Hrs 2 Section 2	s/wk	<b>CP</b> 3
Module Responsible	1	3 /			
Admission Requirements	None				
Recommended Previous Knowledge	None				
Educational Objectives	LATTOR FAKING NART CHECOCCITIIIV CITINONIC NAV	e reached tl	he following	g learni	ng results
Professional Competence					
Knowledge	The primary purpose of the study of Methe capacity to predict the effects of force and simple structures, which are at rest (into the design of many structural or engine of this course are to:  1. Introduce the student to the basic profession of forces applied to elastic bodies, so in equilibrium; 2. Demonstrate sound techniques of mathematical models of real engineers. 3. Promote the analytical and problems.	es on elastices on equilibrium eering system or constructural electrons system of constructural skering system of solving sk	c bodies, st m). Such a ms. The pa quired to a ements and ting and ns;	tructura capacit articular analyse I simple solving	al elements by is critical objectives the effects estructures idealised
Skills	At the end of this course the student shoul  1. Determine average normal and shea 2. Determine shear stresses and the a shaft. 3. Determine thermal stresses in rods. 4. Analyse statically indeterminate rods 5. Determine area moments of inertia a inertia. 6. Determine normal and shear stresse 7. Analyse plane state of stress (stress 8. Analyse stability of equilibrium of columns. 9. Determine displacements and solve the aid of energy (Castigliano's) met	ar stresses.  angle of twises  and shafts  as well as presses as well as  transformat  simple systees  e statically i	rincipal axe deflections ion). tems and b	es and r due to buckling	noments of bending. g of elastic
		- assess the	team colla	boratio	n and their
Autonomy	assess their own strengths and weaknesses, e.g. with the help of the mid-term test.				
	Independent Study Time 124, Study Time in	n Lecture 56	5		
Credit points					
Course achievement	None				

Examination	Written exam
Examination duration and scale	1.5 hours Mechanics of Solids: stress and strain due to axial loading, torsion, bending, stress transformation, moments of inertia, buckling, energy methods.
Assignment for the Following Curricula	General Engineering Science (English program, 7 semester): Core qualification: Compulsory

Course L1417: Med	hanics II (GES)
Тур	Lecture
Hrs/wk	2
СР	3
<b>Workload in Hours</b>	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Prof. Radoslaw Iwankiewicz
Language	EN
Cycle	SoSe
Content	<ol> <li>Normal and shear stress, average normal and shear stress.</li> <li>Normal and shear strain.</li> <li>Axial loading: elastic deformation and statically indeterminate problems. Thermal stresses. Statically indeterminate axially loaded rods.</li> <li>Area moments of inertia.</li> <li>Torsion of a circular shaft: shear strain and stress, the angle of twist.</li> <li>Bending. Pure and symmetric bending: normal strain and stress. Deflection of beams: elastic curve. Statically indeterminate beams.</li> <li>Un-symmetric bending.</li> <li>Bending with a transverse shear: shear stresses in beams. Shear flow in thinwalled members, shear center.</li> <li>Plane-stress transformation.</li> <li>Stability of equilibrium and buckling of elastic columns.</li> <li>Elastic strain energy and energy methods: Castigliano's theorem determination of displacements and statically indeterminate problems.</li> <li>*Membrane theory of rotational shells: thin-walled pressure vessels.*</li> <li>(*) denotes an additional topic.</li> </ol>
Literature	<ol> <li>R.C. Hibbeler, Mechanics of Materials, Pearson, Prentice Hall, SI 2<sup>nd</sup> Edition</li> <li>R.C. Hibbeler, Engineering Mechanics, Statics, Pearson, Prentice Hall, SI 3<sup>rd</sup> Edition</li> <li>J.L. Meriam and L.G, Kraige, Engineering Mechanics, Vol. 1, Statics, John Wiley &amp; Sons, SI Version, 4<sup>th</sup> Edition</li> </ol>

Course L1418: Mechanics II (GES)		
Тур	Recitation Section (large)	
Hrs/wk	2	
СР	3	
<b>Workload in Hours</b>	Independent Study Time 62, Study Time in Lecture 28	
Lecturer	Prof. Radoslaw Iwankiewicz	
Language	EN	
Cycle	SoSe	
Content	See interlocking course	
Literature	See interlocking course	

Module M0737	7: Mathematical Analysis			
Courses				
Title Mathematical Analysis		<b>Typ</b> Lecture Recitation	Hrs/wk 4 Section 2	<b>CP</b> 4
Mathematical Analysis		(large) Recitation	Section 2	2
Mathematical Analysis		(small)	2	Z
Module Responsible	Prof. Marko Lindner			
Admission Requirements	None			
Recommended Previous Knowledge	None			
Educational Objectives	After taking part successfully, students l	have reached	the following learn	ing results
Professional Competence				
Knowledge	<ul> <li>Students can name the basic concepts in analysis. They are able to explain them using appropriate examples.</li> <li>Students can discuss logical connections between these concepts. They are capable of illustrating these connections with the help of examples.</li> <li>They know proof strategies and can reproduce them.</li> </ul>			
Skills	<ul> <li>Students can model problems in analysis with the help of the concepts studied in this course. Moreover, they are capable of solving them by applying established methods.</li> <li>Students are able to discover and verify further logical connections between the concepts studied in the course.</li> <li>For a given problem, the students can develop and execute a suitable approach, and are able to critically evaluate the results.</li> </ul>			
Personal Competence	- Students are able to work togeth heterogeneously composed teams (i.e.	, teams from	different study pr	ograms and
Social Competence	background knowledge) and to present their results appropriately (e.g. during exercise class).			
	- Students are capable of checking their own. They can specify open questions solving them.			
Autonomy	- Students can put their knowledge in re	lation to the c	ontents of other le	ctures.
	- Students have developed sufficient periods in a goal-oriented manner on ha		o be able to wor	k for longer
Workload in Hours	Independent Study Time 128, Study Tim	ne in Lecture 1	.12	
Credit points	8			
Course achievement	None			

Examination	Written exam
Examination duration and scale	120 minutes
the Following	Computer Science: Core qualification: Compulsory General Engineering Science (English program, 7 semester): Core qualification: Compulsory

Course L0647: Mathematical Analysis		
Тур	Lecture	
Hrs/wk	4	
СР	4	
<b>Workload in Hours</b>	Independent Study Time 64, Study Time in Lecture 56	
Lecturer	Dr. Julian Großmann	
Language	EN	
Cycle	SoSe	
Content	Convergence, sequences, and series  Continuity  Elementary functions  Differential calculus  Integral calculus  Sequences of functions	
Literature	Königsberger: Analysis Forster: Analysis	

Course L0648: Mathematical Analysis	
Тур	Recitation Section (large)
Hrs/wk	2
СР	2
<b>Workload in Hours</b>	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Dr. Julian Großmann, Jan Meichsner
Language	EN
Cycle	SoSe
Content	See interlocking course
Literature	See interlocking course

Course L0649: Mathematical Analysis		
Тур	Recitation Section (small)	
Hrs/wk	2	
СР	2	
<b>Workload in Hours</b>	Independent Study Time 32, Study Time in Lecture 28	
Lecturer	Dr. Julian Großmann	
Language	EN	
Cycle	SoSe	
Content	See interlocking course	
Literature	See interlocking course	

Module M134 (GES)	18: Fundamentals of Mechanical Engineering Design	
Courses		
	Typ Hrs/wk CP nanical Engineering (GES) (L1898) Lecture 2 3 nanical Engineering (GES) (L1899) Recitation Section 2 3	
	(Smail)	
Responsible		
Admission Requirements	None	
Recommended Previous Knowledge	Basic knowledge about mechanics and production engineering     Interpolation (Stage I Practical)	
Educational Objectives	After taking part successfully, students have reached the following learning results	
Professional Competence		
Knowledge	<ul> <li>After passing the module, students are able to:</li> <li>explain basic working principles and functions of machine elements,</li> <li>explain requirements, selection criteria, application scenarios and practical examples of basic machine elements, indicate the background of dimensioning calculations.</li> </ul> After passing the module, students are able to:	
Skills	<ul> <li>accomplish dimensioning calculations of covered machine elements,</li> <li>transfer knowledge learned in the module to new requirements and tasks (problem solving skills),</li> <li>recognize the content of technical drawings and schematic sketches,</li> <li>technically evaluate basic designs.</li> </ul>	
Personal Competence		
Social Competence	Students are able to discuss technical information in the lecture supported by activating methods.	
Autonomy	<ul> <li>Students are able to independently deepen their acquired knowledge in exercises.</li> <li>Students are able to acquire additional knowledge and to recapitulate poorly understood content e.g. by using the video recordings of the lectures.</li> </ul>	
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56	
Credit points		
Course achievement	None	
•	Written exam	
Examination duration and scale	120 min	
Assignment for the Following Curricula	Compulsory	

Course L1898: Fund	damentals of Mechanical Engineering (GES)
Тур	Lecture
Hrs/wk	2
СР	3
<b>Workload in Hours</b>	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Dr. Arthur Seibel
Language	EN
Cycle	SoSe
Content	Introduction to design Introduction to the following machine elements Screws Shaft-hub joints Rolling contact bearings Welding / adhesive / solder joints Springs Axes & shafts  Presentation of technical objects (technical drawing)  Exercise  Calculation methods for dimensioning the following machine elements: Screws Shaft-hub joints Rolling contact bearings Welding / adhesive / solder joints Springs Axis & shafts
Literature	
Literature	

Course L1899: Fundamentals of Mechanical Engineering (GES)		
Тур	Recitation Section (small)	
Hrs/wk	2	
СР	3	
<b>Workload in Hours</b>	Independent Study Time 62, Study Time in Lecture 28	
Lecturer	Dr. Arthur Seibel	
Language	EN	
Cycle	SoSe	
Content	See interlocking course	
Literature	See interlocking course	

Module M1105	5: Engineering Mechanics	III (GES)		
Courses				
<b>Title</b> Mechanics III (GES) (L1	421)	<b>Typ</b> Lecture	Hrs/wk	<b>CP</b> 3
Mechanics III (GES) (L1 Mechanics III (GES) (L1		Recitation (small) Recitation	Section 2	2
Module	Prof. Robert Seifried	(large)		
Responsible Admission Requirements				
Recommended Previous Knowledge	None			
•	After taking part successfully, studen	ts have reached	the following learn	ing results
Professional Competence				
	The primary purpose of the study Kinetics) is to develop the capacity necessary for the analysis and design vehicles, aircraft, spacecraft, aut objectives of this course are to:	to predict the ending the of moving mach	effects of forces a nine parts, differen	nd motions, t machinery
Knowledge	<ol> <li>Determine the hydrostatic force</li> <li>Analyse stability of floating boes</li> <li>Analyse the kinematics and systems,</li> <li>Analyse the motion of the systems</li> <li>Analyse the plane motion of acting on it.</li> <li>Analyse the three-dimensional</li> </ol>	dies. kinetics of a pa em of particles a a rigid body (si	article in different and forces acting o mple mechanism)	n it, and forces
	At the end of this course the student	should be able t	0:	
	<ol> <li>Solve the equilibrium problems</li> <li>Analyse stability of simple float</li> </ol>		r hydrostatic press	ure forces.
	3. Calculate the velocity and accessystems.	eleration of a p	article in differer	nt reference
	<ul> <li>4. Derive and solve the equati systems.</li> </ul>	on of motion of a	particle in differe	nt reference
	5. Analyse the motion of the system of work-energy and impulse-moment			with the aid
Skills	6. Calculate the instantaneous line the planar mechanisms.	ar and angular v	velocities and acce	elerations of
	7. Derive and solve the equations of acting on it,	a plane motion o	of a rigid body and	d find forces
	8. Apply work-energy and impulse kinetics of a rigid body.	e-momentum re	lationships to an	alyse plane
	9. Calculate the instantaneous lines the three-dimensional motion of a rig		elocities and acce	lerations of
	10. Derive the equations of a motion	of a three-dimer	nsional motion of a	a rigid body.

	11. Apply in three-dimensional kinematics and kinetics of rigid body both methods of vector algebra and matrix methods.	
Personal Competence		
Social Competence	Students can: - work in groups and report on the findings, - develop joint solutions in mixed teams and present them to others, - assess the team collaboration and their share in it.	
Autonomy	Students are able to: -solve the problems independently with the help of hints, -assess their own strengths and weaknesses, e.g. with the aid of the mid-term test.	
<b>Workload in Hours</b>	Independent Study Time 96, Study Time in Lecture 84	
Credit points	6	
Course achievement	None	
Examination	Written exam	
duration and	2 hours Fluid Statics: hydrostatic pressure, buoyancy, stability of floating vessels. Kinematics of particle, of plane and 3D rigid bod,y. Kinetics of particle, system of particles, of plane and 3D rigid body. Vector and matrix algebra formulation.	
the Following	Engineering Science: Core qualification: Compulsory General Engineering Science (English program, 7 semester): Core qualification: Compulsory Computational Science and Engineering: Specialisation Engineering Sciences: Elective Compulsory	

Course L1421: Mechanics III (GES)		
Тур	Lecture	
Hrs/wk	3	
СР	3	
<b>Workload in Hours</b>	Independent Study Time 48, Study Time in Lecture 42	
Lecturer	Prof. Radoslaw Iwankiewicz	
Language	EN	
Cycle	WiSe	
Content	See interlocking course	
Literature	See interlocking course	

Course L1420: Mechanics III (GES)		
Тур	Recitation Section (small)	
Hrs/wk	2	
СР	2	
<b>Workload in Hours</b>	Independent Study Time 32, Study Time in Lecture 28	
Lecturer	Prof. Radoslaw Iwankiewicz	
Language	EN	
Cycle	WiSe	
Content	See interlocking course	
Literature	See interlocking course	

Course L1419: Mechanics III (GES)		
Тур	Recitation Section (large)	
Hrs/wk	1	
СР	1	
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14	
Lecturer	Prof. Radoslaw Iwankiewicz	
Language	EN	
Cycle	WiSe	
Content	<ol> <li>FLUID STATICS         <ol> <li>Fluid pressure, hydrostatic pressure on flat and cylindrical surfaces.</li> <li>Buoyancy force, buoyancy center, metacenter, stability of floating objects.</li> </ol> </li> <li>KINEMATICS         <ol> <li>Kinematics of a particle. Plane curvilinear motion: rectangular coordinates, normal and tangential coordinates, polar coordinates. Space curvilinear motion.</li> <li>Constrained motion of connected particles.</li> <li>Plane kinematics of a rigid body.</li> <li>Relative (compound) motion.</li> <li>Three-dimensional kinematics of a rigid body.</li> </ol> </li> <li>KINETICS         <ol> <li>Kinetics of a particle and of a system of particles.</li> <li>Plane kinetics of a rigid body.</li> <li>Three-dimensional kinetics of a rigid body.</li> </ol> </li> </ol>	
Literature	<ol> <li>J.L. Meriam and L.G, Kraige, Engineering Mechanics, Vol. 2, Dynamics, John Wiley &amp; Sons, SI Version, 4<sup>th</sup> Edition</li> <li>R.C. Hibbeler, Engineering Mechanics, Dynamics, Pearson, Prentice Hall, SI 3 rd Edition</li> </ol>	

Module M0853	3: Mathematics III			
Courses				
<b>Title</b> Analysis III (L1028)		<b>Typ</b> Lecture	Hrs/wk	<b>CP</b> 2
Analysis III (L1029)		Recitation (small)	Section 1	1
Analysis III (L1030)		Recitation (large)	Section 1	1
Differential Equations	1 (Ordinary Differential Equations) (L1031)	Lecture	2	2
Differential Equations	1 (Ordinary Differential Equations) (L1032)	Recitation (small)	Section 1	1
Differential Equations	1 (Ordinary Differential Equations) (L1033)	Recitation (large)	Section 1	1
Module Responsible	I Prof. Aniisch Taraz			
Admission Requirements				
Recommended	Mathematics I + II			
Educational Objectives	After taking part successfully, students	have reached	the following lear	ning results
Professional Competence				
Knowledge	<ul> <li>Students can name the basic corequations. They are able to explain the students can discuss logical concapable of illustrating these confirmed they know proof strategies and confirmed the strategies.</li> </ul>	nin them using nections betw ections with t	appropriate exan een these concep he help of example	nples. ts. They ar
Skills	<ul> <li>Students can model problems equations with the help of the they are capable of solving them</li> <li>Students are able to discover an the concepts studied in the cours</li> <li>For a given problem, the stud approach, and are able to critical</li> </ul>	concepts stu by applying e d verify furthoe. e. ents can dev	died in this coursestablished methoder logical connections and execut	se. Moreover ds. ons betwee
Personal Competence				
Social Competence	<ul> <li>Students are able to work tog mathematics as a common langu</li> <li>In doing so, they can communicate their cooperating partners. More and deepen the understanding or</li> </ul>	age. ate new conce eover, they c	epts according to	the needs o
Autonomy	<ul> <li>Students are capable of checkir on their own. They can specify of get help in solving them.</li> <li>Students have developed sufficient</li> </ul>	pen question	s precisely and kn	now where t

	periods in a goal-oriented 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 scale	60 min (Analysis III) + 60 min (Differential Equations 1)		
the Following	General Engineering Science (German program, 7 semester): Core qualification: Compulsory Civil- and Environmental Engineering: Core qualification: Compulsory Bioprocess Engineering: Core qualification: Compulsory Computer Science: Core qualification: Compulsory Data Science: Core qualification: Compulsory Digital Mechanical Engineering: Core qualification: Compulsory Electrical Engineering: Core qualification: Compulsory Energy and Environmental Engineering: Core qualification: Compulsory Engineering Science: Core qualification: Compulsory General Engineering Science (English program, 7 semester): Core qualification: Compulsory Computational Science and Engineering: Core qualification: Compulsory Mechanical Engineering: Core qualification: Compulsory Mechatronics: Core qualification: Compulsory Naval Architecture: Core qualification: Compulsory Process Engineering: Core qualification: Compulsory		

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

Course L1029: Analysis III		
Тур	Recitation Section (small)	
Hrs/wk	1	
СР	1	
<b>Workload in Hours</b>	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	
<b>Workload in Hours</b>	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: Diffe	erential Equations 1 (Ordinary Differential Equations)
Тур	Lecture
Hrs/wk	2
СР	2
<b>Workload in Hours</b>	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	
<b>Workload in Hours</b>	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	
<b>Workload in Hours</b>	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	

Courses				
<b>Title</b> Technical Thermodyna	imics II (L0449)	<b>Typ</b> Lecture	Hrs/wk	<b>CP</b> 4
Technical Thermodynamics II (L0450)		Recitation (large)	Section 1	1
Technical Thermodyna	mics II (L0451)	Recitation (small)	Section 1	1
Module Responsible	Prof. Gerhard Schmitz			
Admission Requirements				
Recommended Previous Knowledge	Elementary knowledge in Mathem	atics, Mechanics and	d Technical Therm	odynamics
Educational Objectives	After taking part successfully, stud	lents have reached	the following learr	ing results
Professional Competence				
Knowledge	Students are familiar with different cycle processes like Joule, Otto, Diesel, Stirling, Seiliger and Clausius-Rankine. They are able to derive energetic and exergetic efficiencies and know the influence different factors. They know the difference between anti clockwise and clockwise cycles (heat-power cycle, cooling cycle). They have increased knowledge of steam cycles and are able to draw the different cycles.			
Skills	Students are able to use thermody Especially they are able to formul this to optimise technical proce calculations in regard to an outflow verbal formulated message into a	ate energy, exergy- sses. They are ab ving gas from a tanl	and entropy bala ble to perform si k. They are able to	nces and b mple safet
Personal Competence				-l-
Social Competence				
	Students are able to define indexisting knowledge as well as to fi			
Autonomy				
Workload in Hours	I Independent Study Time 124, Stud	dy Time in Lecture 5	6	
Credit points				
Course achievement	None			
Examination				
Examination				

duration and scale	
Assignment for the Following Curricula	General Engineering Science (English program, / Semester): Core qualification:

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

Course L0450: Technical Thermodynamics II			
Тур	Recitation Section (large)		
Hrs/wk			
СР	1		
<b>Workload in Hours</b>	Independent Study Time 16, Study Time in Lecture 14		
Lecturer	Prof. Gerhard Schmitz		
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	
<b>Workload in Hours</b>	Independent Study Time 16, Study Time in Lecture 14	
Lecturer	Prof. Gerhard Schmitz	
Language	DE	
Cycle	WiSe	
Content	See interlocking course	
Literature	See interlocking course	

Module M1273	3: Advanced Internship AIW/ GES			
Courses				
Title	Typ Hrs/wk CP			
itesponsible				
Admission Requirements	None			
Recommended Previous Knowledge	150 Creditpoints in General Engineering Science			
Educational Objectives	After taking part successfully, students have reached 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 in a company and to understand the language of engineers.			
Autonomy	Students can finish own tasks.			
Workload in Hours	Independent Study Time 540, Study Time in Lecture 0			
Credit points				
Course achievement	None			
Examination	Written elaboration (accord. to Internship Regulations)			
Examination duration and scale	see Internship Regulations			
	General Engineering Science (German program, 7 semester): Core qualification: Compulsory Engineering Science: Core qualification: Compulsory General Engineering Science (English program, 7 semester): Core qualification: Compulsory			

## **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 M0740	0: Structural Ar	nalysis I			
Courses					
Courses					
<b>Title</b> Structural Analysis I (L	.0666)		<b>Typ</b> Lecture	Hrs/wk 2	<b>CP</b> 3
Structural Analysis I (L			Recitation (large)	Section 2	3
Module					
Responsible	I Prot I IWA Staroccar				
Admission Requirements	None				
Recommended Previous Knowledge	Mechanics I, Mathema	atics I			
Educational Objectives	LATTER FAKING NATE SHEE	essfully, students h	ave reached	the following lear	ning results
Professional					
Competence	;				
Knowledge	After successfully completing this module, students can express the basic aspects of linear frame analysis of statically determinate systems.				
Skills	After successful completion of this module, the students are able to distinguish between statically determinate and indeterminate structures. They are able to analyze state variables and to construct influence lines of statically determinate plane and spatial frame and truss structures.				
Personal					
Competence					
	Students can				
Social Competence	<ul> <li>participate in subject-specific and interdisciplinary discussions,</li> <li>defend their own work results in front of others</li> <li>promote the scientific development of colleagues</li> <li>Furthermore, they can give and accept professional constructive criticism</li> </ul>				
Autonomy	The students are able work in-term homework assignments. Due to the in-term feedback, they are enabled to self-assess their learning progress during the lecture period, already.				
Workload in Hours	Independent Study Ti	me 124, Study Time	e in Lecture 5	6	
Credit points	6				
Course achievement		Form Written elaborati	on b	J -	nit Testat, Studentische )
Fyamination	   Written exam		<u>'</u>		,
Examination					
2/411111411011	I	[50]			

duration an	d 90 Minuten
scal	e
Assignment fo the Followin Curricul	General Engineering Science (German program, 7 semester): Specialisation Civil Engineering: Compulsory Civil- and Environmental Engineering: Core qualification: Compulsory General Engineering Science (English program, 7 semester): Specialisation Civil Engineering: Compulsory Technomathematics: Specialisation III. Engineering Science: Elective Compulsory

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

Course L0667: Structural Analysis I			
Тур	Recitation Section (large)		
Hrs/wk	2		
СР	3		
<b>Workload in Hours</b>	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 M0580	0: Principles of Buildin	g Materials an	d Building P	hysics	
Courses					
<b>Title</b> Building Physics (L021	7)	<b>Typ</b> Lecture	Hrs/wk	<b>CP</b> 2	
Building Physics (L021	9)	Recitation (large)	Section 1	1	
Building Physics (L024		Recitation (small)	Section 1	1	
Principles of Building N	Materials (L0215)	Lecture	2	2	
Module Responsible					
Admission Requirements	None				
Recommended Previous Knowledge	Knowledge of physics, chemistry	and mathematics fro	m school		
Educational Objectives	After taking part successfully, stu	udents have reached	the following learr	ning 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 building materials and the correlations between structure and other properties, to show methods of joining and of corrosion processes and to describe the most important regularities and properties of building materials and structures and their measurement in the field of protection against moisture, coldness, fire and noise.				
Skills	The students are able to work with the most important standardized methods and regularities in the field of moisture protection, the German regulation for energy saving, fire protection and noise protection in the case of a small building.				
Personal Competence					
Social Competence	The students are able to suppor knowledge.	t each other to learn	n the very extensi	ve specialis	
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, Stud	dy Time in Lecture 84			
Credit points	6				
Course achievement	None				
Examination	Written exam				
Examination duration and scale	2 h written exam				
the Following	General Engineering Science (German program, 7 semester): Specialisation Civi Engineering: Compulsory Civil- and Environmental Engineering: Core qualification: Compulsory General Engineering Science (English program, 7 semester): Specialisation Civi Engineering: Compulsory Orientierungsstudium: Core qualification: Elective Compulsory Technomathematics: Specialisation III. Engineering Science: Elective Compulsory				

Course L0217: Buil	ding Physics
Тур	Lecture
Hrs/wk	2
СР	2
<b>Workload in Hours</b>	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		
<b>Workload in Hours</b>	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		
<b>Workload in Hours</b>	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 M0744	1: Structural Analysi	s II		
Courses				
<b>Title</b> Structural Analysis II (L		<b>Typ</b> Lecture Recitation (large)	2 Section	<b>CP</b> 3
Module Responsible	Prof. Uwe Starossek			
Admission Requirements	None			
Recommended Previous Knowledge	Structural Analysis I			
Educational Objectives	After taking part successfully,	students have reached	the following learnin	g results
Professional Competence				sic aspects
Knowledge		treatly indeterminate by	scenis.	
Skills	After successful completion of variables and to construct inf frame and truss structures.			
Personal Competence				
Social Competence	<ul><li>participate in subject-s</li></ul>	development of colleagu	ies	iticism
Autonomy	The students are able to wor feedback, they are enabled to period, already.			
Workload in Hours	Independent Study Time 124,	Study Time in Lecture 5	56	
Credit points	6			
	CompulsorBonus Form	ı	Description	

Course achievement		10 %	Written elaboration	Hausübungen betreut durch Tutoren (Tutoriur	
Examination	Written exa	am			
Examination duration and scale	90 Minuter	1			
_	Engineerin Civil- and E General E	g: Compulso Invironment	al Engineering: Core qualifica Science (English program, 7	ation: Compulsory	

Course L0673: Stru	ıctural Analysis II
Тур	Lecture
Hrs/wk	2
СР	3
<b>Workload in Hours</b>	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		
<b>Workload in Hours</b>	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 M0590	D: Building Mate	rials and Bu	ilding Ch	emistry	/	
Courses						
	<b>Title</b> Building Materials and Building Chemistry (L0248) Building Materials and Building Chemistry (L0249)			H 4 Section 1	rs/wk	<b>CP</b> 4 2
Module Responsible	Prof. Frank Schmidt-Döh	าไ	(small)			
Admission Requirements	None					
Recommended Previous Knowledge	Module Principles of Bui	ilding Materials an	d Building Pl	nysics		
Educational Objectives	LATTOR TAKING NATT CHECKS	ssfully, students h	ave reached	the followi	ng learn	ing results
Professional Competence						
Knowledge	The students are able to the structure, the most the corrosion behaviou relevant building mater	important charac ur, the material t	cteristics of t	he mecha	nical be	haviour and
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 to knowledge in learning g					
Autonomy	The students are able to make the timing and the operation steps to learn the specialist knowledge of a very extensive field.					
	Independent Study Time	e 110, Study Time	e in Lecture 7	0		
Credit points						
achievement		Form Presentation		escriptio	n	
Examination						
Examination duration and scale	2 h written exam					
Assignment for the Following Curricula	General Engineering So Engineering: Compulsor Civil- and Environmenta General Engineering S Engineering: Compulsor Orientierungsstudium: O	ry al Engineering: Col cience (English p ry	re qualification rogram, 7 s	on: Compul semester):	loom.	

Course L0248: Building Materials and Building Chemistry		
Тур	Lecture	
Hrs/wk	4	
СР	4	
<b>Workload in Hours</b>	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 Materials and Building Chemistry		
Тур	Recitation Section (small)	
Hrs/wk	1	
СР	2	
<b>Workload in Hours</b>	Independent Study Time 46, Study Time in Lecture 14	
Lecturer	Prof. Frank Schmidt-Döhl, André Rössler	
Language	DE	
Cycle	SoSe	
Content	See interlocking course	
Literature	See interlocking course	

Module M0706	6: Geotechnics I			
Courses				
<b>Title</b> Soil Mechanics (L0550)		<b>Typ</b> Lecture	Hrs/wk	<b>CP</b> 2
Soil Mechanics (L0551)		Recitation (large)	Section 2	2
Soil Mechanics (L1493)	)	Recitation (small)	Section 2	2
Module Responsible	Prof. Jürgen Grabe			
Admission Requirements	None			
Recommended	Modules :			
Previous Knowledge	Mechanics I-II			
Educational Objectives	After taking part successfully, stu	idents have reached t	he following learr	ning results
Professional Competence				
-	The students know the basics of soil mechanics as the structure and characteristics of soil, stress distribution due to weight, water or structures, consolidation and settlement calculations, as well as failure of the soil due to ground- or slope failure.			
Skills	After the successful completion of the module the students should be able to describe the mechanical properties and to evaluate them with the help of geotechnical standard tests. They can calculate stresses and deformation in the soils due to weight or influence of structures. They are are able to prove the usability (settlements) for shallow foundations.			
Personal Competence Social Competence				
Autonomy				
	Independent Study Time 96, Stud	ly Time in Lecture 84		
Credit points		_		
Course achievement	CompulsorBonusFormNo20 %Attestation		escription	
Examination	Written exam			
Examination duration and scale	60 minutes			
the Following	General Engineering Science (G Engineering: Compulsory General Engineering Science (G Engineering: Compulsory Civil- and Environmental Enginee Civil- and Environmental Enginee General Engineering Science (E Engineering: Compulsory Technomathematics: Specialisation	erman program, 7 s ring: Core qualificatio ring: Core qualificatio nglish program, 7 so	emester): Specia n: Compulsory n: Compulsory emester): Special	lisation Civil

Course L0550: Soil Mechanics			
Тур	Lecture		
Hrs/wk			
СР	2		
<b>Workload in Hours</b>	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	
<b>Workload in Hours</b>	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 Mechanics		
Тур	Recitation Section (small)	
Hrs/wk	2	
СР	2	
<b>Workload in Hours</b>	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 M0613	3: Reinforced Co	oncrete Struc	tures I		
Courses					
Title			Тур	Hrs/wk	СР
Project Seminar Concrete D			Seminar Lecture	1 2	1 3
Reinforced Concrete D	esign I (L0305)		Recitation (large)	Section 2	2
Module Responsible	Prof. Günter Rombach	1			
Admission Requirements	None				
Recommended	Basic knowledge in st	ructural analysis an	d building m	aterials.	
Previous Knowledge	Modules: Structural A	analysis I, Mechanics	5  +		
Educational Objectives		essfully, students h	ave reached	the following learn	ing results
Professional Competence					
	The students can outl	-		•	
Knowledge	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 behaviour of the materials and of structural members.				
Skills	The students are able to practical cases. The design them for benchmand execution. Moreoutly draw up technical des	hey are capable to ding and bending w over, they can ma	o draft simpl with axial for	e concrete struct ce, and to plan th	ures and to eir detailing
Personal					
Competence Social Competence	<del>-</del>				
,	The students are able of structures and to cr			conception and d	imensioning
Workload in Hours	Independent Study Tir	me 110, Study Time	in Lecture 7	0	
Credit points	6				
Course achievement	CompulsorBonus Yes None	<b>Form</b> Excercises	C	escription	
Examination	Written exam				
Examination duration and scale	120 minutes				
the Following	General Engineering Engineering: Compuls Civil- and Environmen General Engineering Engineering: Compuls	sory Ital Engineering: Col Science (English p	re qualification	on: Compulsory	

Course L0896: Project Seminar Concrete I		
Тур	Seminar	
Hrs/wk	1	
СР	1	
<b>Workload in Hours</b>	Independent Study Time 16, Study Time in Lecture 14	
Lecturer	Björn Schütte	
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: Rein	nforced Concrete Design I
Тур	Lecture
Hrs/wk	2
СР	3
<b>Workload in Hours</b>	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Prof. Günter Rombach
Language	DE
Cycle	SoSe
Content	<ul> <li>The following subjects/contents are treated:</li> <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>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 Concrete Design I		
Тур	Recitation Section (large)	
Hrs/wk	2	
СР	2	
<b>Workload in Hours</b>	Independent Study Time 32, Study Time in Lecture 28	
Lecturer	Prof. Günter Rombach	
Language	DE	
Cycle	SoSe	
Content	See interlocking course	
Literature	See interlocking course	

Courses				
Title Introduction to Control		<b>Typ</b> Lecture Recitation	Hrs/wk 2 Section 2	4
Introduction to Control	i Systems (Luoss)	(small)		2
Responsible				
Admission Requirements	LNODE			
Recommended Previous Knowledge	Representation of signals and sy transform	Representation of signals and systems in time and frequency domain, Laplace transform		
Educational Objectives	After taking part successfully, stud	dents have reached	the following lear	ning results
Professional Competence				
Knowledge	<ul> <li>Students can represent dynamic system behavior in time and frequency domain, and can in particular explain properties of first and second order systems</li> <li>They can explain the dynamics of simple control loops and interpret dynamic properties in terms of frequency response and root locus</li> <li>They can explain the Nyquist stability criterion and the stability margins derived from it.</li> <li>They can explain the role of the phase margin in analysis and synthesis of control loops</li> <li>They can explain the way a PID controller affects a control loop in terms of its frequency response</li> <li>They can explain issues arising when controllers designed in continuous time domain are implemented digitally</li> </ul>			
Skills	<ul> <li>Students can transform models of linear dynamic systems from time frequency domain and vice versa</li> <li>They can simulate and assess the behavior of systems and control loops</li> <li>They can design PID controllers with the help of heuristic (Ziegler-Nichol tuning rules</li> <li>They can analyze and synthesize simple control loops with the help of rolocus and frequency response techniques</li> <li>They can calculate discrete-time approximations of controllers designed continuous-time and use it for digital implementation</li> <li>They can use standard software tools (Matlab Control Toolbox, Simulink) for carrying out these tasks</li> </ul>			
Personal Competence	:			
Social Competence	Students can work in small groups to jointly solve technical problems, and experimentally validate their controller designs  Students can obtain information from provided sources (lecture notes, software)			
Autonomy	documentation, experiment guide: They can assess their knowledge	s) and use it when s	olving given prob	lems.

<b>Workload in Hours</b>	Independent Study Time 124, Study Time in Lecture 56
Credit points	6
Course achievement	INONE
Examination	Written exam
Examination duration and scale	120 min
the Following	General Engineering Science (German program, 7 semester): Core qualification: Compulsory Bioprocess Engineering: Core qualification: Compulsory Computer Science: Specialisation Computational Mathematics: Elective Compulsory Data Science: Core qualification: Elective Compulsory Electrical Engineering: Core qualification: Compulsory Energy and Environmental Engineering: Core qualification: Compulsory General Engineering Science (English program, 7 semester): Specialisation Electrical Engineering: Compulsory General Engineering Science (English program, 7 semester): Specialisation Civil Engineering: Compulsory General Engineering Science (English program, 7 semester): Specialisation Bioprocess Engineering: Compulsory General Engineering Science (English program, 7 semester): Specialisation Bioprocess Engineering: Compulsory General Engineering Science (English program, 7 semester): Specialisation Engineerial Engineering Science (English program, 7 semester): Specialisation Computer Science: Compulsory General Engineering Science (English program, 7 semester): Specialisation Mechanical Engineering, Science (English program, 7 semester): Specialisation Mechanical Engineering, Science (English program, 7 semester): Specialisation Mechanical Engineering, Focus Energy Systems: Compulsory General Engineering, Science (English program, 7 semester): Specialisation Mechanical Engineering, Focus Materials in Engineering: Compulsory General Engineering, Science (English program, 7 semester): Specialisation Mechanical Engineering, Focus Meterials in Engineering Sciences: Compulsory General Engineering, Science (English program, 7 semester): Specialisation Mechanical Engineering, Focus Meterials in Engineering Sciences: Compulsory General Engineering, Science (English program, 7 semester): Specialisation Mechanical Engineering, Focus Mecharonics: Compulsory General Engineering Science (English program, 7 semester): Specialisation Mechanical Engineering, Focus Product Development and Production: Compulsory General Engineering S

Course L0654: Intr	oduction to Control Systems		
Тур	Lecture		
Hrs/wk			
СР			
Workload in Hours	Independent Study Time 92, Study Time in Lecture 28		
	Prof. Herbert Werner		
Language			
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	
<b>Workload in Hours</b>	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 M0611	L: Steel Structures I			
Courses				
Title Steel Structures I (L02) Steel Structures I (L03)	Pocitation Section			
Module Responsible	Prof. Marcus Rutner			
Admission Requirements	None			
Recommended Previous Knowledge	<ul> <li>Structural analysis I, Structural analysis II</li> <li>Mechanics I, Mechanics II</li> <li>Building Materials and Building Chemistry</li> <li>Principles of Building Materials and Building Physics</li> </ul>			
Educational Objectives	After taking part successfully, students have reached the following learning results			
Professional Competence				
Knowledge	After passing this module students are able to  • give a summary of the security concept			
Skills	Students can rate and apply the material steel appropriately with respect to its properties and usage.  They can use the security concept with respect to loads, forces and resistances.  They can check the ultimate limit state and the serviceability of simple members in tension, compression and bending.			
Personal				
Competence Social Competence	After participation of an optional course (building of a simple truss) they are able to organize themselves in groups. They will be successful in guided building a truss with bolted connections according to design drawings.			
Autonomy				
-	Independent Study Time 124, Study Time in Lecture 56			
Credit points Course				
achievement	None			
Examination				
Examination duration and scale				
the Following	General Engineering Science (German program, 7 semester): Specialisation Civil Engineering: Compulsory Civil- and Environmental Engineering: Core qualification: Compulsory General Engineering Science (English program, 7 semester): Specialisation Civil Engineering: Compulsory			

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

Course L0300: Steel Structures I		
Тур	Recitation Section (large)	
Hrs/wk	2	
СР	3	
<b>Workload in Hours</b>	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 M0730	0: Computer Engineeri	ng		
Courses				
<b>Title</b> Computer Engineering Computer Engineering		<b>Typ</b> Lecture Recitation	Hrs/wk 3 Section 1	<b>CP</b> 4
		(small)	-	
- Responsible	Prof. Heiko Falk			
Admission Requirements	None			
Recommended Previous Knowledge	Basic knowledge in electrical eng	gineering		
Educational Objectives	After taking part successfully, students have reached the following learning results			
Professional Competence				
Knowledge	<ul> <li>This module deals with the foundations of the functionality of computing systems. It covers the layers from the assembly-level programming down to gates. The module includes the following topics:</li> <li>Introduction</li> <li>Combinational logic: Gates, Boolean algebra, Boolean functions, hardware synthesis, combinational networks</li> <li>Sequential logic: Flip-flops, automata, systematic hardware design</li> <li>Technological foundations</li> <li>Computer arithmetic: Integer addition, subtraction, multiplication and division</li> <li>Basics of computer architecture: Programming models, MIPS single-cycle architecture, pipelining</li> <li>Memories: Memory hierarchies, SRAM, DRAM, caches</li> <li>Input/output: I/O from the perspective of the CPU, principles of passing data, point-to-point connections, busses</li> </ul>			
Skills	The students perceive computer identify the internal structure a The students can analyze, how hased on a collection of few an between and to explain the constraint systems - from gates and circuit.  After successful completion of interdependencies between a phon it. In particular, they shall usoftware has on the hardward language down to gates. This was these low abstraction levels hardward propose feasible options.	nd the physical comp nighly specific and indi d simple components. different abstraction is s up to complete proce the module, the stu- nysical computer syste nderstand the consequence-centric abstraction ay, they will be enable	osition of computers vidual computers. They are able to layers of today's essors.  dents are able tom and the softwall uences that the layers from the document of the column of the evaluate the	cer systems. can be built distinguish computing judge the re executed execution of e assembly impact that
Personal Competence		ar problems alone or i	n a group and to	present the
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, St	udy Time in Lecture 56	5	
Credit points	1			

	CompulsorBonus	Form	Description
achievement	Yes 10 %	Excercises	
Examination	Written exam		
Examination duration and scale	90 minutes, contents of	f course and labs	
the Following	Computer Science: Com General Engineering Bioprocess Engineering General Engineering Sc Architecture: Compulso General Engineering Electrical Engineering Electrical Engineering General Engineering Biomedical Engineering General Engineering General Engineering General Engineering General Engineering General Engineering General Engineering Mechanical Engineering General Engineering Mechanical Engineering General Engineering Mechanical Engineering General Engineering Mechanical Engineering	science (German compulsory science (German prory science (German prory science (German compulsory science (German progressering: Compulsory ience (English progressering:	program, 7 semester): Specialisation Process program, 7 semester): Specialisation cs: Compulsory program, 7 semester): Specialisation cs: Compulsory program, 7 semester): Specialisation tems Engineering: Compulsory program, 7 semester): Specialisation Engineering Sciences: Compulsory program, 7 semester): Specialisation Mechanical Engineering: Specialisation Mechanical Engineering Sciences: Compulsory Mems Engineering Sciences: Compulsory Mechanical Engineering Sciences: Specialisation Mems Engineering Sciences: Specialisation Mechanical Engineering: S
ı	l	[71]	

General Engineering Science (English program, 7 semester): Specialisation Mechanical Engineering, Focus Theoretical Mechanical Engineering: Compulsory General Engineering Science (English program, 7 semester): Specialisation Naval Architecture: Compulsory General Engineering Science (English program, 7 semester): Specialisation Process Engineering: Compulsory General Engineering Science (English program, 7 semester): Specialisation Biomedical Engineering: Compulsory Computational Science and Engineering: Core qualification: Compulsory Mechatronics: Core qualification: Compulsory Technomathematics: Specialisation II. Informatics: Elective Compulsory

Course L0321: Com	puter Engineering		
Тур	Lecture		
Hrs/wk			
СР	4		
<b>Workload in Hours</b>	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	
<b>Workload in Hours</b>	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 M0878	8: Applications in Civil and E	invironmental	Engine	ering
Courses				
Courses		<b>T</b>	11 /1-	- CD
Title Applied Structural Dyn	namics (L0701)	<b>Typ</b> Lecture	Hrs/wk 2	<b>CP</b> 2
Applied Structural Dynamics (L0791) Soil Laboratory Course (L0499)		Practical Course	1	2
Building Information Modeling (L1903)		Lecture	1	1
-	-	Project-/problem-	2	2
Building Information M		based Learning	_	2
	is of Structures (L0370)	Lecture	2	3
Introduction in Statitic	s with R (L0286)	Lecture	1	1
Introduction in Statitic	s with R (L0776)	Recitation Section (large)	''1	1
Principles of Geomatic	s (L0470)	Lecture	2	2
Principles of Geomatic	s (L0471)	Recitation Section (small)	n 2	2
Numeric and Matlab (L	_0125)	Practical Course	2	2
	nking Water Chemistry (L1744)	Practical Course	1	2
Projects II (L1228)		Project Seminar	2	2
	and Environmental Engineering (L2411)		1	1
	and Environmental Engineering 2 LP (L2412)		2	2
	and Environmental Engineering 3LP (L2413)		3	3
Fire Protection and Pre	evention (L0472)	Lecture	2	2
Module Responsible	IPINI PELEFENNIE			
Admission				
Requirements	LNODE			
Recommended				
Previous				
Knowledge				
Educational Objectives	LATTER TAKING NART SUCCESSTUUV STUGENTS R	nave reached the follo	wing learr	ning results
Professional				
Competence				
Knowledge	The students are at home doing with typ	ical applications of th	e study pr	ogramme.
Knowieuge				
	The students are able to use the metho practical questions. They are able to we application independently".			
Skills				
Personal				
Competence				
Social Competence	According to the course chosen student project in teams. If so, they can present,			
Autonomy	According to the course chosen individent and work flow for themselves or for the t		n and doc	ument task
Workload in Hours	Depends on choice of courses			
Credit points	-			
	General Engineering Science (German Engineering: Elective Compulsory	program, 7 semeste	r): Specia	lisation Civ
	[73]			

the Following
Civil- and Environmental Engineering: Core qualification: Compulsory
General Engineering Science (English program, 7 semester): Specialisation Civil
Engineering: Elective Compulsory

Course L0791: App	lied Structural Dynamics
Тур	Lecture
Hrs/wk	
СР	
	Independent Study Time 32, Study Time in Lecture 28
Examination Form	Mündliche Prüfung
Examination duration and scale	15 min
Lecturer	Dr. Kira Holtzendorff
Language	
Cycle	
Content	The lecture gives an introduction into the classical structural dynamics, whereas the focus lies on the practical applications. The theoretical basics are worked out in order to apply them for typical issues in practice. For an effective vibration isolation due to vibration excitations by e.g. railway traffic, operating machines oder moving people, different structural measures are presented. The lecture is completed by performing examples of vibration measurements as well as interactive dynamic experiments in the laboratory.  The following topics are covered:  Particular features in structural dynamics  Basic terms of time-dependent excitations  Free vibrations (natural frequencies)  Induced vibrations  Impact excitations of structures  Methods of amplitude reduction (vibration isolation)  Introduction to soil dynamics  Vibration measurements and requirements for vibration protection  Vibrations induced by people
Literature	Helmut Kramer: Angewandte Baudynamik, Ernst & Sohn Verlag, 2. Auflage 2013 Christian Petersen: Dynamik der Baukonstruktionen, Vieweg Verlag, 2. Auflage von 2000

Course L0499: Soil	Laboratory Course
Тур	Practical Course
Hrs/wk	1
СР	2
<b>Workload in Hours</b>	Independent Study Time 46, Study Time in Lecture 14
<b>Examination Form</b>	Schriftliche Ausarbeitung
duration and	Die gesamte Arbeitszeit im Praktikum plus anschließender Bericht = 90 Stunden Arbeitszeit (Das Erstellen der Ausarbeitung = Bearbeitungszeitraum von 4 Wochen und ein Umfang von maximal 50 Seiten.)
Lecturer	Prof. Jürgen Grabe
Language	DE
Cycle	WiSe
Content	<ul> <li>Field experiments</li> <li>Short lecture on laboratory tests</li> <li>soil analysis</li> <li>laboratory test</li> <li>soil clasification</li> <li>Creating a ground and foundation report</li> </ul>
Literature	DIN-Taschenbuch 113, Erkundung und Untersuchung des Baugrundes

Course L1903: Buil	ding Information Modeling
Тур	Lecture
Hrs/wk	
СР	1
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14
Examination Form	Schriftliche Ausarbeitung
Examination duration and scale	siehe Modulhandbuch
Lecturer	Prof. Frank Schmidt-Döhl, Thomas Kölzer
Language	DE
Cycle	WiSe/SoSe
Content	<ul> <li>Basic knowledge of Building Information Modeling:         <ul> <li>Introduction to BIM (development, backgrounds, history, opportunities, risks, levels)</li> <li>Current standards and guidelines (national and international standardisation, structures)</li> <li>Applications of BIM (openBIM, closedBIM, littleBIM, data and interchange formats)</li> <li>Object oriented modeling (requirements, structure, classification, parts catalogues)</li> <li>BIM-Implementation (structures, cycles, professions, job profiles, execution plan)</li> <li>BIM-Tools (software, hardware, application areas)</li> <li>Execution examples (national and international construction projects)</li> </ul> </li> <li>Basic knowledge for the use of the software Allplan 2018:         <ul> <li>Basic settings (project administration, building structures, fileset structures, layers)</li> <li>Construction fundamentals 2D (e. g. line, circle, spline, ellipse, parallel etc.)</li> <li>Modifying of construction elements (e. g. copy, mirror, intersect, fillet etc.)</li> <li>Dimensioning and text adding of designed elements and structural components</li> <li>Generating of areas (hatchings, patterns, fills)</li> <li>Construction fundamentals 3D (floor concept, floor manager, building structures)</li> <li>Walls and columns (height definitions, parameters, attributes, format properties)</li> <li>Slabs (height definitions, parameters, attributes, format properties)</li> <li>Use of libraries (u. a. furnitures, surroundings etc.)</li> <li>Opening Elements and SmartParts (doors and windows)</li> <li>Stairs and ramps (stair wizard, IFC-Ramp)</li> <li>Roof frame and roof covering (custom planes, parameters, attributes, format properties)</li> <li>Attributes and characteristic values (allocations and modifi</li></ul></li></ul>
Literature	-

Course L1904: Building Information Modeling	
Тур	Project-/problem-based Learning
Hrs/wk	2
СР	2
<b>Workload in Hours</b>	Independent Study Time 32, Study Time in Lecture 28
<b>Examination Form</b>	Schriftliche Ausarbeitung
Examination duration and scale	siehe Modulhandbuch
Lecturer	Prof. Frank Schmidt-Döhl, Thomas Kölzer
Language	DE
Cycle	WiSe/SoSe
Content	See interlocking course
Literature	See interlocking course

Course L0370: Com	nputational Analysis of Structures	
Тур	Lecture	
Hrs/wk	2	
СР	3	
<b>Workload in Hours</b>	Independent Study Time 62, Study Time in Lecture 28	
<b>Examination Form</b>	Klausur	
Examination duration and scale		
Lecturer	Prof. Günter Rombach	
Language	DE	
Cycle	WiSe	
Content	<ul> <li>basics of the Finite Element Method, Spreadsheets</li> <li>basics of software 'SOFiSTiK'</li> <li>modeling of an arbitrary cross-section</li> <li>modeling of an arbitrary 2D truss structure incl. loads</li> <li>Teddy: usage of global and local variables</li> <li>design of a concrete section</li> <li>modeling of a T-beam bridge by means of a grillage system</li> <li>modeling and design of a rectangular slab</li> <li>building models</li> </ul>	
Literature	<ul> <li>Vorlesungsunterlagen können im STUDiP heruntergeladen werden</li> <li>Tutorials von SOFiSTiK</li> <li>Rombach G.: Anwendung der Finite - Elemente - Methode im Betonbau. 2. Auflage. Verlag Ernst &amp;.Sohn, Berlin, 2007</li> <li>Rombach G.: Finite-Element Design of Concrete Structures. 2nd edition, ICE Publishing, London, 2011, ISBN 0 7277 32749</li> <li>Rombach G.: EDV-unterstützte Berechnungen im Stahlbetonbau. in: "Stahlbetonbau aktuell 2014" (ed. Gorris A., Hegger J., Mark P.), Berlin 2014 (S. C1C.36)</li> </ul>	

Course L0286: I	ntroduction in Statitics with R
Тур	Lecture
Hrs/wk	1
СР	
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14
Examination Form	Klausur
Examination duration and scale	
	Dr. Joachim Behrendt
Language	
Cycle	
	Introduction to R
	Graphics with R
	Descriptive Statistic (Boxplot, Percentiles, outliers)
	Propability (Combinatorics, relative frequency, dependand probability)
Content	random numbers and distibutions (confidence interval, uniform and discrete distributions, test-distributions (t-F-X²-distribiution))
	Correlation and Regression analysis (Confidence interval of calibration curves, linearity)
	Statistic test procedures (mean value-t-Test, Chi^2-Test, F-Test)
	Analysis of variance (ANOVA, Bartlett-Test, Kruskal-Wallis Rank sum test)
	Introduction time series (tseries)
	Introduction cluster analysis (k-means)
	Regionales Rechenzentrum für Niedersachsen
	Statistik mit R Grundlagen der Datenanalyse , 2013
	Einführung in die Statistik mit R, Andreas Handl, Skript Uni Bielefeld http://www.wiwi.uni-
	bielefeld.de/fileadmin/emeriti/frohn/handl_grundausbildung/statskript.pdf
	und die dazugehörige Aufgabensammlung
	http://www.wiwi.uni- bielefeld.de/fileadmin/emeriti/frohn/handl_grundausbildung/statauf.pdf
Literature	Induktive Statistik [Elektronische Ressource] : eine Einführung mit R und SPSS / Helge von Toutenburg, Helge 2008 http://dx.doi.org/10.1007/978-3-540-77510-2http://dx.doi.org/10.1007/978-3-540-77510-2
	R-Referenzcard: http://cran.r-project.org/doc/contrib/Short-refcard.pdfhttp://cran.r-project.org/doc/contrib/Short-refcard.pdf Grafiken und Statistik in R von Andreas Plank Nachschlage Skript mit Beispielen: http://www.geo.fu-berlin.de/geol/fachrichtungen/pal/mitarbeiter/plank/Formeln_in_R.pdfhttp://www.geo.fu-berlin.de/geol/fachrichtungen/pal/mitarbeiter/plank/Formeln_in_R.pdf

Course L0776: Introduction in Statitics with R	
Тур	Recitation Section (large)
Hrs/wk	1
СР	1
<b>Workload in Hours</b>	Independent Study Time 16, Study Time in Lecture 14
<b>Examination Form</b>	Klausur
Examination duration and scale	siehe Vorlesung
Lecturer	Dr. Joachim Behrendt
Language	DE
Cycle	WiSe
Content	See interlocking course
Literature	See interlocking course

Course L0470: Prin	ciples of Geomatics	
Тур	Lecture	
Hrs/wk	2	
СР	2	
<b>Workload in Hours</b>	Independent Study Time 32, Study Time in Lecture 28	
<b>Examination Form</b>	Schriftliche Ausarbeitung	
Examination duration and scale	schriftliche Ausarbeitungen zu allen fünf Übungen, ggf. Testklausur	
Lecturer	Prof. Peter Andree	
Language	DE	
Cycle	SoSe	
Content	<ul> <li>Overview of geomatics in general</li> <li>Units of measurements</li> <li>Generating of topographical maps</li> <li>Basic surveying instruments and handling</li> <li>Geodetic surveying lines and verification of measurements</li> <li>Methods of horizontal survey</li> <li>Components of geodetic surveying instruments</li> <li>Height determination</li> <li>Setting out points</li> <li>Topographical survey</li> <li>Directions and angles</li> <li>Determination of coordinates</li> <li>Traversing</li> <li>Basics on surveying and positioning with GNSS</li> </ul>	
Literature	Andree, P.: Grundlagen der Geomatik (Skript)  Resnik, B. / Bill, R.: Vermessungskunde für den Planungs- Bau- und Umweltbereich, Wichmann-verlag  Witte, B. / Sparla, P.: Vermessungskunde und Grundlagen der Statistik für das Bauwesen, Wichmann-Verlag  Gruber, F.J. / Joeckel, R.: Formelsammlung für das Vermessungswesen, Vieweg + Teubner-Verlag	

Course L0471: Principles of Geomatics	
Тур	Recitation Section (small)
Hrs/wk	2
СР	2
<b>Workload in Hours</b>	Independent Study Time 32, Study Time in Lecture 28
<b>Examination Form</b>	Schriftliche Ausarbeitung
Examination duration and scale	
Lecturer	Prof. Peter Andree
Language	DE
Cycle	SoSe
Content	See interlocking course
Literature	See interlocking course

Course L0125: Numeric and Matlab	
Тур	Practical Course
Hrs/wk	2
СР	2
<b>Workload in Hours</b>	Independent Study Time 32, Study Time in Lecture 28
<b>Examination Form</b>	Fachtheoretisch-fachpraktische Arbeit
Examination duration and scale	5 Übungsaufgaben jeweils mit Testat am Ende
Lecturer	Prof. Siegfried Rump, Weitere Mitarbeiter
Language	DE
Cycle	SoSe
Content	<ol> <li>Programming in Matlab</li> <li>Numerical methods for systems of nonlinear equations</li> <li>Basics in computer arithmetic</li> <li>Linear and nonlinear optimization</li> <li>Condition of problems and algorithms</li> <li>Verified numerical results with INTLAB</li> </ol>
Literature	Literatur (Software-Teil):  1. Moler, C., Numerical Computing with MATLAB, SIAM, 2004 2. The Math Works, Inc., MATLAB: The Language of Technical Computing, 2007 3. Rump, S. M., INTLAB: Interval Labority, http://www.ti3.tu-harburg.de 4. Highham, D. J.; Highham, N. J., MATLAB Guide, SIAM, 2005

Course L1744: Practical Course in Drinking Water Chemistry		
Тур	Practical Course	
Hrs/wk	1	
СР	2	
<b>Workload in Hours</b>	Independent Study Time 46, Study Time in Lecture 14	
<b>Examination Form</b>	Fachtheoretisch-fachpraktische Arbeit	
Examination duration and scale	6 Versuchsprotokolle	
Lecturer	Dr. Klaus Johannsen	
Language	DE	
Cycle	WiSe	
Content	!Max.12 students!  The students learn basic experimental work in the laboratory. The experiments give an overview about the most important chemical analysis methods of drinking water. This includes sampling, photometric measurement, complexometric titration as well as acid/base titration. The experiments are strongly related to the processes in drinking water treatment and water distribution (e. g. removal of iron and manganese, softening and conditioning). Instrumental analytics is not subject of this practical course.  1. Day: Introduction, safety instructions 2. Day: Electrical conductivity, saturation with respect to calcite, hardness 3. Day: Organic carbon, iron, acid and base neutralization capacity 4. Day: Writing protocols of experiments and presentations 5. Day: Evaluation of the protocols and presentations, final discussion	
Literature	Siehe Skript. See Script.	

Course L1228: Projects II				
Тур	Project Seminar			
Hrs/wk	2			
СР	2			
<b>Workload in Hours</b>	Independent Study Time 32, Study Time in Lecture 28			
<b>Examination Form</b>	Referat			
Examination duration and scale	ca. zehnminütige Präsentation			
Lecturer	Prof. Jürgen Grabe			
Language	DE			
Cycle	SoSe			
Content	Excursions to different construction and enviromental projects.			
Literature	keine			

Course L2411: Special topics of Civil- and Environmental Engineering				
Тур				
Hrs/wk	1			
СР	1			
<b>Workload in Hours</b>	Independent Study Time 16, Study Time in Lecture 14			
<b>Examination Form</b>	laut FSPO			
Examination duration and scale	wird zu Beginn der Lehrveranstaltung festgelegt			
Lecturer	Dozenten des SD B			
Language	DE/EN			
	WiSe/SoSe			
Content	The course occurs only if required. The content is defined at short notice.			
Literature	Die Literatur wird kurzfristig festgelegt.			

Course L2412: Special topics of Civil- and Environmental Engineering 2 LP				
Тур				
Hrs/wk	2			
СР	2			
<b>Workload in Hours</b>	Independent Study Time 32, Study Time in Lecture 28			
<b>Examination Form</b>	laut FSPO			
Examination duration and scale	wird zu Beginn der Lehrveranstaltung festgelegt			
Lecturer	Dozenten des SD B			
Language	DE/EN			
Cycle	WiSe/SoSe			
Content	The course occurs only if required. The content is defined at short notice.			
Literature	Die Literatur wird kurzfristig festgelegt.			

Course L2413: Special topics of Civil- and Environmental Engineering 3LP				
Тур				
Hrs/wk	3			
СР	3			
<b>Workload in Hours</b>	Independent Study Time 48, Study Time in Lecture 42			
<b>Examination Form</b>	laut FSPO			
Examination duration and scale	wird zu Beginn der Lehrveranstaltung festgelegt			
Lecturer	Dozenten des SD B			
Language	DE/EN			
	WiSe/SoSe			
Content	The course occurs only if required. The content is defined at short notice.			
Literature	Die Literatur wird kurzfristig festgelegt.			

Course L0472: Fire	Protection and Prevention
Тур	Lecture
Hrs/wk	2
СР	2
<b>Workload in Hours</b>	Independent Study Time 32, Study Time in Lecture 28
<b>Examination Form</b>	Mündliche Prüfung
Examination duration and scale	
Lecturer	Philipp Below
Language	DE
Cycle	SoSe
Content	<ul> <li>Introduction</li> <li>fire in residential and office buildings</li> <li>town planning: location of residential, office and industry areas, location of fire stations</li> <li>design of roads an water pipes</li> <li>explosions</li> </ul>
Literature	<ul> <li>Schneider U.: Ingenieurmethoden im baulichen Brandschutz. Expert Verlag, 2. Aufl., 2002</li> </ul>

Courses					
		T	I I was founds	CD	
<b>Title</b> Hydrology (L0909)		<b>Typ</b> Lecture	Hrs/wk 1	<b>CP</b> 1	
Hydrology (L0956)		Project-/problem-	1	1	
Hydromechanics (L061	5)	based Learning Lecture	2	2	
Hydromechanics (L061		Project-/problem- based Learning	1	2	
Module Responsible	Prof. Peter Fröhle	based Learning			
Admission Requirements	None				
Recommended	Mathematics I, II and III				
Previous Knowledge	Mechanics I und II				
Educational Objectives	After taking part successfully, s	tudents have reached the fo	ollowing learn	ning results	
Professional Competence					
Knowledge	The students are able to define the basic terms of hydromechanics, hydrology groundwater hydrology and water management. They are able to derive the basic formulations of i) hydrostatics, ii) kinematics of flows and iii) conservation laws and to describe and quantify the relevant processes of the hydrological water cycle Besides, the students can describe the main aspects of rainfall-run-off-modelling and of established reservoir / storage models as well as the concepts of the determination of a unit-hydrograph.				
Skills	The students are able to apply the fundamental formulations of hydromechanics to basic practical problems. Furthermore, they are able to run, explain and documen 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 peel learning approaches. Furthermore, they are able to prepare and present technical presentations for given topics in groups.				
Autonomy	Students are capable of organising their individual work flow to contribute to the conduct of experiments and to present discipline-specific knowledge. They car provide each other with feedback and suggestions on their results. They are capable of reflecting their study techniques and learning strategy on an individua basis.				
Workload in Hours	Independent Study Time 110, S	Study Time in Lecture 70			
Credit points					
Course					

Examination	Written exam
Examination duration and scale	120 minutes
the Following	General Engineering Science (German program, 7 semester): Specialisation Civil Engineering: Compulsory Civil- and Environmental Engineering: Core qualification: Compulsory General Engineering Science (English program, 7 semester): Specialisation Civil Engineering: Compulsory

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

Course L0956: Hyd	rology
Тур	Project-/problem-based Learning
Hrs/wk	1
СР	1
<b>Workload in Hours</b>	Independent Study Time 16, Study Time in Lecture 14
Lecturer	Prof. Peter Fröhle
Language	DE
Cycle	WiSe
Content	<ul> <li>Introduction to basics of Hydrology:</li> <li>Hydrological cycle</li> <li>Data acquisition</li> <li>Data analyses and statistical assessment</li> <li>Statistics of extremes</li> <li>Regionalization methods for hydrological values</li> </ul> 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: Hyd	romechanics
Тур	Lecture
Hrs/wk	2
СР	2
<b>Workload in Hours</b>	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Prof. Peter Fröhle
Language	DE
Cycle	WiSe
Content	<ul> <li>Characteristics of fluids</li> <li>Hydrostatics</li> <li>Kinematics of flows, laminar and turbulent flows</li> <li>Conservation laws         <ul> <li>Conservation of mass</li> <li>Conservation of Energy</li> <li>Momentum Equation</li> </ul> </li> <li>Application of conservation laws to flow conditions</li> </ul>
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	2		
<b>Workload in Hours</b>	Independent Study Time 46, Study Time in Lecture 14		
Lecturer	Prof. Peter Fröhle		
Language	DE		
Cycle	WiSe		
Content	See interlocking course		
Literature	See interlocking course		

Module M075	5: Geotechnics II				
Courses					
<b>Title</b> Foundation Engineerin	g (L0552)	<b>Typ</b> Lecture	2		<b>CP</b> 2
Foundation Engineerin	g (L0553)	Recitation (large)	Section 2		2
Foundation Engineerin	g (L1494)	Recitation (small)	Section 2		2
Module Responsible	Prof. Jürgen Grabe				
Admission Requirements	None				
Recommended Previous Knowledge	Geotechnics I				
Educational Objectives	After taking part successfully, students	have reached	the followi	ing learn	ing results
Professional Competence					
Knowledge	The students know the basic principles and methods which are required to verificate the stability of geotechnical structures.  After successful completion of the module the students are able to:				
Skills	<ul> <li>verificate the stability and usability of foundations,</li> <li>know individual methods of ground improvement and apply them in their range of application,</li> <li>design retaining walls.</li> </ul>				
Personal					
Competence	1 1				
Social Competence					
Autonomy					
	Independent Study Time 96, Study Time	e in Lecture 84	<del>!</del>		<u> </u>
Credit points	! 				
achievement	CompulsorBonusFormNo20 %Attestation	•	Descriptio	on 	
	Written exam				
Examination duration and scale					
the Following	General Engineering Science (German Engineering: Elective Compulsory General Engineering Science (German Engineering: Elective Compulsory Civil- and Environmental Engineering: Scivil- and Environmental Engineering: Scivil- and Environmental Engineering: Compulsory Civil- and Environmental Engineering: Compulsory Civil- and Environmental Engineering Elective Compulsory General Engineering Science (English Engineering: Elective Compulsory Technomathematics: Specialisation III. I	program, 7 some qualification of the pecialisation of the pecialisation of the program, 7 some	semester): on: Compu Civil Engine Traffic an ion Water semester):	Special Ilsory Pering: C and Mobili and E Special	isation Civil ompulsory ity: Elective nvironment: isation Civil

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

Course L0553: Fou	Course L0553: Foundation Engineering		
Typ Recitation Section (large)			
Hrs/wk	2		
СР	2		
<b>Workload in Hours</b>	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: Fou	Course L1494: Foundation Engineering		
Тур	Recitation Section (small)		
Hrs/wk	2		
СР	2		
<b>Workload in Hours</b>	Independent Study Time 32, Study Time in Lecture 28		
Lecturer	Prof. Jürgen Grabe		
Language	DE		
Cycle	WiSe/SoSe		
Content	See interlocking course		
Literature	See interlocking course		

Courses										
Title							Typ		Urc/wk	CD
	sian (I	0200)					<b>Typ</b> Project-/prol	blem-	Hrs/wk 2	<b>CP</b> 4
Basics in Structural Design (L0209) Basics of Structural Design (L0205)					based Learr Lecture	ing	2	1		
Basics of Structural De		•					Recitation	Section	_	1
Dasies III Structural De	isigii (L	0200)					(large)		•	
Module Responsible	1110111	as Kölze	er							
Admission Requirements										
Recommended Previous Knowledge	Conte	ents of m	nodule	"Princip	oles of Bu	uilding	Materials a	and Buildi	ng Physics	5"
Educational Objectives	After	taking p	art suc	cessful	ly, stude	nts ha	ve reached	the follo	wing learn	ing results
Professional Competence	After •	to defin	ne the ain loa	basics o	of buildin as and as	g regu sociat	" module s ulations law ed concept	l :S		
Knowledge	•	to spec to dist risks d to expl	cify typ inguish ue to la ain the	ical buil betwe ack of st main o	lding cor en differ tability objectivs	npone ent po of fire	ossibilities control.	of load b	earing be	
Skills	be ab	to appl carry o develo use Bl	ly indus out prel p stabi M softv o desig	stry-spe iminary lity and vare	ecific drav dimensi foundat	wing c oning ion co	onventions of basic buncepts	s uilding cor	mponents	
Personal Competence		!!								
Social Competence	•	to worl	c in a to the fee	eam and	from oth	ent the	e results of dents to im s in a cons	prove the	own resu	lts
Autonomy	•	to cor presen to divi	ntrol a tations de the	and im (lectur main to	e room)	heir and te	knowledge sts (STUD. t parts, to	IP)		
M -    !	Inden	endent	Study 7	Time 11	0. Study	Time	in Lecture	70		
Workload in Hours	шаер	criaciic			, ,					

achievement	
Examination	Subject theoretical and practical work
Examination duration and scale	Desing, Construction and prelimnary design in a written form
the Following	General Engineering Science (German program, 7 semester): Specialisation Civil Engineering: Compulsory Civil- and Environmental Engineering: Core qualification: Compulsory General Engineering Science (English program, 7 semester): Specialisation Civil Engineering: Compulsory

Course L0209: Basics in Structural Design				
Тур	Project-/problem-based Learning			
Hrs/wk	2			
СР	4			
Workload in Hours	Independent Study Time 92, Study Time in Lecture 28			
Lecturer	Thomas Kölzer			
Language	DE			
Cycle	WiSe			
Content	<ul> <li>Constructing a small individuell building in groups of 4 persons</li> <li>Analysing the informations and the contents of development plans and building regulation laws</li> <li>Design of building components and approving of the funcionality (sealing, facades, roofs)</li> <li>Design and approve of the funcionality of the component interconnections</li> <li>Proofing and assessing of moisture behaviour, energy comsumption, acoustic protection and fire control</li> <li>Assessing the building stabilty</li> <li>Basics of building services</li> <li>Each week the results of different work steps are presented in oral and written form</li> </ul>			
	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			
	<b>Dierks, Klaus</b> (Wormuth, Rüdiger.) Baukonstruktion: [Einführung, Grundlagen, Gründungen, technische Ausrüstung, Wände, Geschossdecken, Treppen, Dächer, Fenster, Türen, Konstruktionsatlas] ISBN: 3804150454 (Gb.) ISBN: 978-3-8041-5045-4 Neuwied: Werner, 2007			
Literature	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			
	[00]			

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

Course L0208: Basics in Structural Design	
Тур	Recitation Section (large)
Hrs/wk	1
СР	1
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14

Lecturer	Thomas Kölzer
Language	DE
Cycle	WiSe
Content	<ul> <li>Constructing a small individuell building in groups of 4 persons</li> <li>Analysing the informations and the contents of development plans and building regulation laws</li> <li>Design of building components and approving of the funcionality (sealing, facades, roofs)</li> <li>Design and approve of the funcionality of the component interconnections</li> <li>Proofing and assessing of moisture behaviour, energy comsumption, acoustic protection and fire control</li> <li>Assessing the building stabilty</li> <li>Basics of building services</li> <li>Each week the results of different work steps are presented in oral and written form</li> </ul>
Literature	Verfügung  Neumann, Dietrich (Hestermann, Ulf.; Rongen, Ludwig.; Weinbrenner, Ulrich) Frick/Knöll Baukonstructionslehre 1 / [Internet-Ressource] ISBN: 978-3-8351-9121-1 Wiesbaden: B.G. Teubner Verlag / GWV Fachverlage GmbH, Wiesbaden, 2006  Frick[Begr.], Otto (Knöll[Begr.], Karl.; Neumann, Dietrich.; Hestermann, Ulf.; Rongen, Ludwig.) Baukonstruktionslehre 2 / [Internet-Ressource] ISBN: 978-3-8348-9486-1 Wiesbaden: Vieweg+Teubner Verlag / GWV Fachverlage GmbH, Wiesbaden, 2008  Dierks, Klaus (Wormuth, Rüdiger.) Baukonstruktion: [Einführung, Grundlagen, Gründungen, technische Ausrüstung, Wände, Geschossdecken, Treppen, Dächer, Fenster, Türen, Konstruktionsatlas] ISBN: 3804150454 (Gb.) ISBN: 978-3-8041-5045-4 Neuwied: Werner, 2007  Schneider, Klaus-Jürgen (Goris, Alfons.; Berner, Klaus) Bautabellen für Ingenieure: mit Berechnungshinweisen und Beispielen; [auf CD-ROM: Stabwerksprogramm IQ 100 B, Tools für den konstr. Ingenieurbau, Fachinformationen, Normentexte] ISBN: 3804152287  Neuwied: Werner, 2006  Wendehorst, Reinhard (Wetzell, Otto W.,; Baumgartner, Herwig,; Deutsches Institut für Normung) Wendehorst Bautechnische Zahlentafeln ISBN: 978-3-8351-0055-8 ISBN: 3835100556  Stuttgart [u.a.]: Teubner Berlin [u.a.]: Beuth, 2007  Neufert, Ernst (Kister, Johannes) Bauentwurfslehre: Grundlagen, Normen, Vorschriften über Anlage, Bau, Gestaltung, Raumbedarf, Raumbeziehungen, Maße 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

Module M063	1: Reinforced Co	oncrete Struc	ctures II		
Courses					
<b>Title</b> Project Concrete Struc	tures II (I 0894)		<b>Typ</b> Project Seminar	Hrs/wk 1	<b>CP</b> 1
Concrete Structures II			Lecture	2	3
Concrete Structures II	(L0349)		Recitation Se (large)	ection 2	2
Module Responsible	Prof. Günter Rombach				
Admission Requirements	None				
Recommended Previous Knowledge	Knowledge in de     Modules: Reinfo     I+II	format are require esign of beams and	ed. d columns for ulti	mate limit stat	
Educational Objectives		ssfully, students h	ave reached the	following learn	ing results
Professional Competence					
-	The students know the concrete structures. The in simple one and two-	ney know the vario			
Skills		nding, torsion) and ol) including detail n estimate the me	d in the servicea ing (anchorage a mber forces of si	bility limit state nd links etc.). mple slabs.	e (crack and
Personal					
Competence	:	an company code			aka lessil e
Social Competence	Cooperation in a project and present the results		ey design in a tea	ım a real concr	ete building
Autonomy Workload in Hours	Indopondent Study Tim	an 110 Study Time	o in Locture 70		
Credit points	Independent Study Tin	ie 110, Study Time	e iii Lecture 70		
-	CompulsorBonus	Form	Desc	ription	
achievement		Excercises	Desi	pc.011	
Examination	Written exam				
Examination duration and scale					
Assignment for the Following		Compulsory Science (German Compulsory al Engineering: Co	program, 7 sem	ester): Special	isation Civil

Curricula	Civil- and Environmental Engineering: Specialisation Traffic and Mobility: Elective
	Compulsory
	Civil- and Environmental Engineering: Specialisation Water and Environment:
	Elective Compulsory
	General Engineering Science (English program, 7 semester): Specialisation Civil
	Engineering: Elective Compulsory

Course L0894: Proj	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	Björn Schütte		
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					
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>				

Course L0349: Concrete Structures II	
Тур	Recitation Section (large)
Hrs/wk	2
СР	2
<b>Workload in Hours</b>	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 M0628	8: Water Management			
Courses				
<b>Title</b> Groundwater Hydrolog	y (L0251)	<b>Typ</b> Lecture	Hrs/v	vk <b>CP</b>
Groundwater Hydrolog	y (L0252)	Recitation (large)	Section 1	2
Water Management ar	nd Water Quality (L0366)	Lecture	2	3
Module Responsible	NN			
Admission Requirements	None			
Recommended Previous Knowledge	Mathemaics I to III; Water Engine	ering I, Chemistry		
Educational Objectives	After taking part successfully, stu	dents have reached th	ne following le	earning results
Professional Competence				
Knowledge	Students are able to define terms of the hydrologic cycle and also parameters to identify the water quality. Typical aquifer types and the occuring flow and storage processes can be explained technically. They are able to derive the Darcy law and the mathematical description of flow processes as well as their solution. They are in a position to explain the physical background of well hydraulics. Fundamentals of solute transport can be reflected.			
Skills	Students are able to use fundamental relationships of hydrology and water management for the solution of practical issues. They are in a position to rate water quality data and to set up hydrological water balances. They are able to construct ground water contour lines and streamlines on the basis of head data. They have the ability to analyse data of hydraulic field and lab tests to determine hydraulic conductivities and storage coefficients.			
Personal				
Competence		har calving casa studi		
-	Students are able to help each ot Are not imparted in this module.	ner solving case studi	<b>E</b> 5.	
	Independent Study Time 124, Stu	udv Time in Lecture 56		
Credit points	· · · · · · · · · · · · · · · · · · ·	,		
Course achievement	None			
Examination	Written exam			
Examination duration and scale				
the Following	General Engineering Science (G Engineering: Elective Compulsory Civil- and Environmental Enginee General Engineering Science (E Engineering: Elective Compulsory	, ring: Core qualificatior nglish program, 7 se	n: Compulsory	/

Course L0251: Groundwater Hydrology		
Тур	Lecture	
Hrs/wk	1	
СР	1	
<b>Workload in Hours</b>	Independent Study Time 16, Study Time in Lecture 14	
Lecturer	Prof. Wilfried Schneider	
Language	DE	
Cycle	WiSe	
Content	Hydrologic water bilance, aquifertyps, groundwater velocities, Darcy law, groundwater contour lines, storage capacity, flow equation, pumping tests, method of Beyer, solute transport in groundwater	
Literature	Todd; K. (2005): Groundwater Hydrology  Fetter, C.W. (2001): Applied Hydrogeology  Hölting & Coldewey (2005): Hydrogeologie  Charbeneau, R.J. (2000): Groundwater Hydraulics and pollutant Transport	

Course L0252: Groundwater Hydrology	
Тур	Recitation Section (large)
Hrs/wk	1
СР	2
<b>Workload in Hours</b>	Independent Study Time 46, Study Time in Lecture 14
Lecturer	Prof. Wilfried Schneider
Language	DE
Cycle	WiSe
Content	See interlocking course
Literature	See interlocking course

Course L0366: Wat	er Management and Water Quality
Тур	Lecture
Hrs/wk	2
СР	3
<b>Workload in Hours</b>	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Prof. Mathias Ernst
Language	DE
Cycle	WiSe
Content	<ul> <li>The lecture water Management and water quality provides knowledge on the local and global water cycle. Content overview:</li> <li>Water balance, water availability, water scarcity, water recycling</li> <li>Water quality parameter (organic, inorganic), assessment and decision support tools.</li> </ul>
Literature	<ul> <li>Teil Wasserwirtschaft:</li> <li>Wasserwirtschaft, Maniak, Ulrich., Berlin [u.a.]: Springer, 2001</li> <li>Wasser; Grohmann, Andreas N Berlin [u.a.]: de Gruyter, 2011</li> <li>Pdf der Vorlesung</li> </ul>

Module M0829	9: Foundations of Manage	ement		
Courses				
<b>Title</b> Management Tutorial (		<b>Typ</b> Recitation (small)	Hrs/wk Section 2	<b>CP</b> 3
Introduction to Manage		Lecture	3	3
Admission Requirements	INONE			
Recommended Previous Knowledge	Basic Knowledge of Mathematics and	Business		
Educational Objectives	I ATTOR TOKING NOTE CHARACTURING CTURES	ts have reached	the following learn	ing results
Professional Competence				
Knowledge	<ul> <li>describe and explain basic be and sourcing, supply chain may management, information or marketing</li> <li>explain the relevance of plan situations under multiple object methods from mathematical Features</li> <li>state basics from accounting and</li> </ul>	ent and Controllicent and Controllicent and Controllicent and Controllicent and to name impossible and go entreprneurial pusiness functions anagement, organagement, ir ning and decision ctives and uncertinance and costing and s	and Organisation to ing. In particular the and Management a rtant definitions from pals in Managemen rojects is as production, particular in making and human annovation management on making in Busing tainty, and explain	no Marketing ney are able and the sub- om the field at and name procurement and ressource ement and ness, esp. in a some basic methods.
Skills	Students are able to analyse busi (organization, objectives, strategies project in a team. In particular, they a	etc.) and to care able to  d structure them  ff structures of care  making under  curement system  ods of marketing  ods from mathe	arry out an Entre appropriately ompanies r multiple objecti ms and Business matical finance to	epreneurship ives, under information o predefined
Personal Competence	Students are able to	students		
	<ul> <li>work successfully in a team of</li> <li>to apply their knowledge from</li> </ul>		າ entrepreneurship	project and
	[00]			

Social Competence	write a coherent report on the project  to communicate appropriately and  to cooperate respectfully with their fellow students.
Autonomy	<ul> <li>Students are able to</li> <li>work in a team and to organize the team themselves</li> <li>to write a report on their project.</li> </ul>
<b>Workload in Hours</b>	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	several written exams during the semester
the Following	General Engineering Science (German program, 7 semester): Core qualification: Compulsory Civil- and Environmental Engineering: Core qualification: Compulsory Civil- and Environmental Engineering: Specialisation Civil Engineering: Elective Compulsory Civil- and Environmental Engineering: Specialisation Water and Environment: Elective Compulsory Civil- and Environmental Engineering: Specialisation Traffic and Mobility: Elective Compulsory Computer Science: Core qualification: Compulsory Bioprocess Engineering: Core qualification: Compulsory Computer Science: Core qualification: Compulsory Data Science: Core qualification: Compulsory Electrical Engineering: Core qualification: Compulsory Energy and Environmental Engineering: Core qualification: Compulsory General Engineering Science (English program, 7 semester): Specialisation Electrical Engineering: Compulsory General Engineering Science (English program, 7 semester): Specialisation Civil Engineering: Compulsory General Engineering Science (English program, 7 semester): Specialisation Bioprocess Engineering: Compulsory General Engineering Science (English program, 7 semester): Specialisation Energy and Environmental Engineering: Compulsory General Engineering Science (English program, 7 semester): Specialisation Computer Science: Compulsory General Engineering Science (English program, 7 semester): Specialisation Mechanical Engineering Science (English program, 7 semester): Specialisation Mechanical Engineering Science (English program, 7 semester): Specialisation Mechanical Engineering, Focus Biomechanics: Compulsory General Engineering Science (English program, 7 semester): Specialisation Mechanical Engineering, Focus Materials in Engineering; Compulsory General Engineering Science (English program, 7 semester): Specialisation Mechanical Engineering, Focus Methanical Engineering; Compulsory General Engineering Science (English program, 7 semester): Specialisation Mechanical Engineering, Focus Mechatronics: Compulsory General Engineering Science (English progra

Mechatronics: Core qualification: Compulsory

Orientierungsstudium: Core qualification: Elective Compulsory

Naval Architecture: Core qualification: Compulsory Technomathematics: Core qualification: Compulsory Process Engineering: Core qualification: Compulsory

Course L0882: Management Tutorial		
Тур	Recitation Section (small)	
Hrs/wk	2	
СР	3	
<b>Workload in Hours</b>	Independent Study Time 62, Study Time in Lecture 28	
Lecturer	Prof. Christoph Ihl, Katharina Roedelius, Tobias Vlcek	
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 self-selected projects that focus on the elaboration of an innovative business idea from the point of view of an established company or a startup. Again, the business knowledge from the lecture should come to practical use. The group projects are guided by a mentor.	
Literature	Relevante Literatur aus der korrespondierenden Vorlesung.	

Course L0880: Intr	oduction to Management
	Lecture
Hrs/wk	
СР	3
Workload in Hours	Independent Study Time 48, Study Time in Lecture 42
	Prof. Christoph Ihl, Prof. Thorsten Blecker, Prof. Christian Lüthje, Prof. Christian Ringle, Prof. Kathrin Fischer, Prof. Cornelius Herstatt, Prof. Wolfgang Kersten, Prof. Matthias Meyer, Prof. Thomas Wrona
Language	DE
Cycle	WiSe/SoSe
Content	<ul> <li>Introduction to Business and Management, Business versus Economics, relevant areas in Business and Management</li> <li>Important definitions from Management,</li> <li>Developing Objectives for Business, and their relation to important Business functions</li> <li>Business Functions: Functions of the Value Chain, e.g. Production and Procurement, Supply Chain Management, Innovation Management, Marketing and Sales 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 M068	6: Sanitary Engineering I			
Courses				
Title Wastewater Disposal (		<b>Typ</b> Lecture Recitation	Hrs/wk 2 Section 1	<b>CP</b> 2
Wastewater Disposal (		(large)	2	1
Drinking Water Supply		Lecture Recitation	Section <sub>1</sub>	1
Drinking Water Supply	(LU3U8)	(large)	1	2
Admission Requirements				
Recommended Previous Knowledge	Hydraulics of pipe systems and     Basic knowledge on water man	l open channels nagement: water		
Educational Objectives		ts have reached	the following learn	ing results
Professional Competence				
Knowledge	The students can examplify their exp. They can present the derivation and the design of drinking water supply and they are capable of reproduci scientific simplifications. The studen engineering processes and the tect treatment. They can also assess engineering by considering legal, rishow to draft the features and effective such as high- and low-pressure memoral of trace pollutants.	detailed explana and wastewater ng the relevants ts are able to hnologies used existing proble k and saftey as veness of import	tion of important soldisposal systems to empiricals assurpresent and discussion for drinking and tems in the field pects. Furthermore tant technologies of	tandards for in Germany nptions and uss sanitary wastewater of sanitary , they know of the future
Skills	The students are able to apply the reand operation of urban water in comprises expert skills to design drin as well as the associated treatment skills the students are able to address drinking water and wastewater treatideas of their own to improve the eand concepts.	frastructures in king water supp facilities. Beside s and solve biocl tment. The stud	dependently. Thei ly and urban drain s the acquirement nemical problems in lents are also able	r expertise age systems of technical the filed of the to develop
Personal Competence Social Competence	Social skills are not targeted in this m	odule.		
Autonomy	Students are able to form concering infrastructure processes. Therefore the being given some clues or informate (preparation and follow-up of the exe	hey can acquire ion with regard	e appropriate know	ledge when

<b>Workload in Hours</b>	Independent Study Time 96, Study Time in Lecture 84
Credit points	6
Course achievement	None
Examination	Written exam
Examination duration and scale	120 min
Assignment for the Following Curricula	Civil- and Environmental Engineering: Core qualification: Compulsory  Civil- and Environmental Engineering: Core qualification: Compulsory

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

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

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

Course L0308: Drinking Water Supply	
Тур	Recitation Section (large)
Hrs/wk	1
СР	2
<b>Workload in Hours</b>	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

Courses				
Title		Тур	Hrs/wk	СР
Hydraulics (L0957)		Lecture	1	1
Hydraulics (L0958)		Project-/problem- based Learning	1	1
Hydraulic Engineering	(L0959)	Lecture	2	2
Hydraulic Engineering	(L0960)	Project-/problem- based Learning	1	2
Module Responsible	Prof. Peter Fröhle			
Admission Requirements	None			
Recommended Previous Knowledge	Hydraulic Engineering I			
Educational Objectives				
Professional Competence				
Knowledge	Students are able to define the basic terms of hydraulic engineering and hydraulics. They are able to explain the application of basic hydrodynamic formulations (conservation laws) to practical hydraulic engineering problems. Besides this, the students can illustrate important tasks of hydraulic engineering and give an overview over river engineering, flood protection, hydraulic power engineering and waterways engineering.			
Skills	The students are able to apply hydraulic engineering methods and approaches to basic practical problems and design respective hydraulic engineering systems. Besides this, they are able to use and apply established approaches of hydraulics and determine water surfaces of channel flows, influences of constructions (weirs etc.) on channel flows as well as flow conditions of pipe system. Furthermore, they are able to run, explain and document basic hydraulic experiments.			
Personal				
Competence				
Social Competence	The students are able to deploy their gained knowledge in applied problems Additionaly, they will be able to work in team with engineers of other disciplines in goal-orientated, structured manner. They can explain their results by use of peelearning approaches.			
Autonomy	The students will be able to independently extend their knowledge and apply it to new problems. Furthermore, they are capable of organising their individual work flow to contribute to the conduct of experiments and to present discipline-specific knowledge.			
Workload in Hours	Independent Study Time 110, Stud	ly Time in Lecture 70		
Credit points				
Course achievement	INONE			
Examination	Written exam			
Examination duration and scale	The duration of the examination is 2 hours. The examination includes tasks with			
Assignment for	General Engineering Science (Ge Engineering: Elective Compulsory Civil- and Environmental Engineeri Civil- and Environmental Engineeri	ng: Core qualification: C	Compulsory	lisation Civ

**Curricula** General Engineering Science (English program, 7 semester): Specialisation Civil Engineering: Elective Compulsory

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

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

Course L0959: Hyd	raulic Engineering
Тур	Lecture
Hrs/wk	2
СР	2
<b>Workload in Hours</b>	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Prof. Peter Fröhle
Language	DE
Cycle	WiSe/SoSe
Content	<ul> <li>Inland waterways engineering</li> <li>waterways</li> <li>Locks and ship lifts</li> <li>Fish passages</li> <li>Nature-oriented hydraulic engineering</li> </ul>
Literature	Strobl, T. & Zunic, F: Wasserbau, Springer 2006  Patt, H. & Gonsowski, P: Wasserbau, Springer 2011

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

# **Specialization Bioprocess Engineering**

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

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

Module M0886: Fundamentals of Process Engineering and Material Engineering				
Courses				
<b>Title</b> Introduction into Process (L0829) Fundamentals of materia	Engineering/Bioprocess Engineering	<b>Typ</b> Lecture Lecture	<b>Hrs/wk</b> 2 2	<b>CP</b> 1 2
Module Responsible	rof. Michael Schlüter			
Admission Requirements	one			
Recommended Previous no Knowledge	one			
Educational Objectives	fter taking part successfully, students	s have reached th	ne following learr	ing results
Professional Competence A: Knowledge	After passing this module the students have the ability to:  • give an overview of the most important fields on process and bioprocess engineering,  • explain some working methods for different fields in process engineering.			
Skills	<ul> <li>list and outline the most importate</li> <li>name the most important work fields of process engineering,</li> <li>read and prepare an engineerine</li> <li>explain the most important to treatment</li> <li>scheme typical chemical and be</li> </ul>	ant fields of proce king approaches g drawing, echnologies for v	ess engineering, or methods of t wastewater and	exhaust ai

	the aid of pointers.
Personal Competence Social Competence	The students are able to  work out results in groups and document them, provide appropriate feedback and handle feedback on their own performance constructively.
Autonomy	The students are able to estimate their progress of learning by themselves and to deliberate their lack of knowledge in Process Engineering and Bioprocess Engineering.
Workload in Hours	Independent Study Time 34, Study Time in Lecture 56
Credit points	3
	CompulsorBonus Form Description
achievement	No 5 % Written elaboration
-	No 5 % Written elaboration Written exam
-	Written exam 90 min

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

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

Module M0730	0: Computer Engineeri	ng		
Courses				
<b>Title</b> Computer Engineering Computer Engineering		<b>Typ</b> Lecture Recitation	Hrs/wk 3 Section 1	<b>CP</b> 4
		(small)		
пезропзівіє	Prof. Heiko Falk			
Admission Requirements	None			
Recommended Previous Knowledge	Basic knowledge in electrical en	gineering		
Educational Objectives	LATTOR TAKING NATT CHECKDECTHIN CT	udents have reached t	he following learn	ing results
Professional Competence				
Knowledge	<ul> <li>This module deals with the foundations of the functionality of computing systems. It covers the layers from the assembly-level programming down to gates. The module includes the following topics: <ul> <li>Introduction</li> <li>Combinational logic: Gates, Boolean algebra, Boolean functions, hardware synthesis, combinational networks</li> <li>Sequential logic: Flip-flops, automata, systematic hardware design</li> <li>Technological foundations</li> <li>Computer arithmetic: Integer addition, subtraction, multiplication and division</li> <li>Basics of computer architecture: Programming models, MIPS single-cycle architecture, pipelining</li> <li>Memories: Memory hierarchies, SRAM, DRAM, caches</li> <li>Input/output: I/O from the perspective of the CPU, principles of passing data, point-to-point connections, busses</li> </ul> </li></ul>			
Skills	The students perceive computer identify the internal structure at the students can analyze, how hased on a collection of few and between and to explain the systems - from gates and circuit. After successful completion of interdependencies between a plon it. In particular, they shall usoftware has on the hardwallanguage down to gates. This we these low abstraction levels hardwall propose feasible options.	and the physical compliant in the physical components. It is simple components. It is up to complete process the module, the study is computer system of the consequence of the module is the consequence of the physical computer system of of the physical computer sy	osition of computers vidual computers. They are able to ayers of today's essors.  dents are able to m and the softwa uences that the layers from the d to evaluate the	ter systems. can be built distinguish computing judge the are executed execution of e assembly impact that
Personal Competence		ar problems alone or i	n a group and to	present the
Autonomy	Students are able to acquire associate this knowledge with ot		n specific literat	cure and to
Workload in Hours	Independent Study Time 124, St	udy Time in Lecture 56	5	
Credit points	!			

	CompulsorBonus	Form	Description
achievement	Yes 10 %	Excercises	
Examination	Written exam		
Examination duration and scale	90 minutes, contents of	course and labs	
the Following	Computer Science: Com General Engineering Bioprocess Engineering General Engineering Sc Architecture: Compulso General Engineering Electrical Engineering Electrical Engineering General Engineering Biomedical Engineering General Engineering General Engineering General Engineering General Engineering General Engineering General Engineering Mechanical Engineering General Engineering Mechanical Engineering General Engineering Sengineering: Compulso Computer Science: Core Data Science: Core qua Electrical Engineering General Engineering General Engineering General Engineering Mechanical Engineering Mechanical Engineering General Engineering Mechanical Engineering	spulsory Science (German Compulsory Science (German pro- ry Science (German pro- ry Science (German Compulsory Science (German Compulsory Science (German prog- receive (German prog- receive (German prog- ry Science (German prog- ry Science (German receive (German receiv	program, 7 semester): Specialisation Process program, 7 semester): Specialisation Civil program, 7 semester): Specialisation Energy program, 7 semester): Specialisation
!		[114]	

General Engineering Science (English program, 7 semester): Specialisation Mechanical Engineering, Focus Theoretical Mechanical Engineering: Compulsory General Engineering Science (English program, 7 semester): Specialisation Naval Architecture: Compulsory General Engineering Science (English program, 7 semester): Specialisation Process Engineering: Compulsory General Engineering Science (English program, 7 semester): Specialisation Biomedical Engineering: Compulsory Computational Science and Engineering: Core qualification: Compulsory Mechatronics: Core qualification: Compulsory Technomathematics: Specialisation II. Informatics: Elective Compulsory

Course L0321: Com	puter Engineering
Тур	Lecture
Hrs/wk	3
СР	4
<b>Workload in Hours</b>	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
<b>Workload in Hours</b>	Independent Study Time 46, Study Time in Lecture 14
Lecturer	Prof. Heiko Falk
Language	DE/EN
Cycle	WiSe
Content	See interlocking course
Literature	See interlocking course

Courses				
Title		Тур	Hrs/wk	СР
Biochemistry (L0351)		Lecture	2	2
Biochemistry (L0728)		Project-/problem- based Learning	1	1
Microbiology (L0881)		Lecture	2	2
Microbiology (L0888)		Project-/problem- based Learning	1	1
Module Responsible				
Admission Requirements	INONA			
Recommended Previous Knowledge	none			
Educational Objectives		dents have reached the fo	ollowing learn	ing results
Professional Competence				
	At the end of this module the stud	lents can:		
	- explain the methods of biological and biochemical research to determine the properties of biomolecules			
	- name the basic components of a	living organism		
Knowledge	- explain the principles of metabo	ism		
	- describe the structure of living c	ells		
	-			
Skills				
Personal Competence				
	The students are able,			
	- to gather knowledge in groups o	f about 10 students		
Social Competence	- to introduce their own knowledg	e and to argue their view	in discussion	s in teams
- to divide a complex task into subtasks, solve these and to present the results				
Autonomy	The students are able to present t	he results of their subtas	ks in a writte	n report
Workload in Hours	Independent Study Time 96, Stud	y Time in Lecture 84		
Credit points	6			
Course achievement				
Examination	Written exam			
Examination duration and				

Assignment for Bioprocess Engineering: Compulsory Bioprocess Engineering: Core qualification: Compulsory

the Following
General Engineering Science (English program, 7 semester): Specialisation

Curricula Bioprocess Engineering: Compulsory

Orientierungsstudium: Core qualification: Elective Compulsory

Technomathematics: Specialisation III. Engineering Science: Élective Compulsory

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

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

Course L0881: Mici	obiology
Тур	Lecture
Hrs/wk	2
СР	2
<b>Workload in Hours</b>	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Dr. Christian Schäfers
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	<ul> <li>Allgemeine Mikrobiologie, 8. Aufl., 2007, Fuchs, G. (Hrsg.), Thieme Verlag (54,95 €)</li> <li>Mikrobiologie, 13 Aufl., 2013, Madigan, M., Martinko, J. M., Stahl, D. A., Clark, D. P. (Hrsg.), ehemals "Brock", Pearson Verlag (89,95 €)</li> <li>Taschenlehrbuch Biologie Mikrobiologie, 2008, Munk, K. (Hrsg.), Thieme Verlag</li> <li>Grundlagen der Mikrobiologie, 4. Aufl., 2010, Cypionka, H., Springer Verlag (29,95 €), http://www.grundlagen-der-mikrobiologie.icbm.de/</li> </ul>

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

Module M0938	3: Bioprocess Engineering -	Fundamentals		
Courses				
Title		Тур	Hrs/wk	СР
	g - Fundamentals (L0841)	Lecture	2	3
Bioprocess Engineering	g- Fundamentals (L0842)	Recitation Section (large)	12	1
Bioprocess Engineering	g - Fundamental Practical Course (L0843)	Practical Course	2	2
Module Responsible	Prof. Andreas Liese			
Admission Requirements	None			
Knowledge	none, module "organic chemistry", modu			
Educational Objectives	After taking part successfully, students h	nave reached the follo	wing learn	ing results
Professional Competence				
Knowledge	Students are able to describe the basic concepts of bioprocess engineering. They are able to classify different types of kinetics for enzymes and microorganisms, as well as to differentiate different types of inhibition. The parameters of stoichiometry and rheology can be named and mass transport processes in bioreactors can be explained. The students are capable to explain fundamental bioprocess management, sterilization technology and downstream processing in detail.			
Skills	<ul> <li>After successful completion of this module, students should be able to</li> <li>describe different kinetic approaches for growth and substrate-uptake and to calculate the corresponding parameters</li> <li>predict qualitatively the influence of energy generation, regeneration of redox equivalents and growth inhibition on the fermentation process</li> <li>analyze bioprocesses on basis of stoichiometry and to set up / solve metabolic flux equations</li> <li>distinguish between scale-up criteria for different bioreactors and bioprocesses (anaerobic, aerobic as well as microaerobic) to compare them as well as to apply them to current biotechnical problem</li> <li>propose solutions to complicated biotechnological problems and to deduce the corresponding models</li> <li>to explore new knowledge resources and to apply the newly gained contents</li> <li>identify scientific problems with concrete industrial use and to formulate solutions.</li> <li>to document and discuss their procedures as well as results in a scientific manner</li> </ul>			
Personal Competence Social Competence	environments.	the ability to take or teamwork in engi	position to neering a	o their ow nd scientifi
Autonomy	After completion of this module parti problem in a team independently by org results in a plenum.			
Workload in Hours	Independent Study Time 96, Study Time	in Lecture 84		

Credit points	6		
Course achievement		Form Subject theoretical practical work	<b>Description</b> and
Examination	Written exam		
Examination duration and scale			
the Following	Engineering: Compulsor General Engineering Bioprocess Engineering Bioprocess Engineering General Engineering Bioprocess Engineering General Engineering General Engineering Sengineering: Compulsor Biomedical Engineerin Compulsory Biomedical Engineerin Compulsory Biomedical Engineerin Elective Compulsory Biomedical Engineerin Elective Compulsory Technomathematics: Sengineerin	Science (German prog: Compulsory g: Core qualification: Core Science (English prog: Compulsory cience (English program ory g: Specialisation Artifician ng: Specialisation Imp	ogram, 7 semester): Specialisation  n, 7 semester): Specialisation Process  al Organs and Regenerative Medicine:  lants and Endoprostheses: Elective  cal Technology and Control Theory:  gement and Business Administration:  ering Science: Elective Compulsory

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

Course L0842: Bioprocess Engineering- Fundamentals		
Тур	Recitation Section (large)	
Hrs/wk	2	
СР	1	
<b>Workload in Hours</b>	Independent Study Time 2, Study Time in Lecture 28	
	Prof. Andreas Liese, Prof. An-Ping Zeng	
Language		
Cycle		
	1. Introduction (Prof. Liese, Prof. Zeng)	
	2. Enzymatic kinetics (Prof. Liese)	
	3. Stoichiometry I + II (Prof. Liese)	
	4. Microbial Kinetics I+II (Prof. Zeng)	
Content	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: Biop	Course L0843: Bioprocess Engineering - Fundamental Practical Course			
Тур	Practical Course			
Hrs/wk	2			
СР	2			
<b>Workload in Hours</b>	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 M0536	6: Fundamentals of Fluid Me	chanics			
Courses					
<b>Title</b> Fundamentals of Fluid Fluid Mechanics for Pro	Mechanics (L0091) ocess Engineering (L0092)	Typ Lecture Recitation (large)		<b>Hrs/wk</b> 2 2	<b>CP</b> 4 2
Module	Prof. Michael Schlüter	(large)			
пезропзівіє	<u> </u>				
Admission Requirements	INONE				
Recommended Previous Knowledge	Technical Thermodynamics I+II     Working with force balances	l differential e	equations	5	
Educational Objectives	After taking part successfully, students ha	ave reached t	he follow	ing learn	ing results
Professional Competence					
Knowledge	<ul> <li>explain simplifications of the Continent physical boundary conditions</li> </ul>	applications	of the	-	·
Skills	<ul> <li>The students are able to</li> <li>describe and model incompressible</li> <li>reduce the governing equations archive quantitative solutions e.g.</li> <li>notice the dependency between th</li> <li>use the learned basics for fluid dengineering</li> </ul>	of fluid med by integration eory and tech	chanics n nnical ap	by simpli	
Personal Competence					
Social Competence	The students      are capable to gather informal publications and relate that inform     able to work together on subject results of present their results effective exercises)     are able to work out solutions for solutions orally and to present their	ation to the c elated tasks i ely in Englis r exercises b	ontext of n small g sh (e.g.	f the lectu groups. The during is	ire and ney are able small group
Autonomy	<ul> <li>The students are able to</li> <li>search further literature for each this literature,</li> <li>work on their exercises by their own with the feedback.</li> </ul>	•	•		_
Workload in Hours	Independent Study Time 124, Study Time	in Lecture 56	5		

Credit points	6		
Course achievement	CompulsorBonus Yes 5 %	<b>Form</b> Midterm	Description
Examination	Written exam		
Examination duration and scale	3 hours		
Assignment for the Following Curricula	Engineering: Compuls General Engineering Bioprocess Engineering General Engineering and Enviromental Eng Bioprocess Engineering Energy and Environm General Engineering Bioprocess Engineering General Engineering and Enviromental Eng General Engineering Engineering: Compuls	sory  J Science (Germ  J Science (Germ  J Science (German  J Science (Compul  J Science (Engl  J Science (Engli  J Science (English  J Specialisation III.	cion: Compulsory : Core qualification: Compulsory ish program, 7 semester): Specialisation program, 7 semester): Specialisation Energy sory program, 7 semester): Specialisation Process Engineering Science: Elective Compulsory

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

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

Module M0544	4: Phase Equilibria Therr	nodynamics		
Courses				
<b>Title</b> Phase Equilibria Therm Phase Equilibria Therm Phase Equilibria Therm	nodynamics (L0140)	<b>Typ</b> Lecture Recitation (small) Recitation (large)	Hrs/wk 2 Section 1 Section 1	<b>CP</b> 2 2
Module Responsible	Prof. Irina Smirnova			
Admission Requirements	None			
Recommended Previous Knowledge	Mathematics, Physical Chemistry, T	hermodynamics I a	and II	
Educational Objectives	After taking part successfully, stude	ents have reached	the following learn	ing results
Professional Competence				
Knowledge	<ul> <li>Starting from the very basimathematical tools to descril</li> <li>They learn how state variable and learn concepts to quanti</li> <li>Moreover, the students learn thematically and which poliquid, solid) coexist in equilible equilibria are taught.</li> <li>For different phase equilibria processes are shown and interpreting the equilibria are</li> </ul>	thermodynamic les are influenced tatively describe th arn how phase henomena may oc orium. Furthermore , several examples the necessary	equilibria. by the mixing of nese properties. equilibria can be cur if different phe the fundamentals relevant for different possible.	compounds e described ases (vapor, s of reaction rent kinds of
Skills	<ul> <li>Applying their knowledge, equation for the determinal simplify these equations med.</li> <li>The students know models with the system in the equilibrium mathematical relations.</li> <li>For specific applications, the physico-chemical properties literature sources.</li> <li>Beside pure compound properties of mixtures.</li> <li>The students know how to know how to interpret the ocenical engineering.</li> </ul>	cion of the equilibration of the equilibration of the equilibration of can be used they are able to of compounds as erties the students visualize phase ecurring phenoments are about the equilibration of compounds as extremed the equilibration of compounds are about the equilibration of the equilibratio	rium state and k to determine the p are able to solve t self-reliantly find well as model pa are capable of de quilibria graphical a. le to understand f	now how to properties of the resulting of necessary arameters in escribing the lly and they fundamental
Personal Competence				

Social Competence	The students are able to work in small groups, to solve the corresponding problems and to present them oraly to the tutors and other students
Autonomy	<ul> <li>The students are able to find necessary information self-reliantly in literature sources and to judge their quality.</li> <li>During the semester the students are able to check their learning progress continuously in exercises. Based on this knowledge the students can adept their learning process.</li> </ul>
<b>Workload in Hours</b>	Independent Study Time 124, Study Time in Lecture 56
Credit points	
Course achievement	None
Examination	Written exam
Examination duration and scale	120 minutes; theoretical questions and calculations
Assignment for the Following Curricula	General Engineering Science (German program, 7 semester): Specialisation Process Engineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Bioprocess Engineering: Compulsory Bioprocess Engineering: Core qualification: Compulsory General Engineering Science (English program, 7 semester): Specialisation Bioprocess Engineering: Compulsory General Engineering Science (English program, 7 semester): Specialisation Process Engineering: Compulsory Process Engineering: Core qualification: Compulsory

Course L0114: Phase Equilibria Thermodynamics				
Тур	Lecture			
Hrs/wk	2			
СР	2			
<b>Workload in Hours</b>	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 L0142: Pha	se Equilibria Thermodynamics
Тур	Recitation Section (large)
Hrs/wk	1
СР	2
<b>Workload in Hours</b>	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>

Courses						
Title		Тур		Hrs/wk	СР	
Signals and Systems (I	L0432)	Lecture		3	4	
Signals and Systems (I	L0433)	Recitation (small)	Section	2	2	
Module Responsible	Prof. Gerhard Bauch					
Admission Requirements	INIONE					
noquire in entre	Mathematics 1-3					
Previous	The modul is an introduction to the theo in maths as covered by the moduls Math with spectral transformations (Fourier se is useful but not required.	nematik 1-3 is	s expecte	d. Further	experienc	
Educational Objectives	I ALI PE LAKINO NATI SHEEPSSHIIIV SHINPINS N	nave reached	the follow	ving learn	ing results	
Professional Competence						
	The students are able to classify and describe signals and linear time-invariant (LTI) systems using methods of signal and system theory. They are able to apply the fundamental transformations of continuous-time and discrete-time signals and systems. They can describe and analyse deterministic signals and systems mathematically in both time and image domain. In particular, they understand the effects in time domain and image domain which are caused by the transition of a continuous-time signal to a discrete-time signal.					
Skills	The students are able to describe and analyse deterministic signals and linear time invariant systems using methods of signal and system theory. They can analyse and design basic systems regarding important properties such as magnitude and phase response, stability, linearity etc They can assess the impact of LTI systems on the signal properties in time and frequency domain.					
Personal						
Competence	l The students can jointly solve specific pr	ohlams				
·	The students can jointly solve specific pro from the students are able to acquire releval sources. They can control their level of solving tutorial problems, software tools,	ant informati of knowledge	during t			
Workload in Hours	Independent Study Time 110, Study Time	e in Lecture 7	70			
Credit points	6					
Course achievement						
Examination	Written exam					
Examination duration and scale	90 min					
	General Engineering Science (German	program, 7	semestei	r): Core q	ualification	

		Engineering er Science: Cor		(English	program,	7	semester):	Specialisation
	General	Engineering	Science					Specialisation
		cal Engineerin						
Assignment for				_				Specialisation
the Following	Mechanic	cal Engineerin	g, Focus E	nergy Sys	tems: Com	puls	sory	
Curricula					. •			Specialisation
	Mechanic	cal Engineerin	g, Focus A	ircraft Sys	items Engir	neei	ring: Compul:	sory
	General	Engineering	Science	(English	program,	7	semester):	Specialisation
	Mechanic	cal Engineerin	g, Focus N	laterials ir	n Engineerir	ng S	Sciences: Cor	npulsory
	General	Engineering	Science	(English	program,	7	semester):	Specialisation
	Mechanic	cal Engineerin	g, Focus N	1echatroni	cs: Compul	sor	y	
	General	Engineering	Science	(English	program,	7	semester):	Specialisation
	Mechanic	cal Engineerin	g, Focus T	heoretical	Mechanica	ıl Er	ngineering: C	ompulsory
	General	Engineering S	cience (Er	nglish prod	gram, 7 ser	nes	ter): Special	isation Process
	Engineer	ing: Compulso	ry					
	General	Engineering	Science	(English	program,	7	semester):	Specialisation
		cal Engineering						-
	Computa	itional Science	and Engi	neering: C	ore qualific	atio	n: Compulso	ry
	Mechatro	onics: Core qu	alification	Compulse	ory			
	Technom	nathematics: S	pecialisat	ion III. Eng	ineering So	ien	ce: Elective (	Compulsory

Course L0432: Sign	Lecture
Hrs/wk	
CP (	
i	Independent Study Time 78, Study Time in Lecture 42
	Prof. Gerhard Bauch
Language	
Cycle	SoSe
	Introduction to signal and system theory
	• Signals
	<ul> <li>Classification of signals         <ul> <li>Continuous-time and discrete-time signals</li> <li>Analog and digital signals</li> <li>Deterministic and random signals</li> </ul> </li> <li>Description of LTI systems by differential equations or difference equations, respectively</li> <li>Basic properties of signals and operations on signals</li> <li>Elementary signals</li> <li>Distributions (Generalized Functions)</li> <li>Power and energy of signals</li> <li>Correlation functions of deterministic signals</li> <li>Autocorrelation function</li> <li>Crosscorrelation function</li> <li>Orthogonal signals</li> <li>Applications of correlation</li> </ul> <li>Linear time-invariant (LTI) systems         <ul> <li>Linearity</li> <li>Time-invariance</li> <li>Description of LTI systems by impulse response and frequency response</li> <li>Convolution</li> <li>Convolution and correlation</li> <li>Properties of LTI-systems</li> <li>Causal systems</li> <li>Stable systems</li> <li>Stable systems</li> <li>Memoryless systems</li> </ul> </li> <li>Fourier Series and Fourier Transform</li>

periodic signals, non-periodic signals • Properties of the Fourier transform • Fourier transform of some basic signals Parseval's theorem Analysis of LTI-systems and signals in the frequency domain Frequency response, magnitude response and phase response Transmission factor, attenuation, gain Frequency-flat and frequency-selective LTI-systems Bandwidth definitions o Basic types of systems (filters), lowpass, highpass, bandpass, bandstop systems Phase delay and group delay Linear-phase systems Distortion-free systems Content • Spectrum analysis with limited observation window: Leakage effect Laplace Transform Relation of Fourier transform and Laplace transform Properties of the Laplace transform Laplace transform of some basic signals Analysis of LTI-systems in the s-domain Transfer function of LTI-systems • Relation of Laplace transform, magnitude response and phase response Analysis of LTI-systems using pole-zero plots Allpass filters Minimum-phase, maximum-phase and mixed phase filters Stable systems Sampling Sampling theorem · Reconstruction of continuous-time signals in frequency domain and time domain Oversampling Aliasing Sampling with pulses of finite duration, sample and hold Decimation and interpolation Discrete-Time Fourier Transform (DTFT) Relation of Fourier transform and DTFT Properties of the DTFT Discrete Fourier Transform (DFT) Relation of DTFT and DFT Cyclic properties of the DFT DFT matrix Zero padding Cyclic convolution Fast Fourier Transform (FFT) o Application of the DFT: Orthogonal Frequency Division Multiplex (OFDM) Z-Transform • Relation of Laplace transform, DTFT, and z-transform Properties of the z-transform Z-transform of some basic discrete-time signals Discrete-time systems, digital filters FIR and IIR filters Z-transform of digital filters • Analysis of discrete-time systems using pole-zero plots in the z-domain Stability Allpass filters • Minimum-phase, maximum-phase and mixed-phase filters Linear phase filters T. Frey , M. Bossert , Signal- und Systemtheorie, B.G. Teubner Verlag 2004

K. Kammeyer, K. Kroschel, Digitale Signalverarbeitung, Teubner Verlag.

# Literature

- B. Girod ,R. Rabensteiner , A. Stenger , Einführung in die Systemtheorie, B.G. Teubner, Stuttgart, 1997
- J.R. Ohm, H.D. Lüke , Signalübertragung, Springer-Verlag 8. Auflage, 2002
- S. Haykin, B. van Veen: Signals and systems. Wiley.
- Oppenheim, A.S. Willsky: Signals and Systems. Pearson.
- Oppenheim, R. W. Schafer: Discrete-time signal processing. Pearson.

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

Courses						
Title		Тур	Hrs/wk	СР		
	gineering (Fundamentals) (L0204)	Lecture	2	2		
Chemical Reaction Eng	gineering (Fundamentals) (L0244)	Recitation Sec (large)	ction 2	2		
Experimental Course C	Chemical Engineering (Fundamentals) (L022	-	2	2		
Module Responsible						
Admission Requirements	None					
Recommended Previous Knowledge	thermodynamics I+II as well as comput			ry, technica		
Educational Objectives	After taking part successfully, students	have reached the f	ollowing learr	ing results		
Professional Competence						
Knowledge	The students are able to explain basic They are able to point out differenc processes. The students have a strong isothermal ideal reactors and to describ	es between thermo ability to outline pa	odynamical a	nd kinetic		
	After successful completion of the mod	ule, students are ab	ole to:			
	- apply different computational me isothermal ideal reactors,	thods to dimensio	on isotherma	l and noi		
Skills	- determine and compute stable operation points for these reactors ,					
	- conduct experiments on a lab-scale p scientific guidelines.	ilot plants and doc	ument these	according t		
Personal						
Competence	i					
Social Competence	After successful completition of the lab organize themselfes in small group engineering. The students can discuss other and with their teachers.	os to solve issue	s in chemic	cal reactio		
Autonomy	The students are able to obtaing relevance autonomously. Students can prepare and conduct experiments.					
Workload in Hours	Independent Study Time 96, Study Tim	e in Lecture 84				
Credit points	6					
Course	Compulsor <b>B</b> onus Form		ription			
achievement	Cubiast than	retical and				
Examination	Written exam					
Examination duration and scale	120 min					
Assignment for the Following	General Engineering Science (German Engineering: Compulsory General Engineering Science (Germ Bioprocess Engineering: Compulsory Bioprocess Engineering: Core qualificat Bioprocess Engineering: Core qualificat	an program, 7 s	•			
the Following	[138]					

Curricula	General	Engineering	Science	(English	program,	7	semester):	Specialisation
	Bioproces	ss Engineering	g: Compul	sory				
	General I	Engineering S	cience (Er	nglish prog	gram, 7 ser	nes	ter): Speciali	isation Process
	Engineer	ing: Compulso	ry					
	Process E	ingineering: C	ore qualif	ication: Co	mpulsory			
	Process E	Engineering: C	ore qualif	ication: Co	mpulsory			

Course L0204: Chemical Reaction Engineering (Fundamentals)					
Тур	Lecture				
Hrs/wk	2				
СР	2				
<b>Workload in Hours</b>	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)				
Content	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)

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

## Literature

- 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	
<b>Workload in Hours</b>	Independent Study Time 32, Study Time in Lecture 28	
Lecturer	Prof. Raimund Horn, Dr. Oliver Korup	

# Language DE Cycle WiSe

Fundamentals of chemical reaction engineering, definitions, calculation of species concentrations (reactor, reaction mixture, reactants, products, inerts and solvents, reaction volume, Reaktor volume, chemical reaction, mass, moles, mole fraction, volume, density, molar concentration, mass-concentration, molality, partial pressure, hydrodynamic residence time, space time, extent of reaction, reactor throughput, reactor load, conversion, selectivity, yield, concentration calculations in stationary and flowing multicomponent-mixtures)

Stoichiometry and stoichiometric calculations (simple reactions, complex reactions, key reactions, key species, matrix of stoichiometric coefficients, linear dependent and independent reactions, element-species-matrix, row reduced form of a matrix, rank of a matrix, Gauss Jordan elimination, relation between stoichiometry and kinetics, calculating the extent of reaction from mole number changes in complex reactions)

Thermodynamics (What is thermodynamics?, importance of thermodynamics in chemical reaction engineering, zeroth law of thermodynamics, temperature scales, temperature measurements in praxis, first law of thermodynamics, internal energy, enthalpy, calorimeter, heat of reaction, standard heat of formation, Hess law, heat capacity, Kirchhoff law, standard heat of reaction, pressure dependence of the heat of reaction, second law of thermodynamics, reversible and irreversible processes, entropy, Clausius inequality, free energy, Gibbs Energy, chemical potential, chemical equilibrium, activity, van't Hoff law, calculation of chemical equilibrium, principle of Le Chatelier and Braun, equilibrium calculations in multiple reaction systems, Lagrange Multipliers)

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

Content

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)
	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
Literature	H. S. Fogler, Elements of Chemical Reaction Engineering, Prentice Hall B
Literature	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			
<b>Workload in Hours</b>	Independent Study Time 32, Study Time in Lecture 28			
Lecturer	Prof. Raimund Horn, Dr. Achim Bartsch			
Language	DE/EN			
Cycle	SoSe			
	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			
Content	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.			
	Levenspiel, O.: Chemical reaction engineering; John Wiley & Sons, New York, 3. Ed., 1999 VTM 309(LB)			
	Praktikumsskript			
Literature	Skript Chemische Verfahrenstechnik 1 (F.Keil)			

Title		Тур	Hrs/wk	СР			
Practical Exercise Environmental Technology (L1387) Environmental Technologie (L0326)		Practical Course Lecture	1 2	1 2			
Module Responsible	I Prof. Martin Kairscomitt						
Admission Requirements	INONA						
Recommended Previous Knowledge	Fundamentals of inorganic/organic chemistry and biology						
Educational Objectives	After taking part successfully, students have reached the following learning results						
Professional Competence							
Knowledge	With the completion of this modul the students obtain profound knowledge of environmental technology. They are able to describe the behaviour of chemicals in the environment. Students can give an overview of scientific disciplines involved They can explain terms and allocate them to related methods.						
Skills	Students are able to propose appropriate management and mitigation measures for environmental problems. They are able to determine geochemical parameters and to assess the potential of pollutants to migrate and transform. The students are able to work out well founded opinions on how Environmental Technology contributes to sustainable development, and they can present and defend these opinions in front of and against the group.						
Personal Competence							
	The students are able to discuss the various technical and scientific tasks, bot subject-specific and multidisciplinary. They are able to develop different approache to the task as a group as well as to discuss their theoretical or practical implementation.						
Autonomy	Students can independently exploit sources about of the subject, acquire the particular knowledge and tranfer it to new problems.						
	Independent Study Time 48, Study	Time in Lecture 42		I			
Workload in Hours	2						
Workload in Hours  Credit points	3						
Credit points	<u>3</u> Compulsor <b>₿</b> onus Form	Descri	ption				
	CompulsorBonus Form	theoretical and	ption				
Credit points Course	CompulsorBonus Form Yes None Subject practical w	theoretical and	ption				
Credit points Course achievement	CompulsorBonus Form Yes None Subject practical w Written exam	theoretical and	ption				

Bioprocess Engineering: Elective Compulsory
General Engineering Science (English program, 7 semester): Specialisation Energy
and Enviromental Engineering: Compulsory
General Engineering Science (English program, 7 semester): Specialisation Process
Engineering: Elective Compulsory
Process Engineering: Core qualification: Elective Compulsory

Course L1387: Practical Exercise Environmental Technology			
Тур	Practical Course		
Hrs/wk	1		
СР	1		
<b>Workload in Hours</b>	Independent Study Time 16, Study Time in Lecture 14		
Lecturer	Prof. Martin Kaltschmitt		
Language	DE		
Cycle	SoSe		
Content	The experiment demonstrates the effect of ionic strength on the binding of dissolved zinc and phosphate by soil surfaces. From the results it can be inferred that the potential of soil surfaces is modified by the application of salt. This has consequences for the retention of nutrients and pollutants. The experiment is carried out with iron oxide rich soil material.  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	F. Scheffer und P. Schachtschabel (2002): "Lehrbuch der Bodenkunde" TUB Signatur AGG-308  W.E.H. Blum (2007): "Bodenkunde in Stichworten" TUB Signatur AGG-317  C. A. J. Appelo; D. Postma (2005): "Geochemistry, groundwater and pollution"  TUB Signatur GWC-515		

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

Courses				
Title		Тур	Hrs/wk	СР
Bioprocess Engineerin	g - Advanced (L1107)	Lecture	2	4
Bioprocess Engineerin	g - Advanced (L1108)	Recitation (small)	Section 2	2
Module Responsible	Prof. An-Ping Zeng			
Admission Requirements				
Recommended	Content of module "Biochemical Engineering I"			
Educational Objectives	After taking part successfully, st	After taking part successfully, students have reached the following learning results		
Professional Competence				
	After successful completion of th	is module, students	should be able to	
	<ul> <li>describe and explain diffe uptake</li> </ul>	erent kinetic approac	thes for growth a	nd substrate
Knowledge	<ul> <li>identification of scientific problems with concrete industrial use (cultivation of microorganisms and mammalian cells)</li> </ul>			
	<ul> <li>describe and explain important downstreaming steps for proteins and their application as well as basic immobilization methods</li> </ul>			
	After successful completion of th	is module, students	should be able to	
Skills	- to identifiy scientific question industrial applications (eg cultiv formulate solutions ,			
	- To assess the application of scale-up criteria for different types of bioreactors and processes and to apply these criteria to given problems (anaerobic , aerobic or microaerobically)			
	- to formulate questions for the analysis and optimization of real biotechnologica production processes appropriate solutions ,			
	- To describe the effects of the energy generation, the regeneration of reduction equivalents, and the growth inhibition of the behavior of microorganisms and to the total fermentation process qualitatively			
	- Establish material flow balance equations and solve them to determine the kinetic parameters of different approaches and to calculate immobilization and activity yields ,			
	- to select process control strate and to calculate basic types and	_	tch , continuity )	appropriatel
Personal				
Competence				

Social Competence	questions in small teams to enhance the ability to take position to their own opinions and increase their capacity for teamwork.
Autonomy	After completion of this module participants are able to aquire new sources of knowledge and apply their knowledge to previously unknown issues and to present these.
<b>Workload in Hours</b>	Independent Study Time 124, Study Time in Lecture 56
Credit points	6
Course achievement	None
Examination	Written exam
Examination duration and scale	
Assignment for the Following Curricula	Bioprocess Engineering: Core qualification: Compulsory  Conoral Engineering Science (English program 7 competer): Specialisation

Courses				
Title		Тур	Hrs/wk	СР
Introduction to Control	Systems (L0654)	Lecture	2 Canting	4
Introduction to Control	Systems (L0655)	Recitation (small)	Section 2	2
Module Responsible	Prof. Herbert Werner			
Admission Requirements	None			
Recommended Previous Knowledge	Representation of signals and systems in time and frequency domain, Laplace transform			
Educational Objectives	LATTOR FAKING NART CHARACTURE CHIRA	lents have reached t	he following learr	ning results
Professional Competence				
Knowledge	<ul> <li>Students can represent dynamic system behavior in time and frequent domain, and can in particular explain properties of first and second ord systems</li> <li>They can explain the dynamics of simple control loops and interpret dynamics properties in terms of frequency response and root locus</li> <li>They can explain the Nyquist stability criterion and the stability marging derived from it.</li> <li>They can explain the role of the phase margin in analysis and synthesis control loops</li> <li>They can explain the way a PID controller affects a control loop in terms of infrequency response</li> <li>They can explain issues arising when controllers designed in continuous ting domain are implemented digitally</li> </ul>			
Skills	<ul> <li>Students can transform models of linear dynamic systems from time frequency domain and vice versa</li> <li>They can simulate and assess the behavior of systems and control loops</li> <li>They can design PID controllers with the help of heuristic (Ziegler-Nicho tuning rules</li> <li>They can analyze and synthesize simple control loops with the help of rolocus and frequency response techniques</li> <li>They can calculate discrete-time approximations of controllers designed continuous-time and use it for digital implementation</li> <li>They can use standard software tools (Matlab Control Toolbox, Simulink) for carrying out these tasks</li> </ul>			
Personal Competence Social Competence	Students can work in small gr		ve technical pro	oblems, a
Autonomy	Students can obtain information documentation, experiment guides  They can assess their knowledge	from provided sour s) and use it when so	olving given probl	ems.

<b>Workload in Hours</b>	Independent Study Time 124, Study Time in Lecture 56		
Credit points			
Course achievement	None		
Examination	Written exam		
Examination duration and scale			
the Following	General Engineering Science (German program, 7 semester): Core qualification: Compulsory Bioprocess Engineering: Core qualification: Compulsory Computer Science: Specialisation Computational Mathematics: Elective Compulsory Data Science: Core qualification: Elective Compulsory Electrical Engineering: Core qualification: Compulsory Electrical Engineering: Core qualification: Compulsory Energy and Environmental Engineering: Core qualification: Compulsory General Engineering Science (English program, 7 semester): Specialisation Electrical Engineering: Compulsory General Engineering Science (English program, 7 semester): Specialisation Civil Engineering: Compulsory General Engineering Science (English program, 7 semester): Specialisation Bioprocess Engineering: Compulsory General Engineering: Compulsory General Engineering: Compulsory General Engineering Science (English program, 7 semester): Specialisation Energy and Environmental Engineering: Compulsory General Engineering Science (English program, 7 semester): Specialisation Computer Science: Compulsory General Engineering Science (English program, 7 semester): Specialisation Mechanical Engineering, Focus Biomechanics: 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 Mecharionics: Compulsory General Engineering Science (English program, 7 semester): Specialisation Mechanical Engineering, Focus Mecharionics: Compulsory General Engineering, Science (English program, 7 semester): Specialisation Mechanical Engineering, Focus Mecharionics: Compulsory General Engineering Science (English program, 7 semester): Specialisation Naval		

Course L0654: Intr	oduction to Control Systems		
Тур	Lecture		
Hrs/wk			
СР	4		
Workload in Hours	Independent Study Time 92, Study Time in Lecture 28		
	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	
<b>Workload in Hours</b>	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 M0546: Thermal Separation Processes				
Courses				
<b>Title</b> Thermal Separation Pr Thermal Separation Pr		Typ Lecture Recitation (small)	Hrs/wl 2 Section 2	k <b>CP</b> 2 2
Thermal Separation Pr	ocesses (L0141)	Recitation (large)	Section 1	1
Separation Processes (	(L1159)	Practical Cours	se 1	1
Module Responsible	Prof. Irina Smirnova			
Admission Requirements	LNIONA			
Recommended Previous Knowledge		modynamics III		
Educational Objectives	After taking part successfully, stud	ents have reached t	he following lea	arning results
Professional Competence				
Knowledge	<ul> <li>The students can distinguish and describe different types of separation processes such as distillation, extraction, and adsorption</li> <li>The students develop an understanding for the course of concentration during a separation process, the estimation of the energy demand of a process, the possibilities of energy saving, and the selection of separation systems</li> <li>They have good knowledge of designing methods for separation processes and devices</li> </ul>			
Skills	<ul> <li>Using the gained knowledge boundary for a given separate and material balances</li> <li>The students can use differ separation process and defined the separation process and designed given case based on the addition of the students are capable properties from appropriate.</li> <li>They can calculate continuore the students are able to experimental lab work.</li> <li>The students are able to discontinuore of the experimental work with the students are capable of link other lectures and use it together lectures such as thermodynamics,</li> </ul>	erent graphical met ne the amount of the a basic type of the vantages and disadv to obtain indepen sources (diagrams a us and discontinuous to prove their the scuss the theoretical th the teachers in co	hods for the operation stages rmal separation antages of the dently the nearly the nearly the nearly the separation are processes expredical known background are folloquium.	designing of a required n process eded material reduced m
Personal Competence	The students can work tech	nical assignments in	small groups a	nd present th

	combined results in the tutorial			
Social Competence	<ul> <li>The students are able to carry out practical lab work in small groups and organize a functional division of labor between them. They are able to discuss their results and to document them scientifically in a report.</li> </ul>			
Autonomy	<ul> <li>The students are capable to obtain the needed information from suitable sources by themselves and assess their quality</li> <li>The students can proof the state of their knowledge with exam resembling assignments and in this way control their learning process</li> </ul>			
<b>Workload in Hours</b>	Independent Study Time 96, Study Time in Lecture 84			
Credit points	6			
Course achievement	None			
Examination	Written exam			
Examination duration and scale	120 minutes; theoretical questions and calculations			
the Following	General Engineering Science (German program, 7 semester): Specialisation Process Engineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Bioprocess Engineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Energy and Environmental Engineering: Compulsory Bioprocess Engineering: Core qualification: Compulsory Energy and Environmental Engineering: Core qualification: Compulsory General Engineering Science (English program, 7 semester): Specialisation Bioprocess Engineering: Compulsory General Engineering Science (English program, 7 semester): Specialisation Energy and Environmental Engineering: Compulsory General Engineering Science (English program, 7 semester): Specialisation Process Engineering: Compulsory Process Engineering: Core qualification: Compulsory			

Course L0118: The	rmal Separation Processes		
Тур	Lecture		
Hrs/wk	2		
СР	2		
<b>Workload in Hours</b>	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.  <ul> <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> </li> </ul>		

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

Course L0141: The	rmal Separation Processes		
Тур	Typ Recitation Section (large)		
Hrs/wk	1		
СР	1		
<b>Workload in Hours</b>	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: Sep	aration Processes		
Тур	Practical Course		
Hrs/wk	1		
СР	1		
<b>Workload in Hours</b>	Independent Study Time 16, Study Time in Lecture 14		
Lecturer	Prof. Irina Smirnova		
Language	DE/EN		
Cycle	WiSe		
	The students work on eight different experiments in this practical course. For every one of the eight experiments, a colloquium takes place in which the students explain and discuss the theoretical background and its translation into practice with staff and fellow students.		
	The students work small groups with a high degree of division of labor. For every experiment, the students write a report. They receive instructions in terms of scientific writing as well as feedback on their own reports and level of scientific writing so they can increase their capabilities in this area.		
	Topics of the practical course:		
	<ul> <li>Introduction in the thermal process engineering and to the main features of separation processes</li> </ul>		
Content	<ul> <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	fluids and the application to separation processes. Steinkopff, Darmstadt;		
	<ul> <li>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 M0538: Heat and Mass Transfer				
Courses				
Title Heat and Mass Transfer (L0101) Heat and Mass Transfer (L0102) Heat and Mass Transfer (L1868)		Typ Lecture Recitation (small) Recitation (large)	Hrs/wk 2 Section 1 Section 1	<b>CP</b> 2 2
Module	Prof. Irina Smirnova	(idige)		
Admission				
Requirements Recommended Previous Knowledge		lynamics		
Educational Objectives	After taking part successfully, studer	nts have reached	the following learr	ning results
Professional Competence				
Knowledge	<ul> <li>The students are capable of explaining qualitative and determining quantitative heat transfer in procedural apparatus (e. g. heat exchanger, chemical reactors).</li> <li>They are capable of distinguish and characterize different kinds of heat transfer mechanisms namely heat conduction, heat transfer and thermal radiation.</li> <li>The students have the ability to explain the physical basis for mass transfer in detail and to describe mass transfer qualitative and quantitative by using suitable mass transfer theories.</li> <li>They are able to depict the analogy between heat- and mass transfer and to describe complex linked processes in detail.</li> </ul>			
Skills	<ul> <li>The students are able to set reasonable system boundaries for a given transport problem by using the gained knowledge and to balance the corresponding energy and mass flow, respectively.</li> <li>They are capable to solve specific heat transfer problems (e.g. heated chemical reactors, temperature alteration in fluids) and to calculate the corresponding heat flows.</li> <li>Using dimensionless quantities, the students can execute scaling up of technical processes or apparatus.</li> <li>They are able to distinguish between diffusion, convective mass transition and mass transfer. They can use this knowledge for the description and design of apparatus (e.g. extraction column, rectification column).</li> <li>In this context, the students are capable to choose and design fundamental types of heat and mass exchanger for a specific application considering their advantages and disadvantages, respectively.</li> <li>In addition, they can calculate both, steady-state and non-steady-state processes in procedural apparatus.</li> <li>The students are capable to connect their knowledge obtained in this course with knowlegde of other courses (In particular the courses thermodynamics, fluid mechanics and chemical process engineering) to solve concrete technical problems.</li> </ul>			
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Personal Competence				
Social Competence	<ul> <li>The students are capable to work on subject-specific challenges in teams and to present the results orally in a reasonable manner to tutors and other students.</li> </ul>			
Autonomy	<ul> <li>The students are able to find and evaluate necessary information from suitable sources</li> <li>They are able to prove their level of knowledge during the course with accompanying procedure continuously (clicker-system, exam-like assignments) and on this basis they can control their learning processes.</li> </ul>			
<b>Workload in Hours</b>	Independent Study Time 124, Study Time in Lecture 56			
Credit points	6			
Course achievement	None			
Examination	Written exam			
Examination duration and scale	120 minutes; theoretical questions and calculations			
Assignment for the Following Curricula	General Engineering Science (German program, 7 semester): Specialisation Process Engineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Bioprocess Engineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Energy and Environmental Engineering: Compulsory Bioprocess Engineering: Core qualification: Compulsory Energy and Environmental Engineering: Core qualification: Compulsory General Engineering Science (English program, 7 semester): Specialisation Bioprocess Engineering: Compulsory General Engineering Science (English program, 7 semester): Specialisation Energy and Environmental Engineering: Compulsory General Engineering Science (English program, 7 semester): Specialisation Process Engineering: Compulsory Technomathematics: Specialisation III. Engineering Science: Elective Compulsory Process Engineering: Core qualification: Compulsory			

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

Course L0102: Heat and Mass Transfer		
Тур	Recitation Section (small)	
Hrs/wk	1	
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	
<b>Workload in Hours</b>	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	0: Particle Tec	hnology and S	olids Process	Engine	ering
Courses					
Title Particle Technology I (I			Typ Lecture Recitation Sect	Hrs/wk 2	<b>CP</b> 3
Particle Technology I (I			(small)	-	1
Particle Technology I (I			Practical Course	2	2
1100   011011110		n			
Admission Requirements	1				
Recommended Previous Knowledge	keine				
Educational Objectives	After taking part suc	ccessfully, students h	ave reached the fol	lowing learn	ing results
Professional Competence					
Knowledge	<ul> <li>name and engineering,</li> </ul>	npletion of the modul explain processes particles, particle	and unit-operati	ons of soli	•
Skills	<ul> <li>Students are able to</li> <li>choose and design apparatuses and processes for solids processing according to the desired solids properties of the product</li> <li>asses solids with respect to their behavior in solids processing steps</li> <li>document their work scientifically.</li> </ul>				
Personal Competence					
Social Competence	scientific personal a	able to discuss scier nd to develop solutio	ns for technical-scie	entific issues	in a group.
Autonomy	independently.	to analyze and s	olve questions re	garding sol	id particles
<b>Workload in Hours</b>	Independent Study	Time 110, Study Time	e in Lecture 70		
Credit points	6				
Course achievement	CompulsorBonus Yes None	<b>Form</b> Written elaborati		<b>ption</b> Berichte (p icht) à 5-10 (	
Examination	Written exam				
Examination duration and scale	90 minutes				
Assignment for	Engineering: Compu General Engineerin Bioprocess Engineer General Engineering and Enviromental En	ng Science (Germa	n program, 7 se rogram, 7 semeste ory	mester): Sp	pecialisation

the Following	Energy and Environmental Engineering: Core qualification: Compulsory				
Curricula	General Engineering Science (English program, 7 semester): Specialisation				
	Bioprocess Engineering: Compulsory				
	General Engineering Science (English program, 7 semester): Specialisation Energy				
	and Environmental Engineering: Compulsory				
	General Engineering Science (English program, 7 semester): Specialisation Process				
	Engineering: Compulsory				
	Process Engineering: Core qualification: Compulsory				

Course L0434: Particle Technology I			
Тур	Lecture		
Hrs/wk			
СР	3		
<b>Workload in Hours</b>	Independent Study Time 62, Study Time in Lecture 28		
Lecturer	Prof. Stefan Heinrich		
Language	DE		
Cycle	SoSe		
Content	<ul> <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	
<b>Workload in Hours</b>	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: Part	cicle Technology I
Тур	Practical Course
Hrs/wk	2
СР	2
<b>Workload in Hours</b>	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: Process and Plant Engineering I						
Courses						
Courses						
<b>Title</b> Process and Plant Engi	ineering I (I 0095)		<b>Typ</b> Lecture	Hrs/wk	<b>CP</b> 2	
Process and Plant Engi	_		Recitation	Section 1	2	
			(large) Recitation	Section <sub>1</sub>		
Process and Plant Engi	ineering I (L1214)		(small)	1	2	
Module Responsible	Prof. Mirko Skiborowski					
Admission Requirements	None					
Recommended	unit operation of therma	al an dmechanical	separation p	orocesses		
Previous Knowledge	chemical reactor eingin	eering				
Educational Objectives	After taking part succes	sfully, students h	ave reached	the following learn	ing results	
Professional						
Competence	    students can:					
	classify and formulate blobal balance equations of chemical processes					
Knowledge	specify linear component equations of complex chemical processes					
	explain linear regression and data reconcilliation problems					
	explain pfd-diagrams					
	students are capable of					
	- formulation of mass and energy balance equations and estimation of product streams					
Skills	- estimation of component streams of chemical plants using linear component balance models					
	- solution of data reconcilliation tasks					
	- conduction of process synthesis					
	- economic evaluation of processes and the estimation of production costs					
Personal						
Competence	i					
Social Competence	<u> </u>					
Autonomy Workload in Hours	Independent Study Time 124, Study Time in Lecture 56					
Credit points	!	C 124, Study Hille	. III ECCLUIE 3			
	Compulsor <b>B</b> onus	Form		escription		
Course achievement		Subject theore practical work		·		
Examination	Written exam					
Examination						
duration and scale	120 Min. lectures notes and books					
	General Engineering Sc	ience (German pr	ogram, 7 ser	nester): Specialisa	tion Process	

	Engineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Bioprocess Engineering: Compulsory					
	General Engineering Science (German program, 7 semester): Specialisation Energy					
Assignment for	and Enviromental Engineering: Elective Compulsory					
	Bioprocess Engineering: Core qualification: Compulsory					
Curricula	General Engineering Science (English program, 7 semester): Specialisation					
	Bioprocess Engineering: Compulsory					
	General Engineering Science (English program, 7 semester): Specialisation Energy					
	and Enviromental Engineering: Elective Compulsory					
	General Engineering Science (English program, 7 semester): Specialisation Process					
	Engineering: Compulsory					
	Process Engineering: Core qualification: Compulsory					

Course L0095: Pro	cess and Plant Engineering I
Тур	Lecture
Hrs/wk	2
СР	2
<b>Workload in Hours</b>	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Prof. Mirko Skiborowski
Language	DE
Cycle	SoSe
Content	1. Introduction Structure and operation of production plants Operational business process Technical process design Motivation and targets of process development Life cycle of production plants 2. Engineering methods and tools Mass and energy balances Strategies of process synthesis Graphical representation of processes Multidimensional regression Data reconciliation and data validation 3. Process Synthesis Decision levels Experimental process development Reactor synthesis Synthesis of separation processes (process alternatives and criteria for selection) Integration of reaction systems/separation systems (interactions, recycle streams) 4. Process safety 5. Cost estimation of production plants Production costs, capital costs, economic evaluation
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	M. H. Bauer, J. Stichlmair, ChemIngTech., 68(1996), Nr. 8, 911-916
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## Literature

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- G. Kaibel, Chem.-Ing.-Tech. 61 (1989), Nr. 2, S. 104-112
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- H.J. Lang, Chem. Eng. 55(6), 112, 1948
- F. Lestak, C. Collins, Chemical Engineering, July 1997, S. 72-76

Course L0096: Process and Plant Engineering I		
Тур	Recitation Section (large)	
Hrs/wk	1	
СР	2	
Workload in Hours	Independent Study Time 46, Study Time in Lecture 14	
Lecturer	Prof. Mirko Skiborowski, Dr. Thomas Waluga	
Language	DE	
Cycle	SoSe	
Content	See interlocking course	
Literature	See interlocking course	

Course L1214: Process and Plant Engineering I		
Тур	Recitation Section (small)	
Hrs/wk	1	
СР	2	
<b>Workload in Hours</b>	Independent Study Time 46, Study Time in Lecture 14	
Lecturer	Prof. Mirko Skiborowski, Dr. Thomas Waluga	
Language	DE	
Cycle	SoSe	
Content	See interlocking course	
Literature	See interlocking course	

Module M0829	9: Foundations of Manager	nent			
Courses		T		Here to the	CD
Title	(1,0002)	<b>Typ</b> Recitation	Section	Hrs/wk	СР
Management Tutorial Introduction to Management		(small)		3	3
		Lecture		3	3
1100001111111					
Admission Requirements	None				
Recommended Previous Knowledge	Basic Knowledge of Mathematics and E	Business			
Educational Objectives	After taking part successfully, students	have reached	the follo	wing learn	ing results
Professional Competence					
Knowledge	<ul> <li>After taking this module, students know the important basics of many different areas in Business and Management, from Planning and Organisation to Marketing and Innovation, and also to Investment and Controlling. In particular they are able to</li> <li>explain the differences between Economics and Management and the sub-disciplines in Management and to name important definitions from the field of Management</li> <li>explain the most important aspects of and goals in Management and name the most important aspects of entreprneurial projects</li> <li>describe and explain basic business functions as production, procurement and sourcing, supply chain management, organization and human ressource management, information management, innovation management and marketing</li> <li>explain the relevance of planning and decision making in Business, esp. in situations under multiple objectives and uncertainty, and explain some basic methods from mathematical Finance</li> <li>state basics from accounting and costing and selected controlling methods.</li> </ul>				
Skills Personal Competence	systems  analyse and apply basic method select and apply basic method problems  apply basic methods from acco problems	etc.) and to care able to structure them structures of care making under arement system as of marketing as from mather	appropriompanies multip	an Entre iately s le object Business finance to	preneurshi ives, unde informatio predefine
Competence	Students are able to  work successfully in a team of so  to apply their knowledge from to		ı entrepr	eneurship	project an

Social Competence	write a coherent report on the project  to communicate appropriately and  to cooperate respectfully with their fellow students.				
Autonomy	<ul> <li>Students are able to</li> <li>work in a team and to organize the team themselves</li> <li>to write a report on their project.</li> </ul>				
<b>Workload in Hours</b>	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	several written exams during the semester				
the Following	General Engineering Science (German program, 7 semester): Core qualification: Compulsory Civil- and Environmental Engineering: Core qualification: Compulsory Civil- and Environmental Engineering: Specialisation Civil Engineering: Elective Compulsory Civil- and Environmental Engineering: Specialisation Water and Environment: Elective Compulsory Civil- and Environmental Engineering: Specialisation Water and Environment: Elective Compulsory Civil- and Environmental Engineering: Specialisation Traffic and Mobility: Elective Compulsory Bioprocess Engineering: Core qualification: Compulsory Bioprocess Engineering: Core qualification: Compulsory Computer Science: Core qualification: Compulsory Data Science: Core qualification: Compulsory Electrical Engineering: Core qualification: Compulsory Energy and Environmental Engineering: Core qualification: Compulsory General Engineering Science (English program, 7 semester): Specialisation Electrical Engineering: Compulsory General Engineering Science (English program, 7 semester): Specialisation Civil Engineering: Compulsory General Engineering: Compulsory General Engineering: Compulsory General Engineering Science (English program, 7 semester): Specialisation Energy and Environmental Engineering: Compulsory General Engineering Science (English program, 7 semester): Specialisation Computer Science: Compulsory General Engineering Science (English program, 7 semester): Specialisation Mechanical Engineering, Focus Biomechanics: Compulsory General Engineering Science (English program, 7 semester): Specialisation Mechanical Engineering, Focus Brenzy Systems: Compulsory General Engineering Science (English program, 7 semester): Specialisation Mechanical Engineering, Focus Aircraft Systems Engineering: 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 Science (English program,				

Mechatronics: Core qualification: Compulsory

Orientierungsstudium: Core qualification: Elective Compulsory

Naval Architecture: Core qualification: Compulsory Technomathematics: Core qualification: Compulsory Process Engineering: Core qualification: Compulsory

Course L0882: Man	agement Tutorial
Тур	Recitation Section (small)
Hrs/wk	2
СР	3
<b>Workload in Hours</b>	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Prof. Christoph Ihl, Katharina Roedelius, Tobias Vlcek
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 self-selected projects that focus on the elaboration of an innovative business idea from the point of view of an established company or a startup. Again, the business knowledge from the lecture should come to practical use. The group projects are guided by a mentor.
Literature	Relevante Literatur aus der korrespondierenden Vorlesung.

Course L0880: Intr	oduction to Management				
Тур	Lecture				
Hrs/wk	3				
СР	3				
Workload in Hours	Independent Study Time 48, Study Time in Lecture 42				
Lecturer	Prof. Christoph Ihl, Prof. Thorsten Blecker, Prof. Christian Lüthje, Prof. Christian Ringle, Prof. Kathrin Fischer, Prof. Cornelius Herstatt, Prof. Wolfgang Kersten, Prof. Matthias Meyer, Prof. Thomas Wrona				
Language	DE				
Cycle	WiSe/SoSe				
Content	<ul> <li>Introduction to Business and Management, Business versus Economics, relevant areas in Business and Management</li> <li>Important definitions from Management,</li> <li>Developing Objectives for Business, and their relation to important Business functions</li> <li>Business Functions: Functions of the Value Chain, e.g. Production and Procurement, Supply Chain Management, Innovation Management, Marketing and Sales 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 M1274	1: Environmental Techno	logy		
Courses				
Title		Тур	Hrs/wk	СР
Environmental Assessn	ment (L0860)	Lecture	2	2
Environmental Assessn	ment (L1054)	Recitation (small)	Section 1	1
Module Responsible	Prof. Martin Kaltschmitt			
Admission Requirements	None			
Recommended Previous Knowledge	Fundamentals of inorganic/organic of	chemistry and biolo	gy	
Educational Objectives	After taking part successfully, stude	ents have reached th	ne following learn	ing results
Professional				
Competence				
Knowledge	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.			
Skills	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 EcoInvent. After finishing the course the students have the competence to critically judge research results or other publications on environmental impacts.			
Personal Competence				
Social Competence	The students are able to discuss the various technical and scientific tasks, both subject-specific and multidisciplinary. They are able to develop jointly different solutions and to discuss their theoretical or practical implementation. Due to the selected lecture topics, the students receive insights into the multi-layered issues of the environment protection and the concept of sustainability. Their sensitivity and consciousness towards these subjects are raised and which helps to raise their awareness of their future social responsibilities in their role as engineers.			
Autonomy	The students learn to research, process and present a scientific topic independently. They are able to carry out independent scientific work. They can solve an environmental problem in a business context and are able to judge results of other publications.			
Workload in Hours	Independent Study Time 48, Study	Time in Lecture 42		
Credit points				
Course				
Examination	Written exam			
Examination				

duration and scale	1 hour written exam
Assignment for the Following	General Engineering Science (German program, 7 semester): Specialisation Energy and Enviromental Engineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Bioprocess Engineering: Elective Compulsory General Engineering Science (German program, 7 semester): Specialisation Process Engineering: Elective Compulsory Bioprocess Engineering: Core qualification: Elective Compulsory Energy and Environmental Engineering: Core qualification: Compulsory General Engineering Science (English program, 7 semester): Specialisation Bioprocess Engineering: Elective Compulsory General Engineering Science (English program, 7 semester): Specialisation Energy and Enviromental Engineering: Compulsory General Engineering Science (English program, 7 semester): Specialisation Process Engineering: Elective Compulsory Process Engineering: Core qualification: Elective Compulsory

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

Course L1054: Env	ironmental Assessment
Тур	Recitation Section (small)
Hrs/wk	1
СР	1
<b>Workload in Hours</b>	Independent Study Time 16, Study Time in Lecture 14
Lecturer	Prof. Martin Kaltschmitt
Language	DE
Cycle	SoSe
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

## **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 M070 Transients	08: Electrical	Engineering	j III:	Circuit	Theo	ory	and
Courses							
Title Circuit Theory (L0566)			<b>Typ</b> Lecture Recitation	Section	Hrs/wk 3	<b>CP</b> 4	
Circuit Theory (L0567)  Module	Prof. Arne Jacob		(small)		2	2	
Admission							
Recommended Previous Knowledge	Electrical Engineering	I and II, Mathemati	cs I and II				
Educational Objectives	After taking part succe	essfully, students h	ave reache	ed the follow	ving learr	ning re	sults
Professional Competence							
	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.			
<b>Workload in Hours</b>	Independent Study Time 110, Study Time in Lecture 70			
Credit points				
Course achievement	None			
Examination	Written exam			
Examination duration and scale				
the Following	General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Mechatronics: Compulsory General Engineering Science (German program, 7 semester): Specialisation Electrical Engineering: Compulsory Electrical Engineering: Core qualification: Compulsory General Engineering Science (English program, 7 semester): Specialisation Electrical Engineering: Compulsory General Engineering Science (English program, 7 semester): Specialisation Mechanical Engineering, Focus Mechatronics: Compulsory Computational Science and Engineering: Specialisation II. Mathematics & Engineering Science: Elective Compulsory Computational Science and Engineering: Specialisation Engineering Sciences: Elective Compulsory Mechatronics: Core qualification: Compulsory Technomathematics: Specialisation III. Engineering Science: Elective Compulsory			

Course L0566: Circ	uit Theory
Тур	Lecture
Hrs/wk	3
СР	4
<b>Workload in Hours</b>	Independent Study Time 78, Study Time in Lecture 42
Lecturer	Prof. Arne Jacob
Language	
Cycle	WiSe
	- Circuit theorems
	- N-port circuits
	- Periodic excitation of linear circuits
Content	- Transient analysis in time domain
	- Transient analysis in frequency domain; Laplace Transform
	- Frequency behaviour of passive one-ports
	- 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)
Literature	- T. Harriehausen, D. Schwarzenau, "Moeller Grundlagen der Elektrotechnik", Springer (2013)
	<ul> <li>- A. Hambley, "Electrical Engineering: Principles and Applications", Pearson (2008)</li> <li>- R. C. Dorf, J. A. Svoboda, "Introduction to electrical circuits", Wiley (2006)</li> </ul>
	- 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	
<b>Workload in Hours</b>	Independent Study Time 32, Study Time in Lecture 28	
Lecturer	Prof. Arne Jacob	
Language	DE	
Cycle	WiSe	
Content	see interlocking course	
	siehe korrespondierende Lehrveranstaltung	
Literature	see interlocking course	

Module M0730	0: Computer Engineerii	ng			
Courses					
<b>Title</b> Computer Engineering Computer Engineering		<b>Typ</b> Lecture Recitation (small)	Hrs/wk 3 Section 1	<b>CP</b> 4 2	
Module Responsible		(Smail)			
Admission Requirements	None				
Recommended Previous Knowledge	Basic knowledge in electrical eng	ineering			
Educational Objectives	I ATTOR TAKING NATE CHECKECTHING CTI	udents have reached t	he following learn	ing results	
Professional Competence					
Knowledge	<ul> <li>This module deals with the foundations of the functionality of computing systems. It covers the layers from the assembly-level programming down to gates. The module includes the following topics: <ul> <li>Introduction</li> <li>Combinational logic: Gates, Boolean algebra, Boolean functions, hardware synthesis, combinational networks</li> <li>Sequential logic: Flip-flops, automata, systematic hardware design</li> <li>Technological foundations</li> <li>Computer arithmetic: Integer addition, subtraction, multiplication and division</li> <li>Basics of computer architecture: Programming models, MIPS single-cycle architecture, pipelining</li> <li>Memories: Memory hierarchies, SRAM, DRAM, caches</li> <li>Input/output: I/O from the perspective of the CPU, principles of passing data, point-to-point connections, busses</li> </ul> </li> <li>The students perceive computer systems from the architect's perspective, i.e., they</li> </ul>				
Skills	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 a collection of few and simple components. They are able to distinguis between and to explain the different abstraction layers of today's computin 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 execute on it. In particular, they shall understand the consequences that the execution confits on the hardware-centric abstraction layers from the assemble language down to gates. This way, they will be enabled to evaluate the impact that these low abstraction levels have on an entire system's performance and the propose feasible options.				
Personal Competence Social Competence		ar problems alone or i	n a group and to	present the	
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, Stu	udy Time in Lecture 50	6		
Credit points	6				

	CompulsorBonus	Form	Description
achievement	Yes 10 %	Excercises	
Examination	Written exam		
Examination duration and scale	90 minutes, contents of	f course and labs	
the Following	Computer Science: Con General Engineering Bioprocess Engineering General Engineering Scarchitecture: Compulso General Engineering Electrical Engineering Biomedical Engineering General Engineering Mechanical Engineering Mechanical Engineering Mechanical Engineering General Engineering Mechanical Engineering Mechanical Engineering General Engineering Mechanical Engineering Mechanical Engineering General Engineering General Engineering Mechanical Engineering General Engineering Genera	science (German prory Science (German prory Science (German prory Science (German progression (German prog	program, 7 semester): Specialisation Process program, 7 semester): Specialisation Civi program, 7 semester): Specialisation program, 7 semester): Specialisation Civi program, 7 semester): Specialisation
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General Engineering Science (English program, 7 semester): Specialisation Mechanical Engineering, Focus Theoretical Mechanical Engineering: Compulsory General Engineering Science (English program, 7 semester): Specialisation Naval Architecture: Compulsory General Engineering Science (English program, 7 semester): Specialisation Process Engineering: Compulsory General Engineering Science (English program, 7 semester): Specialisation Biomedical Engineering: Compulsory Computational Science and Engineering: Core qualification: Compulsory Mechatronics: Core qualification: Compulsory Technomathematics: Specialisation II. Informatics: Elective Compulsory

Course L0321: Com	puter Engineering			
Тур	Lecture			
Hrs/wk	3			
СР				
<b>Workload in Hours</b>	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: Com	Course L0324: Computer Engineering		
Тур	Recitation Section (small)		
Hrs/wk	1		
СР	2		
<b>Workload in Hours</b>	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> Electrical Machines an	d Actuators (L0293)	<b>Typ</b> Lecture	Hrs/wk	<b>CP</b> 4				
Electrical Machines and	d Actuators (L0294)	Recitation (large)	Section 2	2				
Module Responsible	Prof. Thorsten Kern							
Admission Requirements	None	None						
Recommended	Basics of mathematics, in particula	ar complexe numbe	rs, integrals, differ	entials				
Previous Knowledge	Pasies of electrical angineering an							
Educational Objectives	After taking part successfully, stud	ents have reached	the following learn	ing results				
Professional Competence								
·	Students can to draw and expla fields.	in the basic princi	ples of electric ar	nd magnet				
Knowledge	They can describe the function of the standard types of electric machines and present the corresponding equations and characteristic curves. For typically used drives they can explain the major parameters of the energy efficiency of the whole system from the power grid to the driven engine.							
Skills	Students arw able to calculate two-dimensional electric and magnetic fields in particular ferromagnetic circuits with air gap. For this they apply the usual methods of the design auf electric machines.  They can calulate the operational performance of electric machines from their giver characteristic data and selected quantities and characteristic curves. They apply the usual equivalent circuits and graphical methods.							
Personal Competence								
Social Competence	none							
Autonomy	Students are able independently to calculate electric and magnatic fields for applications. They are able to analyse independently the operational performance of electric machines from the charactersitic data and theycan calculate thereof selected quantities and characteristic curves.							
Workload in Hours	Independent Study Time 110, Stud	ly Time in Lecture 7	0					
Credit points	6							
Course achievement	None							
Examination	Subject theoretical and practical w	ork						
Examination duration and scale	Design of four machines and actuators, review of design files							
	General Engineering Science (Ger and Enviromental Engineering: Co General Engineering Science ( Electrical Engineering: Elective Co	mpulsory German program,	•					

	General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering: Elective Compulsory					
	General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Energy Systems: Compulsory					
	General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Mechatronics: Compulsory					
	General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Theoretical Mechanical Engineering: Elective					
Assignment for the Following	Digital Mechanical Engineering: Core qualification: Compulsory					
Curricula	Electrical Engineering: Core qualification: Elective Compulsory Energy and Environmental Engineering: Core qualification: Compulsory General Engineering Science (English program, 7 semester): Specialisation Electrical					
	Engineering: Elective Compulsory					
	General Engineering Science (English program, 7 semester): Specialisation Energy and Environmental Engineering: Compulsory					
	General Engineering Science (English program, 7 semester): Specialisation Mechanical Engineering: Elective Compulsory					
	Computational Science and Engineering: Specialisation Engineering Sciences: Elective Compulsory					
	Logistics and Mobility: Specialisation Engineering Science: Elective Compulsory Mechanical Engineering: Core qualification: Elective Compulsory					
	Mechatronics: Core qualification: Compulsory Technomathematics: Specialisation III. Engineering Science: Elective Compulsory					

Course L0293: Elec	trical Machines and Actuators	
Тур	Lecture	
Hrs/wk	3	
СР	4	
<b>Workload in Hours</b>	Independent Study Time 78, Study Time in Lecture 42	
Lecturer	Prof. Thorsten Kern, Dennis Kähler	
Language	DE	
Cycle	SoSe	
	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	
Content	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	
	Hermann Linse, Roland Fischer: "Elektrotechnik für Maschinenbauer", Vieweg- Verlag; Signatur der Bibliothek der TUHH: ETB 313	
Literature	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: Elec	Course L0294: Electrical Machines and Actuators		
Тур	Recitation Section (large)		
Hrs/wk	2		
СР	2		
<b>Workload in Hours</b>	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 M0748	3: Materials in Electrical Eng	ineering			
Courses					
Courses		_			
<b>Title</b> Electrotechnical Experi	ments (10714)	<b>Typ</b> Lecture		Hrs/wk 1	<b>CP</b> 1
Materials in Electrical E		Lecture		2	3
	Engineering (Problem Solving Course) (L0687)	Recitation (small)	Section	2	2
Module Responsible	Prof. Manfred Eich				
Admission Requirements	None				
Recommended					
Previous Knowledge	Highschool level physics and mathematic	S			
	After taking part successfully, students ha	ave reached	the follow	wing learn	ing results
Professional					
Competence					
Knowledge	Students can explain the composition and in electrical engineering. Students can electrical, thermal, dielectric, magnetic a of their applications in electrical engineer	explicate t nd chemical	he relev	ance of	mechanical
Skills	Students can identify appropriate mathematically. They can derive app influential on the performance of materia	roximative	solutions	and jud	dge factors
Personal Competence					
Social Competence	Students can jointly solve subject relate their results effectively within the framew				
Autonomy	Students are capable to extract relevant and to relate this information to the cor acquired level of expertise with the help exam typical exam questions. Students that acquired from other lectures.	ntent of the of lecture ac	lecture. <sup>-</sup> company	They can ring measu	reflect thei ures such as
Workload in Hours	Independent Study Time 110, Study Time	in Lecture 7	0		
Credit points	6				
Course achievement	None				
Examination	Written exam				
Examination duration and scale	60 minutes				
Assignment for the Following	General Engineering Science (German Electrical Engineering: Compulsory Electrical Engineering: Core qualification: General Engineering Science (English pro Engineering: Compulsory	Compulsory			

Curricula	Computational	Science	and	Engineering:	Specialisation	Engineering	Sciences:
	<b>Elective Compu</b>	Isory					
	Orientierungsst	udium: Co	ore qu	ialification: Ele	ctive Compulso	ry	

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

Course L0685: Mat	erials in Electrical Engineering
Тур	Lecture
Hrs/wk	2
СР	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
	Prof. Manfred Eich
Language	
Cycle	The Hamiltonian approach to classical mechanics. Analysis of a simple oscillator.
Content	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			
<b>Workload in Hours</b>	ndependent Study Time 32, Study Time in Lecture 28			
Lecturer	Prof. Manfred Eich			
Language	DE			
Cycle	SoSe			
Content	<ul> <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)			

	1: Electromagnetics for Engineers I: Time-Independer
Fields	
Courses	
Title	Typ Hrs/wk CP
	ingineers I: Time-Independent Fields (L2281) Lecture 3 5
Electromagnetics for E	ingineers I: Time-Independent Fields (L2282) Recitation Section 2 1 (small)
Module Responsible	Dr. Cheng Yang
Admission	None
Recommended	Basic principles of electrical engineering and advanced mathematics
Previous Knowledge	
Educational Objectives	Latter taking nart successfully students have reached the following learning results
Professional Competence	
	Students can explain the fundamental formulas, relations, and methods of t theory of time-independent electromagnetic fields. They can explicate the princip behavior of electrostatic, magnetostatic, and current density fields with regard respective sources. They can describe the properties of complex electromagne fields by means of superposition of solutions for simple fields. The students a aware of applications for the theory of time-independent electromagnetic fields a are able to explicate these.
	Students can apply Maxwell's Equations in integral notation in order to solve high symmetrical, time-independent, electromagnetic field problems. Furthermore, thare capable of applying a variety of methods that require solving Maxwel Equations for more general problems. The students can assess the principal effect of given time-independent sources of fields and analyze these quantitatively. The can deduce meaningful quantities for the characterization of electrostate magnetostatic, and electrical flow fields (capacitances, inductances, resistance etc.) from given fields and dimension them for practical applications.
Personal Competence	
·	Students are able to work together on subject related tasks in small groups. Th are able to present their results effectively (e.g. during exercise sessions).
Autonomy	Students are capable to gather necessary information from provided references a relate this information to the lecture. They are able to continually reflect the knowledge by means of activities that accompany the lecture, such as short or quizzes during the lectures and exercises that are related to the exam. Based respective feedback, students are expected to adjust their individual learni process. They are able to draw connections between their knowledge obtained this lecture and the content of other lectures (e.g. Electrical Engineering I, Line Algebra, and Analysis).
Workload in Hours	Independent Study Time 110, Study Time in Lecture 70
Credit points	6
Course achievement	INONE
Examination	
Examination duration and scale	120 min

	Engineering Science: Core qualification: Compulsory	
Assignment for	General Engineering Science (English program, 7 semester): Core qualification:	
the Following		
Curricula	General Engineering Science (English program, 7 semester): Specialisation Electrical	
	Engineering: Compulsory	

Course L2281: Electromagnetics for Engineers I: Time-Independent Fields		
Тур	Lecture	
Hrs/wk	3	
СР		
	Independent Study Time 108, Study Time in Lecture 42	
	Dr. Cheng Yang, Prof. Christian Schuster	
Language		
Cycle		
	- Maxwell's Equations in integral and differential notation	
	- 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	
Content	- 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.	
	- G. Lehner, "Elektromagnetische Feldtheorie: Für Ingenieure und Physiker", Springer (2010)	
	- H. Henke, "Elektromagnetische Felder: Theorie und Anwendung", Springer (2011)	
Literature	- W. Nolting, "Grundkurs Theoretische Physik 3: Elektrodynamik", Springer (2011)	
Literature	- D. Griffiths, "Introduction to Electrodynamics", Pearson (2012)	
	- J. Edminister, " Schaum's Outline of Electromagnetics", Mcgraw-Hill (2013)	
	- Richard Feynman, "Feynman Lectures on Physics: Volume 2", Basic Books (2011)	

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

Module M0854	I: Mathematics IV			
Courses				
Title	2 (Partial Differential Equations) (L1043)	<b>Typ</b> Lecture	Hrs/wk	<b>CP</b>
·	2 (Partial Differential Equations) (L1044)	Recitation (small)	Section 1	1
Differential Equations 2	2 (Partial Differential Equations) (L1045)	Recitation (large)	Section 1	1
Complex Functions (L1	038)	Lecture	2	1
Complex Functions (L1	041)	Recitation (small)	Section 1	1
Complex Functions (L1	042)	Recitation (large)	Section 1	1
Module Responsible	Prof. Anusch Taraz			
Admission	None			
Recommended	Mathematics 1 - III			
Educational Objectives	After taking part successfully, students	have reached	the following lear	ning results
Professional Competence				
Knowledge	<ul> <li>Students can name the basic of explain them using appropriate</li> <li>Students can discuss logical control capable of illustrating these control They know proof strategies and</li> </ul>	examples. nnections betw nections with t	een these concep he help of example	ts. They ar
Skills	<ul> <li>Students can model problems in studied in this course. Moreo applying established methods.</li> <li>Students are able to discover a the concepts studied in the cour</li> <li>For a given problem, the stu approach, and are able to critical</li> </ul>	ver, they are nd verify furtherse. dents can dev	capable of solvi er logical connecti velop and execut	ng them b
Personal Competence				
Social Competence	<ul> <li>Students are able to work to mathematics as a common lang</li> <li>In doing so, they can communic their cooperating partners. Mo and deepen the understanding of</li> </ul>	uage. cate new conce reover, they c	epts according to	the needs o
Autonomy	<ul> <li>Students are capable of checking on their own. They can specify get help in solving them.</li> <li>Students have developed suffice</li> </ul>	open questions	s precisely and kn	ow where t

	periods in a goal-oriented manner on hard problems.
	Independent Study Time 68, Study Time in Lecture 112
Credit points	
Course achievement	None
Examination	Written exam
Examination duration and scale	60 min (Complex Functions) + 60 min (Differential Equations 2)
the Following	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 semester): Specialisation Naval Architecture: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Theoretical Mechanical Engineering: Elective Compulsory Computer Science: Specialisation Computational Mathematics: Elective Compulsory Computer Science: Specialisation II. Mathematics and Engineering Science: Elective Compulsory Computer Science: Specialisation Electrical Engineering: Compulsory Engineering Science: Specialisation Electrical Engineering: Compulsory General Engineering Science (English program, 7 semester): Specialisation Electrical Engineering: Compulsory General Engineering Science (English program, 7 semester): Specialisation Electrical Engineering: Compulsory General Engineering Science (English program, 7 semester): Specialisation Mechanical Engineering, Focus Mechatronics: Compulsory General Engineering Science (English program, 7 semester): Specialisation Mechanical Engineering, Focus Theoretical Mechanical Engineering: Compulsory General Engineering Science (English program, 7 semester): Specialisation Naval Architecture: Compulsory Computational Science and Engineering: Specialisation II. Mathematics & Engineering Science: Elective Compulsory Mechanical Engineering: Specialisation Theoretical Mechanical Engineering: Elective Compulsory Mechanical Engineering: Specialisation Theoretical Mechanical Engineering: Elective Compulsory Mechanical Engineering: Specialisation: Compulsory Mechanical Engineering: Specialisation: Compulsory Mechanical Engineering: Specialisation: Compulsory Mechanical Engineering: Engineering: Technical Complementary Course Core Studies: Elective Compulsory

Course L1043: Differential Equations 2 (Partial Differential Equations)		
Тур	Lecture	
Hrs/wk	2	
СР	1	
<b>Workload in Hours</b>	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  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	
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	
<b>Workload in Hours</b>	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	
<b>Workload in Hours</b>	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	
<b>Workload in Hours</b>	Independent Study Time 2, Study Time in Lecture 28	
Lecturer	Dozenten des Fachbereiches Mathematik der UHH	
Language	DE	
Cycle	SoSe	
Content	<ul> <li>Main features of complex analysis</li> <li>Functions of one complex variable</li> <li>Complex differentiation</li> <li>Conformal mappings</li> <li>Complex integration</li> <li>Cauchy's integral theorem</li> <li>Cauchy's integral formula</li> <li>Taylor and Laurent series expansion</li> <li>Singularities and residuals</li> <li>Integral transformations: Fourier and Laplace transformation</li> </ul>	
Literature	http://www.math.uni-hamburg.de/teaching/export/tuhh/index.html	

Course L1041: Complex Functions	
Тур	Recitation Section (small)
Hrs/wk	1
СР	1
<b>Workload in Hours</b>	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
<b>Workload in Hours</b>	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						
<b>Title</b> Signals and Systems (I	L0432)	<b>Typ</b> Lecture		Hrs/wk	<b>CP</b> 4	
Signals and Systems (I	L0433)	Recitation (small)	Section	12	2	
Module Responsible	Prof. Gerhard Bauch					
Admission Requirements	None					
	Mathematics 1-3					
Previous	The modul is an introduction to the thecin maths as covered by the moduls Math with spectral transformations (Fourier so is useful but not required.	hematik 1-3 is	expecte	ed. Further	experienc	
Educational Objectives	l Affer faking nart sliccessfilliv, sfilgents r	nave reached	the follo	wing learn	ing results	
Professional Competence						
·	The students are able to classify and describe signals and linear time-invariant (LTI) systems using methods of signal and system theory. They are able to apply the fundamental transformations of continuous-time and discrete-time signals and systems. They can describe and analyse deterministic signals and systems mathematically in both time and image domain. In particular, they understand the effects in time domain and image domain which are caused by the transition of a continuous-time signal to a discrete-time signal.					
Skills	The students are able to describe and analyse deterministic signals and linear time invariant systems using methods of signal and system theory. They can analyse and design basic systems regarding important properties such as magnitude and phase response, stability, linearity etc They can assess the impact of LTI systems on the signal properties in time and frequency domain.					
Personal Competence						
	The students can jointly solve specific pr	roblems.				
Autonomy	The students are able to acquire relev- sources. They can control their level of solving tutorial problems, software tools	of knowledge	during			
Workload in Hours	Independent Study Time 110, Study Tim	e in Lecture 7	70			
Credit points	6					
Course achievement	LNONE					
Examination	Written exam					
Examination duration and scale	90 min					
	General Engineering Science (German Compulsory Computer Science: Core qualification: Condition Computer Science: Core qualification: Computer Science: Core qualification: Computering Engineering: Core qualification General Engineering Science (English processer) General Engineering Science (English Bioprocesser)	ompulsory Isory I: Compulsory ogram, 7 sem	ester): S	pecialisati	on Electric	

		Engineering er Science: Cor		(English	program,	7	semester):	Specialisation
	General	Engineering	Science					Specialisation
		cal Engineerin	•		•		•	
Assignment for					. •			Specialisation
the Following								
Curricula	General	Engineering	Science	(English	program,	7	semester):	Specialisation
	Mechanic	cal Engineerin	g, Focus A	ircraft Sys	stems Engir	ieei	ing: Compuls	sory
	General	Engineering	Science	(English	program,	7	semester):	Specialisation
		cal Engineerin			. •			
	General	Engineering	Science	(English	program,	7	semester):	Specialisation
		cal Engineerin			. •			•
	General	Engineering	Science	(English	program,	7	semester):	Specialisation
		cal Engineerin						
		-	-					sation Process
		ing: Compulso			,		,	
			•	(English	nrogram	7	semester).	Specialisation
		cal Engineering			program,	•	semester).	Specialisation
		itional Science		-	oro qualific	atio	n: Compulso	rv/
			•	•	•	atic	ni. Compuiso	ı y
		onics: Core qua		•	•	. :	Flashiva (	
	recnnom	nathematics: S	pecialisati	ion III. Eng	ineering Sc	ien	ce: Elective (	Lompuisory

Tvp	Lecture
Hrs/wk	
CP	
	Independent Study Time 78, Study Time in Lecture 42
	Prof. Gerhard Bauch
Language	
Cycle	
	Introduction to signal and system theory  Signals  Classification of signals  Analog and digital signals  Deterministic and random signals  Description of LTI systems by differential equations or difference equations, respectively  Basic properties of signals and operations on signals  Elementary signals  Distributions (Generalized Functions)  Power and energy of signals  Correlation functions of deterministic signals  Autocorrelation function  Crosscorrelation function  Crosscorrelation function  Crosscorrelation function  Crosscorrelation function  Crosscorrelation function  Crosscorrelation function  Corthogonal signals  Applications of correlation  Linear time-invariant (LTI) systems  Linearity  Time-invariance  Description of LTI systems by impulse response and frequency response  Convolution  Convolution  Convolution  Convolution and correlation  Properties of LTI-systems  Causal systems  Stable systems  Memoryless systems  Memoryless systems  Fourier Series and Fourier Transform  Fourier Series and Fourier Transform  Fourier transform of continuous-time signals, discrete-time signals

periodic signals, non-periodic signals • Properties of the Fourier transform • Fourier transform of some basic signals Parseval's theorem Analysis of LTI-systems and signals in the frequency domain Frequency response, magnitude response and phase response Transmission factor, attenuation, gain Frequency-flat and frequency-selective LTI-systems Bandwidth definitions o Basic types of systems (filters), lowpass, highpass, bandpass, bandstop systems Phase delay and group delay Linear-phase systems Distortion-free systems Content • Spectrum analysis with limited observation window: Leakage effect Laplace Transform Relation of Fourier transform and Laplace transform Properties of the Laplace transform Laplace transform of some basic signals Analysis of LTI-systems in the s-domain Transfer function of LTI-systems Relation of Laplace transform, magnitude response and phase response Analysis of LTI-systems using pole-zero plots Allpass filters Minimum-phase, maximum-phase and mixed phase filters Stable systems Sampling Sampling theorem · Reconstruction of continuous-time signals in frequency domain and time domain Oversampling Aliasing Sampling with pulses of finite duration, sample and hold Decimation and interpolation Discrete-Time Fourier Transform (DTFT) Relation of Fourier transform and DTFT Properties of the DTFT Discrete Fourier Transform (DFT) Relation of DTFT and DFT Cyclic properties of the DFT DFT matrix Zero padding Cyclic convolution Fast Fourier Transform (FFT) • Application of the DFT: Orthogonal Frequency Division Multiplex (OFDM) Z-Transform • Relation of Laplace transform, DTFT, and z-transform Properties of the z-transform Z-transform of some basic discrete-time signals Discrete-time systems, digital filters FIR and IIR filters Z-transform of digital filters • Analysis of discrete-time systems using pole-zero plots in the z-domain Stability Allpass filters • Minimum-phase, maximum-phase and mixed-phase filters Linear phase filters • T. Frey , M. Bossert , Signal- und Systemtheorie, B.G. Teubner Verlag 2004

K. Kammeyer, K. Kroschel, Digitale Signalverarbeitung, Teubner Verlag.

## Literature

- 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: Sign	Course L0433: Signals and Systems			
Тур	Recitation Section (small)			
Hrs/wk	2			
СР	2			
<b>Workload in Hours</b>	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			

	40: Introduction to tic Compatibility	Waveguides	, Antenna	is, an
Courses				
<b>Title</b> Introduction to Waveg Compatibility (L1669)	uides, Antennas, and Electromagnetic	<b>Typ</b> Lecture	Hrs/wk	<b>CP</b> 4
Introduction to Waveg Compatibility (L1877)	uides, Antennas, and Electromagnetic	Recitation (small)	Section 2	2
Module Responsible	Prof. Christian Schuster			
Admission Requirements	LNODE			
Recommended		ectrical engineering		
Educational Objectives	After taking part successfully, stu	dents have reached t	he following learr	ning result
Professional Competence				
Knowledge	- General theory of waveguides - Most important types of wavegu - Radiation and basic antenna par - Most important types of antenna - Numerical techniques and CAD t - Fundamentals of Electromagneti - Coupling mechanisms and count - Shielding, grounding, filtering - Standards and regulations - EMC measurement techniques	enomena of electrical of electrical circuits enomena of electromagnetion of electromagnetimeters ults from transmission osition, reflection and ides and their proper ameters and their properties ools for waveguide a c Compatibility ermeasures	gnetic Compatibic circuits  agnetic fields and c fields and wave in line theory is refraction ties  s and antenna desig	ility. Specii I waves es
Skills	Students know how to apply vari- choice of waveguides and antenn electromagnetic properties. They Electromagnetic Compatibilty to systems.	as. They are able to can apply results ar	assess and qualif nd strategies from	fy their bas n the field
Personal Competence				
Social Competence	Students are able to work togeth are able to present their results exercises).			
Autonomy	Students are capable to gather information from subject related, professional publications and relate that information to the context of the lecture. They are able to make a connection between their knowledge obtained in this lecture with the content of other lectures (e.g. theory of electromagnetic fields, fundamentals of electrical engineering / physics). They can discuss technical problems and physical effects in English.			

<b>Workload in Hours</b>	Independent Study Time 110, Study Time in Lecture 70
Credit points	
Course achievement	None
Examination	Oral exam
Examination duration and scale	45 min
the Following	General Engineering Science (German program, 7 semester): Specialisation Electrical Engineering: Elective Compulsory Electrical Engineering: Core qualification: Elective Compulsory Aircraft Systems Engineering: Specialisation Air Transportation Systems: Elective Compulsory Aircraft Systems Engineering: Specialisation Cabin Systems: Elective Compulsory General Engineering Science (English program, 7 semester): Specialisation Electrical Engineering: Elective Compulsory Mechatronics: Specialisation System Design: Elective Compulsory

Course L1669: Intro	oduction to Waveguides, Antennas, and Electromagnetic Compatibility
Тур	Lecture
Hrs/wk	3
СР	4
<b>Workload in Hours</b>	Independent Study Time 78, Study Time in Lecture 42
Lecturer	Prof. Christian Schuster
Language	DE/EN
Cycle	SoSe
	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:
Content	<ul> <li>Fundamental properties and phenomena of electrical circuits</li> <li>Steady-state sinusoidal analysis of electrical circuits</li> <li>Fundamental properties and phenomena of electromagnetic fields and waves</li> <li>Steady-state sinusoidal description of electromagnetic fields and waves</li> <li>Useful microwave network parameters</li> <li>Transmission lines and basic results from transmission line theory</li> <li>Plane wave propagation, superposition, reflection and refraction</li> <li>General theory of waveguides</li> <li>Most important types of waveguides and their properties</li> <li>Radiation and basic antenna parameters</li> <li>Most important types of antennas and their properties</li> <li>Numerical techniques and CAD tools for waveguide and antenna design</li> <li>Fundamentals of Electromagnetic Compatibility</li> <li>Coupling mechanisms and countermeasures</li> <li>Shielding, grounding, filtering</li> <li>Standards and regulations</li> <li>EMC measurement techniques</li> </ul>
Literature	<ul> <li>Zinke, Brunswig, "Hochfrequenztechnik 1", Springer (1999)</li> <li>J. Detlefsen, U. Siart, "Grundlagen der Hochfrequenztechnik", Oldenbourg (2012)</li> <li>D. M. Pozar, "Microwave Engineering", Wiley (2011)</li> </ul>
	<ul><li>Y. Huang, K. Boyle, "Antenna: From Theory to Practice", Wiley (2008)</li><li>H. Ott, "Electromagnetic Compatibility Engineering", Wiley (2009)</li></ul>
	- A. Schwab, W. Kürner, "Elektromagnetische Verträglichkeit", Springer (2007)

Course L1877: Intro	Course L1877: Introduction to Waveguides, Antennas, and Electromagnetic Compatibility			
Тур	Recitation Section (small)			
Hrs/wk	2			
СР	2			
<b>Workload in Hours</b>	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 M0760	0: Electronic De	vices			
Courses					
<b>Title</b> Electronic Devices (L0' Electronic Devices (L0'			<b>Typ</b> Lecture Project-/prob based Learni	,	<b>CP</b> 4 2
Module Responsible	Prof. Hoc Khiem Trieu		33333 2331111	9	
Admission Requirements	None				
Recommended Previous Knowledge	Atomic model and que basics in solid-state phe Successful participation Engineering or courses	ysics on of Phy	sics for Engineers		
Educational Objectives	After taking part succe	ssfully, stu	dents have reached	the following lear	ning results
Professional Competence					
Knowledge	<ul> <li>Students are able</li> <li>to represent the basics of semiconductor physics,</li> <li>to explain the operating principle of important semiconductor devices,</li> <li>to outline device characteristics and equivalent circuits as well as to explain their derivation and</li> <li>to discuss the limitation of device models.</li> </ul>				
Skills			rcuits, ext and to solve con	nplex problems by	oneself
Personal Competence	:				
Social Competence	Students are able to pwell as to present and				eam work as
Autonomy	their experiments.	•			er to prepare
	Independent Study Tin	ne 110, Stu	dy Time in Lecture 7	70	
Credit points	! !				
Course achievement		<b>Form</b> Subject	S K b	Kleingruppen Wiss bestimmten demonstrieren die	Thema, eses in Form

	practical work	Präsentation und Diskussion. Darüber hinaus betreut jede Gruppe eine Übungsaufgabe, die inhaltlich zu dem jeweiligen Versuch gehört.
Examination	Written exam	
Examination duration and scale		
Assignment for the Following Curricula	General Engineering Science (German progra Electrical Engineering: Compulsory Electrical Engineering: Core qualification: Compuls Engineering Science: Specialisation Electrical Engi General Engineering Science (English program, 7 s Engineering: Compulsory Computational Science and Engineering: Sp Engineering Science: Elective Compulsory	sory neering: Compulsory semester): Specialisation Electrical

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

Course L0721: Elec	Course L0721: Electronic Devices		
Тур	Project-/problem-based Learning		
Hrs/wk	2		
СР	2		
<b>Workload in Hours</b>	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 M06 Processes	75: Introduction	to Com	nmunicati	ons a	and	Random
Courses						
Title Introduction to Commu	unications and Random Process	es (L0442)	<b>Typ</b> Lecture	3		<b>CP</b> 4
Introduction to Commu	unications and Random Process	es (L0443)	Recitation (large)	Section 1	-	1
Introduction to Commu	unications and Random Process	es (L2354)	Recitation (small)	Section 1	-	1
	Prof. Gerhard Bauch					
Admission Requirements	None					
Recommended Previous Knowledge	Mathematics 1-3     Signals and Systems					
Educational Objectives	After taking part successfull	y, students h	ave reached t	he followi	ing lear	ning results
Professional Competence						
Knowledge	The students know and understand the fundamental building blocks of a communications system. They can describe and analyse the individual building blocks using knowledge of signal and system theory as well as the theory of stochastic processes. The are aware of the essential resources and evaluation criteria of information transmission and are able to design and evaluate a basic communications system.					
Skills	The students are able to design and evaluate a basic communications system. In particular, they can estimate the required resources in terms of bandwidth and power. They are able to assess essential evaluation parameters of a basic communications system such as bandwidth efficiency or bit error rate and to decide for a suitable transmission method.					
Personal Competence						
Social Competence	The students can jointly solve specific problems.					
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 tutorial problems, software tools, clicker system.					
Workload in Hours	Independent Study Time 11	0, Study Time	e in Lecture 70	)		
Credit points	6					
Course achievement	None					
Examination	Written exam					
Examination duration and scale						
the Following	General Engineering Scient Electrical Engineering: Comp Computer Science: Special Compulsory Computer Science: Specialist Data Science: Core qualificat Electrical Engineering: Core General Engineering Science Engineering: Compulsory	pulsory lisation Compusation Compu tion: Elective qualification:	puter and So tational Mathe Compulsory Compulsory	ftware E ematics: E	ngineer Elective	ing: Elective Compulsory

Computational Science and Engineering: Core qualification: Compulsory Computational Science and Engineering: Specialisation Engineering Sciences: Elective Compulsory Technomathematics: Specialisation III. Engineering Science: Elective Compulsory

Course L0442: Intro	oduction to Communications and Random Processes
Тур	Lecture
Hrs/wk	3
СР	4
<b>Workload in Hours</b>	Independent Study Time 78, Study Time in Lecture 42
	Prof. Gerhard Bauch
Language	
Cycle	WiSe
	<ul> <li>Fundamentals of random processes</li> <li>Introduction to communications engineering</li> <li>Quadrature amplitude modulation</li> </ul>
	<ul> <li>Description of radio frequency transmission in the equivalent complex baseband</li> </ul>
Content	Transmission channels, channel models
Content	<ul> <li>Analog digital conversion: Sampling, quantization, pulsecode modulation (PCM)</li> </ul>
	Fundamentals of information theory, source coding, channel coding
	<ul> <li>Digital baseband transmission: Pulse shaping, eye diagramm, 1. and 2.</li> <li>Nyquist condition, matched filter, detection, error probability</li> </ul>
	Fundamentals of digital modulation
	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
l ita watu wa	J.G. Proakis, M. Salehi: Communication Systems Engineering. Prentice-Hall.
Literature	J.G. Proakis, M. Salehi, G. Bauch, Contemporary Communication Systems. Cengage Learning.

Course L0443: Intro	Course L0443: Introduction to Communications and Random Processes		
Тур	Recitation Section (large)		
Hrs/wk	1		
СР	1		
<b>Workload in Hours</b>	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: Intr	Course L2354: Introduction to Communications and Random Processes		
Тур	Recitation Section (small)		
Hrs/wk	1		
СР	1		
<b>Workload in Hours</b>	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 M1235:	<b>Electrical</b>	Power	Systems	l:	Introduction	to	<b>Electrical</b>
<b>Power Systems</b>							

Courses				
		<b>T</b>	11 (1-	CD
<b>Title</b> Electrical Power System	ms I: Introduction to Electrical Power Systems	Тур	Hrs/wk	СР
(L1670)		Lecture	3	4
Electrical Power System (L1671)	ms I: Introduction to Electrical Power Systems	Recitation Sect (large)	ion <sub>2</sub>	2
Module Responsible	Prof. Christian Becker			
Admission Requirements	None			
Recommended Previous Knowledge	Fundamentals of Electrical Engineering			
Educational Objectives	After taking part successfully, students h	ave reached the fol	lowing learn	ing results
Professional Competence				
Knowledge	Students are able to give an overview of systems. They can explain in detail and power generation, transmission, storage equipment into electric power systems.	d critically evaluate	technologie	s of electric
Skills	With completion of this module the students are able to apply the acquired skills in applications of the design, integration, development of electric power systems and to assess the results.			
Personal				
Competence				
Social Competence	The students can participate in spec advance ideas and represent their own w			discussions,
Autonomy	Students can independently tap knowled	ge of the emphasis	of the lectu	res.
<b>Workload in Hours</b>	Independent Study Time 110, Study Time	e in Lecture 70		
Credit points	6			
Course achievement	None			
Examination	Written exam			
Examination duration and scale	90 - 150 minutes			
Assignment for the Following Curricula		ory compulsory compulsory compulsory compulsory compulsory competitive Compulso competitive Compulso competitive Compulso competitive Computer c	ry gy Engineer mpulsory Specialisati n II. Math	ing: Elective on Electrical nematics &

Theoretical	Mechanical	Engineering:	Technical Comp	olementar	y Course:	Elective
Compulsory						
Theoretical	Mechanical	Engineering:	Specialisation	Energy	Systems:	Elective
Compulsory						

Course L1670: Electrical Power Systems I: Introduction to Electrical Power Systems			
Тур	Lecture		
Hrs/wk	3		
СР	4		
<b>Workload in Hours</b>	Independent Study Time 78, Study Time in Lecture 42		
Lecturer	Prof. Christian Becker		
Language	DE		
Cycle	WiSe		
Content	<ul> <li>fundamentals and current development trends in electric power engineering</li> <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> <li>control in networks and power stations</li> <li>grid protection</li> </ul> <li>grid planning</li> <li>power economy fundamentals</li>		
Literature	<ul> <li>K. Heuck, KD. Dettmann, D. Schulz: "Elektrische Energieversorgung", Vieweg + Teubner, 9. Auflage, 2013</li> <li>A. J. Schwab: "Elektroenergiesysteme", Springer, 5. Auflage, 2017</li> <li>R. Flosdorff: "Elektrische Energieverteilung" Vieweg + Teubner, 9. Auflage, 2008</li> </ul>		

Course L1671: Electrical Power Systems I: Introduction to Electrical Power Systems				
Тур	Recitation Section (large)			
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	<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> <li>control in networks and power stations</li> <li>grid protection</li> <li>grid planning</li> <li>power economy fundamentals</li> </ul>			
Literature	<ul> <li>K. Heuck, KD. Dettmann, D. Schulz: "Elektrische Energieversorgung", Vieweg + Teubner, 9. Auflage, 2013</li> <li>A. J. Schwab: "Elektroenergiesysteme", Springer, 5. Auflage, 2017</li> <li>R. Flosdorff: "Elektrische Energieverteilung" Vieweg + Teubner, 9. Auflage, 2008</li> </ul>			

Module M0783	3: Measurements: Methods	and Data Proce	essing	
Courses				
<b>Title</b> EE Experimental Lab (I Measurements: Method	L0781) ds and Data Processing (L0779)	Typ Practical Course Lecture	Hrs/wk 2 2	<b>CP</b> 2 3
Measurements: Method	ds and Data Processing (L0780)	Recitation Section (small)	1	1
Module Responsible	Prof. Alexander Schlaefer			
Admission Requirements	None			
	principles of mathematics principles of electrical engineering			
Educational Objectives	After taking part successfully, students h	ave reached the follo	wing learni	ng results
Professional Competence				
Knowledge	The students are able to explain the purpose of metrology and the acquisition and processing of measurements. They can detail aspects of probability theory and errors, and explain the processing of stochastic signals. Students know methods to digitalize and describe measured signals.			
Skills	The students are able to evaluate problems of metrology and to apply methods for describing and processing of measurements.			
Personal Competence				
Social Competence	The students solve problems in small gro	oups.		
Autonomy	The students can reflect their knowledge and discuss and evaluate their results.			
Workload in Hours	Independent Study Time 110, Study Time	e in Lecture 70		
Credit points	6			
Course achievement	CompulsorBonusFormYes10 %Excercises	Descript	ion	
Examination	Written exam			
Examination duration and scale				
the Following	General Engineering Science (Germa Electrical Engineering: Elective Compulsor Electrical Engineering: Core qualification: General Engineering Science (English pro Engineering: Elective Compulsory Computational Science and Engineering Compulsory Computational Science and Engineering Elective Compulsory	ory : Compulsory ogram, 7 semester): S : Specialisation Comp	pecialisatio	on Electrical ce: Elective

Technomathematics: Specialisation III. Engineering Science: Elective Compulsory

Course L0781: EE E	Course L0781: EE Experimental Lab			
Тур	Practical Course			
Hrs/wk	2			
СР	2			
<b>Workload in Hours</b>	Independent Study Time 32, Study Time in Lecture 28			
	Prof. Alexander Schlaefer, Prof. Christian Schuster, Prof. Thanh Trung Do, Prof. Rolf-Rainer Grigat, Prof. Arne Jacob, Prof. Herbert Werner, Dozenten des SD E, Prof. Heiko Falk, Prof. Thorsten Kern			
Language	DE			
Cycle				
Content	lab experiments: digital circuits, semiconductors, micro controllers, analog circuits, AC power, electrical machines			
Literature	Wird in der Lehrveranstaltung festgelegt			

Course L0779: Mea	Course L0779: Measurements: Methods and Data Processing			
Тур	Lecture			
Hrs/wk	2			
СР	3			
<b>Workload in Hours</b>	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
<b>Workload in Hours</b>	Independent Study Time 16, Study Time in Lecture 14
Lecturer	Prof. Alexander Schlaefer
Language	DE
Cycle	WiSe
Content	See interlocking course
Literature	See interlocking course

Courses				
Title		Тур	Hrs/wk	СР
Introduction to Control	l Systems (L0654)	Lecture	2	4
Introduction to Control	l Systems (L0655)	Recitation (small)	Section 2	2
Module Responsible	Prof. Herbert Werner			
Admission Requirements	LNODE			
Recommended Previous Knowledge	Representation of signals and sys transform	tems in time and	frequency doma	ain, Laplac
Educational Objectives		nts have reached t	he following learn	ing results
Professional Competence				
Knowledge	<ul> <li>Students can represent dyn domain, and can in particular systems</li> <li>They can explain the dynami properties in terms of frequer</li> <li>They can explain the Nyquiderived from it.</li> <li>They can explain the role of control loops</li> <li>They can explain the way a P frequency response</li> <li>They can explain issues arising domain are implemented digital</li> </ul>	er explain propertions of simple controllers of simple controller affecting when controllers	les of first and solutions and interpoot locus on and the stabilities in analysis and solutions a control loop in	econd orderet dynamility margin synthesis of terms of it
Skills	<ul> <li>Students can transform mo frequency domain and vice volonge of the control to the can design PID control tuning rules</li> <li>They can design PID control tuning rules</li> <li>They can analyze and syntholocus and frequency response</li> <li>They can calculate discrete-continuous-time and use it fo</li> <li>They can use standard softwo carrying out these tasks</li> </ul>	ersa s the behavior of sy lers with the help esize simple contro e techniques time approximation r digital implement	vstems and control of heuristic (Zies of loops with the ns of controllers action	ol loops gler-Nichols help of roo designed
Personal Competence				
Social Competence	Students can work in small grouexperimentally validate their contro Students can obtain information for documentation, experiment guides)	ller designs rom provided soui	rces (lecture note	es, softwar
Autonomy	They can assess their knowledge in learning progress.	n weekly on-line te	ests and thereby	control the

Course L0654: Intro	oduction to 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	
<b>Workload in Hours</b>	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 M150 Fields	2: Electromagnetics for En	gineers	II: Time-De <sub>l</sub>	pendent
Courses				
<b>Title</b> Electromagnetics for E	ngineers II: Time-Dependent Fields (L2283)	<b>Typ</b> Lecture	Hrs/wk	<b>CP</b> 5
Electromagnetics for E	ndineers II. Time-Denendent Fields (1.7.784)	Recitation (small)	Section 2	1
Module Responsible	Dr. Cheng Yang			
Admission Requirements	None			
	Electrical Engineering I, Electrical Enginee	ring II, Theor	etical Electrical Er	ngineering I
Previous Knowledge	Mathematics I, Mathematics II, Mathemati	ics III, Mathen	natics IV	
Educational Objectives	After taking part successfully, students ha	ave reached t	he following learn	ing results
Professional Competence				
Knowledge	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 proporties of complex			
Skills	Students are able to apply a variety of procedures in order to solve the diffusion and the wave equation for general time-dependent field problems. They can assess the principal effects of given time-dependent sources of fields and analyze these quantitatively. They can deduce meaningful quantities for the characterization of fully dynamic fields (wave impedance, skin depth, Poynting-vector, radiation resistance, etc.) from given fields and interpret them with regard to practical applications.			
Personal Competence				
•	Students are able to work together on so are able to present their results effectively			
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 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	)	
Credit points				
Course achievement				
Examination	Written exam			
Examination duration and scale				
	[221]			

Engineering Science: Specialisation Electrical Engineering: Compulsory

Assignment for the Following Curricula

Curricula

Consort Formal Science: Specialisation Electrical Engineering: Compulsory Engineering Science: Specialisation Mechatronics: Compulsory General Engineering Science (English program, 7 semester): Specialisation Electrical Engineering: Compulsory General Engineering: Compulsory

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

Mechatronics: Compulsory

Course L2283: Electromagnetics for Engineers II: Time-Dependent Fields		
Тур	Lecture	
Hrs/wk	3	
СР	5	
Workload in Hours	Independent Study Time 108, Study Time in Lecture 42	
	Dr. Cheng Yang, Prof. Christian Schuster	
Language		
Cycle		
	- 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	
Content	- Polarization and superposition of planar waves	
Content	- 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.	
	- G. Lehner, "Elektromagnetische Feldtheorie: Für Ingenieure und Physiker", Springer (2010)	
	- H. Henke, "Elektromagnetische Felder: Theorie und Anwendung", Springer (2011)	
Literature	- 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 L2284: Electromagnetics for Engineers II: Time-Dependent Fields		
Тур	Recitation Section (small)	
Hrs/wk	2	
СР	1	
<b>Workload in Hours</b>	Independent Study Time 2, Study Time in Lecture 28	
Lecturer	Dr. Cheng Yang, Prof. Christian Schuster	
Language	EN	
Cycle	WiSe	
Content	See interlocking course	
Literature	See interlocking course	

Module M077	7: Semiconductor Circui	it Design		
Courses				
<b>Title</b> Semiconductor Circuit Semiconductor Circuit		<b>Typ</b> Lecture Recitation (small)	Hrs/wk 3 Section 1	<b>CP</b> 4 2
Module Responsible	Prof. Matthias Kuhl	(Siliali)		
Admission Requirements	None			
Recommended Previous Knowledge	Fundamentals of electrical engine Basics of physics, especially semi	_		
Educational Objectives	After taking part successfully, stud	dents have reached t	the following learn	ing results
Professional Competence				
Knowledge	<ul> <li>Students are able to explain electronic circuits.</li> <li>Students are able to explain applied.</li> <li>Students are able to explain amplifiers and their specific.</li> <li>Students know the fundant advantages and disadvantages.</li> <li>Students have knowledge functionality and specifications.</li> <li>Students know the appropring students.</li> </ul>	n how analog circuits ain the functionality cations. nental digital logic or ages. about memory circuits	s functions and what of fundamental circuits and can concuits and can expense.	operational discuss their explain their
Skills	<ul> <li>Students can calculate the define the parameters of el</li> <li>Students are able to developes of logic circuits.</li> <li>Students can use MOS dev for specific applications.</li> </ul>	ectronic circuits. op different logic cir	cuits and can des	ign different
Personal Competence				
Social Competence	<ul> <li>Students are able work effice</li> <li>Students working together professional questions.</li> </ul>			and answer
Autonomy	Students are able to assess	their level of knowle	edge.	
Workload in Hours	Independent Study Time 124, Stu	dy Time in Lecture 5	6	
Credit points				
Course	None			

achievement				
Examination	Written exam			
Examination duration and scale	120 min			
	General Engineering Science (German program, 7 semester): Specialisation Electrical Engineering: Compulsory			
	General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Mechatronics: Compulsory Data Science: Core qualification: Elective Compulsory Electrical Engineering: Core qualification: Compulsory			
	Engineering Science: Specialisation Electrical Engineering: Compulsory Engineering Science: Specialisation Mechatronics: Compulsory			
	General Engineering Science (English program, 7 semester): Specialisation Electrical			
	Engineering: Compulsory			
Curricula	General Engineering Science (English program, 7 semester): Specialisation Mechanical Engineering, Focus Mechatronics: Compulsory			
	General Engineering Science (English program, 7 semester): Specialisation Mechatronics: Compulsory			
	Computational Science and Engineering: Specialisation II. Mathematics &			
	Engineering Science: Elective Compulsory  Mechanical Engineering: Specialisation Mechatronics: Compulsory			
	Mechatronics: Core qualification: Compulsory			
	Technomathematics: Specialisation III. Engineering Science: Elective Compulsory			

Course L0763: Sem	niconductor Circuit Design
Тур	Lecture
Hrs/wk	3
СР	4
<b>Workload in Hours</b>	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	<ul> <li>U. Tietze und Ch. Schenk, E. Gamm, Halbleiterschaltungstechnik, Springer Verlag, 14. Auflage, 2012, ISBN 3540428496</li> <li>R. J. Baker, CMOS - Circuit Design, Layout and Simulation, J. Wiley &amp; Sons Inc., 3. Auflage, 2011, ISBN: 047170055S</li> <li>H. Göbel, Einführung in die Halbleiter-Schaltungstechnik, Berlin, Heidelberg Springer-Verlag Berlin Heidelberg, 2011, ISBN: 9783642208874 ISBN: 9783642208867</li> <li>URL: http://site.ebrary.com/lib/alltitles/docDetail.action?docID=10499499</li> <li>URL: http://dx.doi.org/10.1007/978-3-642-20887-4</li> <li>URL: http://ebooks.ciando.com/book/index.cfm/bok_id/319955</li> <li>URL: http://www.ciando.com/img/bo</li> </ul>

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

Module M0734	1: Electrical Engineering P	roject Laborato	ry	
Courses				
Title		Тур	Hrs/wk	СР
Electrical Engineering Project Laboratory (L0640)  Project-/problem-based Learning			8	6
Module Responsible	Prof. Christian Becker			
Admission Requirements	None			
Recommended Previous Knowledge	Electrical Engineering I, Electrical Engir	neering II		
Educational Objectives	After taking part successfully, students	have reached the follo	owing learn	ing results
Professional Competence				
Knowledge	Students are able to give a summary of the technical details of projects in the area of electrical engineering and illustrate respective relationships. They are capable of describing and communicating relevant problems and questions using appropriate			
Skills	The students can transfer their fundan the process of solving practical prol problems during the realization of pro Students are able to develop, compar standardized problems.	blems. They identify jects in the context of	and overco	ome typica engineering
Personal Competence Social Competence	Students are able to cooperate in independently derive solutions to givengineering. They are able to effective in groups in front of a qualified aud alternative approaches to an electric groups and discuss advantages as well	iven problems in the ely present and explai ience. Students have al engineering proble	e context on their resulthe ability	of electrica ults alone on to develor
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 Tim	ne in Lecture 112		
Credit points	6			
Course				
	None			

achievement	
Examination	Subject theoretical and practical work
Examination duration and scale	based on task + presentation
Assignment for the Following Curricula	General Engineering Science (German program, 7 semester): Specialisation Electrical Engineering: Compulsory Electrical Engineering: Core qualification: Compulsory General Engineering Science (English program, 7 semester): Specialisation Electrical Engineering: Compulsory Technomathematics: Specialisation III. Engineering Science: Elective Compulsory

Course L0640: Electrical Engineering Project Laboratory		
Тур	Project-/problem-based Learning	
Hrs/wk	8	
СР	6	
<b>Workload in Hours</b>	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).	

Module M0829	9: Foundations of Manager	nent		
Courses				
<b>Title</b> Management Tutorial (		<b>Typ</b> Recitation (small)	Hrs/wk Section 2	<b>CP</b> 3
Introduction to Manage		Lecture	3	3
	1			
Admission Requirements	110000			
Recommended Previous Knowledge	Basic Knowledge of Mathematics and E	Business		
Educational Objectives	I NTTOR FAVING NART CHECOCCTIIIIV CTHOONTS	have reached	the following learn	ing results
Professional Competence				
Knowledge	<ul> <li>After taking this module, students know the important basics of many different areas in Business and Management, from Planning and Organisation to Marketing and Innovation, and also to Investment and Controlling. In particular they are able to</li> <li>explain the differences between Economics and Management and the sub-disciplines in Management and to name important definitions from the field of Management</li> <li>explain the most important aspects of and goals in Management and name the most important aspects of entreprneurial projects</li> <li>describe and explain basic business functions as production, procurement and sourcing, supply chain management, organization and human ressource management, information management, innovation management and marketing</li> <li>explain the relevance of planning and decision making in Business, esp. in situations under multiple objectives and uncertainty, and explain some basic methods from mathematical Finance</li> <li>state basics from accounting and costing and selected controlling methods.</li> </ul>			
Skills	Students are able to analyse busin (organization, objectives, strategies of project in a team. In particular, they are analyse Management goals and analyse organisational and staff apply methods for decision uncertainty and under risk analyse production and procusystems analyse and apply basic method select and apply basic method problems  apply basic methods from accorproblems	etc.) and to care able to structure them structures of care making under structures of care making under structures of care making under	arry out an Entre appropriately ompanies r multiple object ms and Business matical finance to	preneurship ives, under information predefined
Personal Competence	Students are able to  work successfully in a team of st			
	to apply their knowledge from t	ne lecture to ar	ı entrepreneurship	project and

Social Competence	write a coherent report on the project  to communicate appropriately and  to cooperate respectfully with their fellow students.				
Autonomy	<ul> <li>Students are able to</li> <li>work in a team and to organize the team themselves</li> <li>to write a report on their project.</li> </ul>				
<b>Workload in Hours</b>	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	several written exams during the semester				
the Following	General Engineering Science (German program, 7 semester): Core qualification: Compulsory Civil- and Environmental Engineering: Core qualification: Compulsory Civil- and Environmental Engineering: Specialisation Civil Engineering: Elective Compulsory Civil- and Environmental Engineering: Specialisation Water and Environment: Elective Compulsory Civil- and Environmental Engineering: Specialisation Traffic and Mobility: Elective Compulsory Civil- and Environmental Engineering: Specialisation Traffic and Mobility: Elective Compulsory Bioprocess Engineering: Core qualification: Compulsory Bioprocess Engineering: Core qualification: Compulsory Computer Science: Core qualification: Compulsory Data Science: Core qualification: Compulsory Electrical Engineering: Core qualification: Compulsory Energy and Environmental Engineering: Core qualification: Compulsory General Engineering Science (English program, 7 semester): Specialisation Electrical Engineering: Compulsory General Engineering Science (English program, 7 semester): Specialisation Eloprocess Engineering: Compulsory General Engineering Science (English program, 7 semester): Specialisation Energy and Environmental Engineering: Compulsory General Engineering Science (English program, 7 semester): Specialisation Computer Science: Compulsory General Engineering Science (English program, 7 semester): Specialisation Mechanical Engineering, Focus Biomechanics: Compulsory General Engineering Science (English program, 7 semester): Specialisation Mechanical Engineering, Focus Biomechanics: Compulsory General Engineering Science (English program, 7 semester): Specialisation Mechanical Engineering, Focus Materials in Engineering: Compulsory General Engineering Science (English program, 7 semester): Specialisation Mechanical Engineering, Focus Mechatronics: Compulsory General Engineering Science (English program, 7 semester): Specialisation Mechanical Engineering, Focus Mechatronics: Compulsory General Engineering Science (English program, 7 semester): Specialisation Mechani				

Mechatronics: Core qualification: Compulsory

Orientierungsstudium: Core qualification: Elective Compulsory

Naval Architecture: Core qualification: Compulsory Technomathematics: Core qualification: Compulsory Process Engineering: Core qualification: Compulsory

Course L0882: Man	agement Tutorial
Тур	Recitation Section (small)
Hrs/wk	2
СР	3
<b>Workload in Hours</b>	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Prof. Christoph Ihl, Katharina Roedelius, Tobias Vlcek
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 self-selected projects that focus on the elaboration of an innovative business idea from the point of view of an established company or a startup. Again, the business knowledge from the lecture should come to practical use. The group projects are guided by a mentor.
Literature	Relevante Literatur aus der korrespondierenden Vorlesung.

Course L0880: Intr	oduction to Management			
Тур	Lecture			
Hrs/wk	3			
СР	3			
Workload in Hours	Independent Study Time 48, Study Time in Lecture 42			
Lecturer	Prof. Christoph Ihl, Prof. Thorsten Blecker, Prof. Christian Lüthje, Prof. Christian Ringle, Prof. Kathrin Fischer, Prof. Cornelius Herstatt, Prof. Wolfgang Kersten, Prof. Matthias Meyer, Prof. Thomas Wrona			
Language	DE			
Cycle	WiSe/SoSe			
Content	<ul> <li>Introduction to Business and Management, Business versus Economics, relevant areas in Business and Management</li> <li>Important definitions from Management,</li> <li>Developing Objectives for Business, and their relation to important Business functions</li> <li>Business Functions: Functions of the Value Chain, e.g. Production and Procurement, Supply Chain Management, Innovation Management, Marketing and Sales         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.			

## **Specialization Energy and Environmental Engineering**

One of the main challenges in modern society is the reliable, environmentally benign and sustainable supply of energy. An efficient energy supply is moreover essential to secure the economic future of the country.

The exponential increase in world population, the raised living standards and the continuously increasing hunger for feedstocks, acreage and energy make imperative the sustainable handling of natural resources. This includes the reduction of emissions and the minimisation of environmental impact. An example with growing significance is the control of the  $CO_2$  emissions that are responsible for the greenhouse effect. For this, possibilities are sought that bring energy savings or involve increased use of renewable energy sources. In a continued utilisation of fossil fuels the reduction of  $CO_2$  emissions is pursued by increasing efficiency and also through separation and underground storage of the  $CO_2$  emitted. The latter approaches make a close cooperation between Energy Engineering and Environmental Engineering unavoidable.

The study specialisation in Energy and Environmental Engineering of the degree General Engineering Science responds to two developments: on the one hand the increasing significance of environmental protection through  $CO_2$  separation in large power stations and, on the other, the growing supply of electricity from regenerative energy sources. Both these key developments in electricity generation are taken into consideration in designing the degree course. Not only for the  $CO_2$  separation technologies but also for other environmental protection purposes, as for example air pollution protection, key qualifications in Chemistry play an important role. Conventional and renewable electricity generation technologies are covered in the degree more detailed but still under a generalist viewpoint.

The study specialisation in Energy and Environmental Engineering of the degree General Engineering Science conveys a wide and well-founded multidisciplinary fundamental knowledge in the disciplines of Energy Engineering and of Environmental Engineering. Extending a well-grounded understanding in the core qualifications over basic engineering methods (mathematics, mechanics, thermodynamics, fluid mechanics, physics, chemistry, electrical engineering, informatics and engineering construction) additional skills are conveyed in energy technology, environmental assessment, environmental technology, materials science and particle technology, along with non-technical subjects. These provide necessary qualifications for elaborating the supporting processes during system development. At the skills level the Bachelor degree prepares the student for a Master study or even a PhD research too, so that after graduation also professional qualifications suitable for a potential future research career are gained.

Module M0933: Fundamentals of Materials Science				
Courses				
Title		Тур	Hrs/wk	СР
Fundamentals of Mate	rials Science I (L1085)	Lecture	2	2
Fundamentals of Materials Science II (Advanced Ceramic Materials, Polymers and Composites) (L0506)		Lecture	2	2
Physical and Chemical Basics of Materials Science (L1095)		Lecture	2	2
Module Responsible	Prof. Jörg Weißmüller			
Admission Requirements	None			
Recommended Previous Knowledge				
Educational	After taking part successfully, students h	ave reached the	following learn	ning results

Professional	
Competence	
Knowledge	The students have acquired a fundamental knowledge on metals, ceramics and polymers and can describe this knowledge comprehensively. Fundamental knowledge here means specifically the issues of atomic structure, microstructure, phase diagrams, phase transformations, corrosion and mechanical properties. The students know about the key aspects of characterization methods for materials and can identify relevant approaches for characterizing 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 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	None
Examination	Written exam
Examination duration and scale	
Assignment for the Following Curricula	General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Biomedical Engineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Energy and Enviromental Engineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Naval Architecture: Compulsory General Engineering Science (German program, 7 semester): Specialisation Naval Architecture: Compulsory Data Science: Specialisation Materials Science: Compulsory Digital Mechanical Engineering: Core qualification: Compulsory Energy and Environmental Engineering: Core qualification: Compulsory General Engineering Science (English program, 7 semester): Specialisation Energy and Enviromental Engineering: Compulsory General Engineering Science (English program, 7 semester): Specialisation Mechanical Engineering: Compulsory General Engineering Science (English program, 7 semester): Specialisation Naval

Mechatronics: Core qualification: Compulsory Naval Architecture: Core qualification: Compulsory Technomathematics: Specialisation III. Engineering Science: Elective Compulsory

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

Module M0598	3: Mechanical Engineeri	ng: Design		
Courses				
<b>Title</b> Embodiment Design ar	Typ Lecture	Hrs/wk	<b>CP</b> 1	
Mechanical Design Pro	ject I (L0695)	Project-/problem- based Learning	3	2
Mechanical Design Pro	ject II (L0592)	Project-/problem- based Learning Project-/problem-	3	2
Team Project Design M	lethodology (L0267)	based Learning	2	1
Module Responsible	Prof. Dieter Krause			
Admission Requirements	None			
Recommended Previous Knowledge	<ul> <li>Eundamontals of Matorials Science</li> </ul>			
Educational Objectives	After taking part successfully, stud	ents have reached the foll	owing learr	ning results
Professional Competence				
Knowledge	<ul> <li>After passing the module, students are able to:</li> <li>explain design guidelines for machinery parts e.g. considering load situation, materials and manufacturing requirements,</li> <li>describe basics of 3D CAD,</li> <li>explain basics methods of engineering designing.</li> </ul>			
Skills	After passing the module, students are able to:  • independently create sketches, technical drawings and documentations e.g. using 3D CAD,  • design components based on design guidelines autonomously,  • dimension (calculate) used components,  • use methods to design and solve engineering design tasks systamtically and solution-oriented,  • apply creativity techniques in teams.			
Personal Competence	After passing the module, students	s are able to:		
Social Competence	develop and evaluate solutions in groups including making and documenting decisions			
Autonomy	<ul> <li>Students are able</li> <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>			
Workload in Hours	Independent Study Time 40, Study	Time in Lecture 140		
Credit points	6			

	Compulso	r <b>B</b> onus	Form				cription	
Course	Yes	None	Written	elaboratio	n		mprojekt struktionsme	thodik
achievement	Yes	None	Written	elaboratio	n	Kon	struktionspro	jekt 1
	Yes	None	Written	elaboratio	n	Kon	struktionspro	jekt 2
	Yes	None	Written	elaboratio	n	3D-0	CAD-Praktiku	m
Examination	Written exa	m						
Examination duration and scale								
Assignment for the Following Curricula	Mechanical General Er Biomedical General En and Enviror Digital Mecl Energy and General En and Enviror General Er Mechanical General Er Biomedical Mechanical Mechanical	Engineering ngineering Engineering Somental Engir Environmer gineering Somental Engir ental Engir ental Engir Engineering Engineering	g: Compu Science : Compu cience (G neering: ( neering: ( neering: ( Science g: Compu Science : Compu g: Core qu lification	Isory (German Isory erman pro Compulsory Core qualification (English Isory (English Isory ualification : Compulsory	program gram, 7 s y fication: Core qualific gram, 7 s y program program : Compuls	, 7 eme omp catio eme , 7	semester): ster): Specia ulsory n: Compulsor ster): Specia semester):	

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

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

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

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

Module M0730	0: Computer Engineerin	g		
Courses				
<b>Title</b> Computer Engineering Computer Engineering		<b>Typ</b> Lecture Recitation	Hrs/wk 3 Section 1	<b>CP</b> 4
		(small)	-	_
пезропзівіє	Prof. Heiko Falk			
Admission Requirements	None			
Recommended Previous Knowledge	Basic knowledge in electrical engli	neering		
Educational Objectives	LATTOR FAVING NART CHARACTURIN CITIE	lents have reached t	he following learn	ing results
Professional Competence				
Knowledge	<ul> <li>This module deals with the foundations of the functionality of computing systems. It covers the layers from the assembly-level programming down to gates. The module includes the following topics: <ul> <li>Introduction</li> <li>Combinational logic: Gates, Boolean algebra, Boolean functions, hardware synthesis, combinational networks</li> <li>Sequential logic: Flip-flops, automata, systematic hardware design</li> <li>Technological foundations</li> <li>Computer arithmetic: Integer addition, subtraction, multiplication and division</li> <li>Basics of computer architecture: Programming models, MIPS single-cycle architecture, pipelining</li> <li>Memories: Memory hierarchies, SRAM, DRAM, caches</li> <li>Input/output: I/O from the perspective of the CPU, principles of passing data, point-to-point connections, busses</li> </ul> </li></ul>			
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 a 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 has on the hardware-centric abstraction layers from the assembly language down to gates. This way, they will be enabled to evaluate the impact that these low abstraction levels have on an entire system's performance and to propose feasible options.			
Personal Competence		problems alone or i	n a group and to	present the
Autonomy	Students are able to acquire nassociate this knowledge with other		n specific literat	cure and to
Workload in Hours	Independent Study Time 124, Stud	dy Time in Lecture 50	5	
Credit points	6			

Course	Compulsor <b>B</b> onus	Form	Description
achievement		Excercises	·
Examination	Written exam		
Examination duration and scale	90 minutes, contents of	course and labs	
Assignment for the Following	Computer Science: Com General Engineering Bioprocess Engineering General Engineering Sc Architecture: Compulso General Engineering Electrical Engineering Electrical Engineering General Engineering Biomedical Engineering General Engineering General Engineering General Engineering General Engineering General Engineering General Engineering Mechanical Engineering General Engineering Mechanical Engineering Sengineering: Compulso Computer Science: Core Data Science: Core qua Electrical Engineering General Engineering Sengineering: Compulso General Engineering General Engineering Mechanical Engineering	spulsory Science (German Compulsory Science (German pro ry Science (German Compulsory Science (German Compulsory Science (German Compulsory Science (German prog German Compulsory German Compulsory German Compulsory German Compulsory German Compulsory German Compulsory German Cous Mechatronic Coence (German Cous Aircraft Syst Coence (German Cous Aircraft Syst Coence (German Cous Coerman Cous Theoretical Coence (German Cous Energy Syst Coence (English progrey Coence (English progrey Coence (English progrey Coence (English progrey Coence (English Compulsory Coence (English Compulsory Coence (English Cous Biomechanic Coence (English Cous Energy Syst Coence (English Cous Energy Syst Coence (English Cous Aircraft Syst Coence (English Cous Materials in Coence (English Cous Materials in Coence (English Coence (	program, 7 semester): Specialisation Processions: Compulsory program, 7 semester): Specialisation
		[244]	

General Engineering Science (English program, 7 semester): Specialisation Mechanical Engineering, Focus Theoretical Mechanical Engineering: Compulsory General Engineering Science (English program, 7 semester): Specialisation Naval Architecture: Compulsory General Engineering Science (English program, 7 semester): Specialisation Process Engineering: Compulsory General Engineering Science (English program, 7 semester): Specialisation Biomedical Engineering: Compulsory Computational Science and Engineering: Core qualification: Compulsory Mechatronics: Core qualification: Compulsory Technomathematics: Specialisation II. Informatics: Elective Compulsory

Course L0321: Com	puter Engineering
Тур	Lecture
Hrs/wk	3
СР	4
<b>Workload in Hours</b>	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	
<b>Workload in Hours</b>	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	0: Electrical Machines and A	ctuators			
Courses					
Title Electrical Machines and	d Actuators (L0293)	<b>Typ</b> Lecture	Hrs/wk	<b>CP</b> 4	
Electrical Machines and	d Actuators (L0294)	Recitation (large)	Section 2	2	
Module Responsible					
Admission Requirements	None				
Recommended	Basics of mathematics, in particular com	plexe numbe	rs, integrals, differ	entials	
Previous Knowledge	I Racice of oloctrical onginooring and mod	Basics of electrical engineering and mechanical engineering			
Educational Objectives		ave reached	the following learn	ing results	
Professional					
Competence	Students can to draw and explain the fields.			_	
Knowledge	They can describe the function of the standard types of electric machines an present the corresponding equations and characteristic curves. For typically use drives they can explain the major parameters of the energy efficiency of the whol system from the power grid to the driven engine.				
Skills	Students arw able to calculate two-dimensional electric and magnetic fields in particular ferromagnetic circuits with air gap. For this they apply the usual methods of the design auf electric machines.  They can calulate the operational performance of electric machines from their given characteristic data and selected quantities and characteristic curves. They apply the usual equivalent circuits and graphical methods.				
Personal Competence Social Competence Autonomy	1 1	dependently t sitic data a	he operational per	formance o	
Workload in Hours	Independent Study Time 110, Study Time	e in Lecture 7	0		
Credit points	6				
Course achievement	None				
Examination	Subject theoretical and practical work				
Examination duration and scale	Design of four machines and actuators, r	eview of desi	gn files		
	General Engineering Science (German p and Enviromental Engineering: Compulso General Engineering Science (Germa Electrical Engineering: Elective Compulso	ory n program,	•		

Assignment for the Following Curricula	Energy and Environmental Engineering: Core qualification: Compulsory General Engineering Science (English program, 7 semester): Specialisation Electrical Engineering: Elective Compulsory General Engineering Science (English program, 7 semester): Specialisation Energy and Environmental Engineering: Compulsory General Engineering Science (English program, 7 semester): Specialisation Mechanical Engineering: Elective Compulsory Computational Science and Engineering: Specialisation Engineering Sciences: Elective Compulsory Logistics and Mobility: Specialisation Engineering Science: Elective Compulsory Mechanical Engineering: Core qualification: Elective Compulsory Mechatronics: Core qualification: Compulsory
	Technomathematics: Specialisation III. Engineering Science: Elective Compulsory

Course L0293: Elec	trical Machines and Actuators
Тур	Lecture
Hrs/wk	3
СР	4
<b>Workload in Hours</b>	Independent Study Time 78, Study Time in Lecture 42
Lecturer	Prof. Thorsten Kern, Dennis Kähler
Language	DE
Cycle	SoSe
	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
Content	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
	Hermann Linse, Roland Fischer: "Elektrotechnik für Maschinenbauer", Vieweg- Verlag; Signatur der Bibliothek der TUHH: ETB 313
Literature	Ralf Kories, Heinz Schmitt-Walter: "Taschenbuch der Elektrotechnik"; Verlag Harri Deutsch; Signatur der Bibliothek der TUHH: ETB 122
	"Grundlagen der Elektrotechnik" - anderer Autoren
	Fachbücher "Elektrische Maschinen"

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

Courses				
<b>Title</b> Fundamentals of Fluid	Mechanics (L0091)	Typ Lecture	Hrs/wk	<b>CP</b> 4
Fluid Mechanics for Pro	ocess Engineering (L0092)	Recitation (large)	Section 2	2
Module Responsible	Prof. Michael Schlüter			
Admission Requirements	None			
Recommended Previous Knowledge	Technical Thermodynamics I+II     Working with force balances			
Educational Objectives	After taking part successfully, stude	ents have reached	the following lea	rning results
Professional Competence	Students are able to:			
Knowledge	explain the difference between different types of flow     give an overview for different applications of the Reynolds Transport			
Skills	<ul> <li>describe and model incompressible flows mathematically</li> <li>reduce the governing equations of fluid mechanics by simplifications archive quantitative solutions e.g. by integration</li> <li>notice the dependency between theory and technical applications</li> <li>use the learned basics for fluid dynamical applications in fields of proce engineering</li> </ul>			
Personal Competence				
Social Competence	<ul> <li>are capable to gather in publications and relate that in able to work together on sub to present their results ef exercises)</li> <li>are able to work out solution solutions orally and to present</li> </ul>	nformation to the nject related tasks fectively in Engl ons for exercises	context of the led in small groups. ish (e.g. during	cture and They are ab small grou
Autonomy	<ul> <li>The students are able to</li> <li>search further literature for this literature,</li> <li>work on their exercises by the with the feedback.</li> </ul>	·	•	_

Credit points	6			
Course achievement	CompulsorBonus Yes 5 %	<b>Form</b> Midterm	Description	
Examination	Written exam			
Examination duration and scale	3 hours			
Assignment for the Following Curricula	Engineering: Compulso General Engineering Bioprocess Engineering General Engineering So and Enviromental Engineering Bioprocess Engineering Energy and Environme General Engineering Bioprocess Engineering General Engineering So and Enviromental Engineering So Engineering: Compulso	ory Science (Geg: Compulsory cience (Germaneering: Compulsory Science (Englisheering: Compulsory Cience (Englisheering: Compulsory Cience (Englisheering: Compulsory Specialisation I	an program, 7 semester): Specialical pulsory cation: Compulsory ng: Core qualification: Compulsory glish program, 7 semester): h program, 7 semester): Specialical pulsory h program, 7 semester): Specialical program, 8 semester): Specialical program, 9 semester): Specialical pro	Specialisation sation Energy  / Specialisation sation Energy sation Process

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

Course L0092: Fluid	d Mechanics for Process Engineering
Тур	Recitation Section (large)
Hrs/wk	2
СР	2
<b>Workload in Hours</b>	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 M0618	3: Renewables and Energ	y Systems		
Courses				
Title Power Industry (L0316 Energy Systems and E Renewable Energy (L0 Renewable Energy (L1	nergy Industry (L0315) 313)	Typ Lecture Lecture Lecture Recitation (small)	Hrs/wk 1 2 2 Section 1	CP 1 2 2 1
Module Responsible	Prof. Martin Kaltschmitt			
Admission Requirements	None			
Recommended Previous Knowledge	none			
Educational Objectives	After taking part successfully, stude	nts have reached th	ne following learn	ing results
Professional Competence				
Knowledge	With completion of this module, characteristics of energy systems at the issues occurring in this context. generation, power distribution and contexts. The students can explain energy systems in general, especi discuss them. Furthermore, the stufrom the use of such systems.	and their economic Furthermore, they I power trading win these aspects, whally for renewable	efficiency. They can explain deta in regard to sul nich are applical energy systems	can explain ills of power oject-related ole to many and critical
Skills	Students are able to apply methodemand or energy production for they can evaluate energy systems and design them under certain givenecessary subject-specific calculation problem.  The students are able to explain processing from the field of renewating the right context.	various types of er technically, enviro yen conditions. The on rules, also for no n questions and	nergy systems. Findering and extended from the control of the cont	curthermore, economically choose the olutions of a ches to its
Personal Competence				
Social Competence	The students are able to analyze su with technical, economical and ecol allows them to make an effective co	ogical criteria unde	r sustainability a	spects. This
Autonomy	Students can independently explo about the subject area and transform			r knowledge
	Independent Study Time 96, Study	Fime in Lecture 84		
Credit points				
Course achievement	None			
Examination	Written exam			

Examination duration and scale	3 hours written exam
Assignment for the Following Curricula	Compulsory

Course L0316: Pow	er Industry
Тур	Lecture
Hrs/wk	1
СР	1
<b>Workload in Hours</b>	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> <li>Cost and efficiency calculation</li> </ul> </li> </ul>
Literature	Folien der Vorlesung

Course L0315: Energy Systems and Energy Industry		
Тур	Lecture	
Hrs/wk	2	
СР	2	
<b>Workload in Hours</b>	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: Ren	ewable Energy
	Lecture
Hrs/wk	
СР	2
<b>Workload in Hours</b>	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: Ren	ewable Energy
Тур	Recitation Section (small)
Hrs/wk	1
СР	1
<b>Workload in Hours</b>	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 M0956	6: Measuremen	t Technology	for Mechanic	cal Engir	eers
Courses					
	urement and Control Sy		<b>Typ</b> Practical Course Lecture	Hrs/wk 2 2	<b>CP</b> 2 3
Measurement Technol	ogy for Mechanical Engir	neering (L1118)	Recitation Sect (large)	ion <sub>1</sub>	1
Module Responsible	Prof. Thorsten Kern		(90)		
Admission Requirements	None				
Recommended Previous Knowledge	Basic knowledge of pl	hysics, chemistry ar	nd electrical engine	ering	
Educational Objectives	After taking part succ	essfully, students h	ave reached the fol	llowing learn	ing results
Professional Competence					
	Students are able to Technology (Quantition Properties of Sensors	es and Units, Unce			
Knowledge	They can outline the quantities to be n quantities, Flow, Tim	naesured (Electric			
	They can describe Spectroscopy, Gas Ch		ds of chemical <i>I</i>	Analysis (Ga	s Sensors,
	Students can select refering measuremen			problems a	nd can use
Skills	The students are able technology and solu context and application	tion approaches as	-		
Personal Competence					
Social Competence	Students can arrive report.	at work results in	groups and docum	ent them in	a common
Autonomy	Students are able to f	amiliarize themselv	es with new measu	rement tech	nologies.
	Independent Study Ti	me 110, Study Time	e in Lecture 70		
Credit points	6				
Course achievement	Compulsoryonus Yes None	Form Subject theore practical work	<b>Descri</b> etical and	ption	
Examination	Written exam				
Examination duration and scale	105 minutes				
	General Engineering	Science (Germa	n program, 7 se	mester): Sp	pecialisation

Mechanical Engineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Biomedical Engineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Energy and Environmental Engineering: Compulsory Digital Mechanical Engineering: Core qualification: Compulsory Energy and Environmental Engineering: Core qualification: Compulsory Engineering Science: Specialisation Mechatronics: Compulsory Engineering Science: Specialisation Mechanical Engineering: Compulsory Engineering Science: Specialisation Biomedical Engineering: Elective Compulsory Assignment for General Engineering Science (English program, 7 semester): Specialisation Energy the Following and Environmental Engineering: Compulsory Curricula General Engineering Science (English program, 7 semester): Specialisation Mechanical Engineering: Compulsory General Engineering Science (English program, 7 semester): Specialisation Biomedical Engineering: Compulsory General Engineering Science (English program, 7 semester): Specialisation Mechatronics: Compulsory General Engineering Science (English program, 7 semester): Specialisation Mechanical Engineering: Compulsory General Engineering Science (English program, 7 semester): Specialisation Biomedical Engineering: Elective Compulsory Mechanical Engineering: Core qualification: Compulsory Mechatronics: Core qualification: Compulsory Process Engineering: Core qualification: Compulsory

Course L1119: Prac	tical Course: Measurement and Control Systems
Typ	Practical Course
Hrs/wk	
СР	
	Independent Study Time 32, Study Time in Lecture 28
	Prof. Thorsten Kern
Language	
	WiSe/SoSe
	Experiment 1: Emission and immission measurement of gaseous pollutants:
Content	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	<ul> <li>Versuch 1:</li> <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> <li>Versuch 2:</li> <li>Grundlagen über elektrische Maschinen, speziell: Asynchronmotoren</li> <li>Simulationsmethoden, speziell: Verwendung von Blockschaltbildern</li> <li>Betriebsverhalten von Kreispumpen, speziell: Kennlinien, Ähnlichkeitsgesetze</li> <li>Versuch 3:</li> <li>Unger, HG.: Optische Nachrichtentechnik, Teil 1: Optische Wellenleiter. Hüthing Verlag, Heidelberg, 1984</li> <li>Dakin, J., Cushaw, B.: Optical Fibre Sensors: Principles and Components. Artech House Boston, 1988</li> <li>Culshaw, B., Dakin, J.: Optical Fibre Sensors: Systems and Application. Artech House Boston, 1989</li> <li>Versuch 4:</li> <li>Leonhard: Einführung in die Regelungstechnik. Vieweg Verlag, Braunschweig-Wiesbaden</li> <li>Jan Lunze: Systemtheoretische Grundlagen, Analyse und Entwurf einschleifiger Regelungen</li> </ul>

Course L1116: Measurement Technology for Mechanical Engineering		
Тур	Lecture	
Hrs/wk	2	
СР		
	Independent Study Time 62, Study Time in Lecture 28	
	Prof. Thorsten Kern, Dennis Kähler	
Language Cycle		
Сусте	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	
Content	2.4 Oscilloscope	
	2.5 Analog-to-Digital Conversion	
	2.6 Data Transmission	
	3 Measurement of Nonelectric Quantities	
	3.1 Temperature	
	3.2 Length, Displacement, Angle	
	3.3 Strain, Force, Pressure	
	3.4 Flow	
	3.5 Time, Frequency	
Literature	Lerch, R.: "Elektrische Messtechnik; Analoge, digitale und computergestützte Verfahren", Springer, 2006, ISBN: 978-3-540-34055-3.	
	Profos, P. Pfeifer, T.: "Handbuch der industriellen Messtechnik", Oldenbourg, 2002, ISBN: 978-3486217940.	

Course L1118: Measurement Technology for Mechanical Engineering	
Тур	Recitation Section (large)
Hrs/wk	1
СР	1
<b>Workload in Hours</b>	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 M065!	5: Computational Fluid Dyn	namics I		
Courses				
<b>Title</b> Computational Fluid D	vnamics I (I 0235)	<b>Typ</b> Lecture	Hrs/wk	<b>CP</b> 3
Computational Fluid D		Recitation (large)	Section 2	3
Modulo	<u> </u>	(large)		
Admission Requirements	INONE			
Recommended Previous Knowledge	Mathematical Methods for Engin     Fundamentals of Differential/inter-		nd series expansio	ons
Educational Objectives		have reached	the following learr	ning results
Professional Competence				
Knowledge	The students are able to list the basic r	numerics of par	tial differential equ	uations.
Skills	The students are able develop approprior the governing partial differential algorithms in a structured way.			
Personal Competence Social Competence	The students can arrive at work results	s in groups and	document them.	
	The students can independently analys	se approaches t	co solving specific	problems.
Autonomy				
	I Independent Study Time 124, Study Ti	me in Lecture 5	56	
Credit points				
Course achievement	LNone			
Examination	Written exam			
Examination duration and scale	2h			
	General Engineering Science (German and Enviromental Engineering: Comput General Engineering Science (German Architecture: Compulsory General Engineering Science (German Mechanical Engineering, Focus Energy General Engineering, Focus Energy Mechanical Engineering, Focus Energy	lsory n program, 7 so nan program, Systems: Elect nan program,	emester): Specialis 7 semester): S ive Compulsory 7 semester): S	sation Nava

	General Engineering Science (German program, 7 semester): Specialisation Energy and Enviromental Engineering: Elective Compulsory
	General Engineering Science (German program, 7 semester): Specialisation
Assignment for	Mechanical Engineering, Focus Theoretical Mechanical Engineering: Elective
the Following	
Curricula	Energy Systems: Technical Complementary Course Core Studies: Elective
	Compulsory
	General Engineering Science (English program, 7 semester): Specialisation Energy
	and Enviromental Engineering: Elective Compulsory
	General Engineering Science (English program, 7 semester): Specialisation Energy
	and Enviromental Engineering: Compulsory
	General Engineering Science (English program, 7 semester): Specialisation
	Mechanical Engineering, Focus Energy Systems: Elective Compulsory
	General Engineering Science (English program, 7 semester): Specialisation Naval
	Architecture: Compulsory
	Mechanical Engineering: Specialisation Energy Systems: Elective Compulsory
	Naval Architecture: Core qualification: Compulsory
	Technomathematics: Specialisation III. Engineering Science: Elective Compulsory

Course L0235: Com	putational Fluid Dynamics I
Тур	Lecture
Hrs/wk	2
СР	3
<b>Workload in Hours</b>	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	
<b>Workload in Hours</b>	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	

ironmental Technology (L1387) ologie (L0326) Prof. Martin Kaltschmitt	<b>Typ</b> Practical C	Hrs/wk	СР
Prof Martin Kaltschmitt	Practical C		CP
TProf. Martin Kairschmitt	Lecture	ourse 1 2	1 2
Prof. Martin RaitSemmet			
None			
Fundamentals of inorganic/org	anic chemistry and b	iology	
After taking part successfully,	students have reache	ed the following lear	ning results
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.			
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.			
.  '. '			• • • .
Students can independently exploit sources about of the subject, acquire the particular knowledge and tranfer it to new problems.			
Independent Study Time 48, S	tudy Time in Lecture	42	
3			
		<b>Description</b>	
<u> </u>			
1 hour			
and Enviromental Engineering General Engineering Science Bioprocess Engineering: Electi General Engineering Science ( Engineering: Elective Compuls Bioprocess Engineering: Core	Compulsory  (German progran  (e Compulsory  German program, 7 s  ory  qualification: Elective  nineering: Core qualifi	n, 7 semester): Semester): Semester): Specialis	Specialisation
	After taking part successfully, so the environmental technology. The the environment. Students can they can explain terms and all students are able to propose a environmental problems. They to assess the potential of possible to work out well four contributes to sustainable devopinons in front of and against to the task as a group as implementation.  Students can independently particular knowledge and transfer to the task as a group as implementation.  Students can independently particular knowledge and transfer to the task as a group as implementation.  Students can independently particular knowledge and transfer to the task as a group as implementation.  Students can independently particular knowledge and transfer to the task as a group as implementation.  Students can independently particular knowledge and transfer to the task as a group as implementation.  Students can independently particular knowledge and transfer to the task as a group as implementation.  Students can independently particular knowledge and transfer to the task as a group as implementation.  Students can independently particular knowledge and transfer to the task as a group as implementation.  Students can independently particular knowledge and transfer to the task as a group as implementation.  Students can independently particular knowledge and transfer to the task as a group as implementation.	After taking part successfully, students have reached with the completion of this modul the students environmental technology. They are able to describe the environment. Students can give an overview They can explain terms and allocate them to related Students are able to propose appropriate managemenvironmental problems. They are able to determit to assess the potential of pollutants to migrate a able to work out well founded opinions on a contributes to sustainable development, and they opinons in front of and against the group.  The students are able to discuss the various technological states are able to determit to assert the states are able to determit to assert the states are able to determit to assert the able to discuss the various and the various are able to determit to assert the able to determit the able to determit the able to determit the able to determit to assert the able to determit to	After taking part successfully, students have reached the following lear  With the completion of this modul the students obtain profound environmental technology. They are able to describe the behaviour of the environment. Students can give an overview of scientific discipling They can explain terms and allocate them to related methods.  Students are able to propose appropriate management and mitigation environmental problems. They are able to determine geochemical part to assess the potential of pollutants to migrate and transform. The able to work out well founded opinions on how Environmental contributes to sustainable development, and they can present and opinions in front of and against the group.  The students are able to discuss the various technical and scientific subject-specific and multidisciplinary. They are able to develop different to the task as a group as well as to discuss their theoretical implementation.  Students can independently exploit sources about of the subject particular knowledge and tranfer it to new problems.  Independent Study Time 48, Study Time in Lecture 42  3  Compulsor one Subject theoretical and practical work  Written exam  1 hour  General Engineering Science (German program, 7 semester): Specialis and Environmental Engineering: Compulsory General Engineering: Elective Compulsory General Engineering Science (German program, 7 semester): Specialis Engineering: Elective Compulsory General Engineering: Core qualification: Elective Compulsory Bioprocess Engineering: Core qualification: Elective Compulsory

Bioprocess Engineering: Elective Compulsory
General Engineering Science (English program, 7 semester): Specialisation Energy
and Environmental Engineering: Compulsory
General Engineering Science (English program, 7 semester): Specialisation Process
Engineering: Elective Compulsory
Process Engineering: Core qualification: Elective Compulsory

Course L1387: Prac	ctical 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
Language	DE
Cycle	SoSe
Content	The experiment demonstrates the effect of ionic strength on the binding of dissolved zinc and phosphate by soil surfaces. From the results it can be inferred that the potential of soil surfaces is modified by the application of salt. This has consequences for the retention of nutrients and pollutants. The experiment is carried out with iron oxide rich soil material.  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	F. Scheffer und P. Schachtschabel (2002): "Lehrbuch der Bodenkunde" TUB Signatur AGG-308  W.E.H. Blum (2007): "Bodenkunde in Stichworten" TUB Signatur AGG-317  C. A. J. Appelo; D. Postma (2005): "Geochemistry, groundwater and pollution"  TUB Signatur GWC-515

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

Courses				
Title		Тур	Hrs/wk	СР
Introduction to Control	Systems (L0654)	Lecture	2	4
Introduction to Control	Systems (L0655)	Recitation (small)	Section 2	2
Module Responsible	Prof. Herbert Werner			
Admission Requirements	None			
Recommended Previous Knowledge		tems in time and	frequency doma	ain, Laplac
Educational Objectives	After taking part successfully, stude	nts have reached t	he following learn	ing results
Professional Competence				
Knowledge	<ul> <li>Students can represent dyn domain, and can in particular systems</li> <li>They can explain the dynami properties in terms of frequenter of they can explain the Nyquiderived from it.</li> <li>They can explain the role of control loops</li> <li>They can explain the way a Properties of the frequency response</li> <li>They can explain issues arising domain are implemented digital</li> </ul>	ar explain propertics of simple controllers	les of first and solutions and interpoot locus on and the stabilities in analysis and solutions a control loop in	econd orderet dynamicallity marginessynthesis of terms of it
Skills	<ul> <li>Students can transform mo frequency domain and vice vice.</li> <li>They can simulate and assess.</li> <li>They can design PID control tuning rules.</li> <li>They can analyze and syntholocus and frequency response.</li> <li>They can calculate discrete-continuous-time and use it fo.</li> <li>They can use standard softwo carrying out these tasks.</li> </ul>	ersa s the behavior of sylers with the help esize simple contro e techniques time approximatio r digital implement	vstems and control of heuristic (Zies of loops with the ns of controllers action	ol loops gler-Nichols help of roo designed i
Personal Competence				
Social Competence	Students can work in small grown experimentally validate their control Students can obtain information f documentation, experiment guides)	ller designs rom provided sou	rces (lecture note	es, softwar
Autonomy	They can assess their knowledge in learning progress.	n weekly on-line te	ests and thereby	control the

	<u> </u>
<b>Workload in Hours</b>	Independent Study Time 124, Study Time in Lecture 56
Credit points	6
Course achievement	
Examination	Written exam
Examination duration and scale	120 min
the Following	General Engineering Science (German program, 7 semester): Core qualification: Compulsory Bioprocess Engineering: Core qualification: Compulsory Computer Science: Specialisation Computational Mathematics: Elective Compulsory Data Science: Core qualification: Elective Compulsory Electrical Engineering: Core qualification: Compulsory Electrical Engineering: Core qualification: Compulsory Energy and Environmental Engineering: Core qualification: Compulsory General Engineering Science (English program, 7 semester): Specialisation Electrical Engineering: Compulsory General Engineering Science (English program, 7 semester): Specialisation Civil Engineering: Compulsory General Engineering Science (English program, 7 semester): Specialisation Bioprocess Engineering: Compulsory General Engineering Science (English program, 7 semester): Specialisation Energy and Enviromental Engineering: Compulsory General Engineering Science (English program, 7 semester): Specialisation Computer Science: Compulsory General Engineering Science (English program, 7 semester): Specialisation Mechanical Engineering, Focus Biomechanics: Compulsory General Engineering Science (English program, 7 semester): Specialisation Mechanical Engineering, Focus Energy Systems: Compulsory General Engineering Science (English program, 7 semester): Specialisation Mechanical Engineering, Focus Materials in Engineering: Compulsory General 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 Mechatronics: 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 Mechatronics: Compulsory General Engineering Science (English program, 7

Course L0654: Intro	oduction to Control Systems
Тур	Lecture
Hrs/wk	
СР	
Workload in Hours	Independent Study Time 92, Study Time in Lecture 28
	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	
<b>Workload in Hours</b>	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	

	<u></u>				
Courses					
<b>Title</b> Thermal Separation Pr	ocesses (L0118)	<b>Typ</b> Lecture		Hrs/wk 2	<b>CP</b> 2
Thermal Separation Pr	rocesses (L0119)	Recitation (small)	Section	2	2
Thermal Separation Pr	rocesses (L0141)	Recitation (large)	Section	1	1
Separation Processes (	(L1159)	Practical Cours	е	1	1
Module Responsible	I Prof. Irina Smirnova				
Admission Requirements					
-	Recommended requirements: Thern	nodynamics III			
Educational Objectives	TATTOT TAKING NATT CHECCOCCITIIN CITING	nts have reached th	ne follov	ving learn	ing results
Professional Competence					
Knowledge	<ul> <li>The students can distinguis processes such as distillation.</li> <li>The students develop an unduring a separation process process, the possibilities of systems</li> <li>They have good knowledge and devices</li> </ul>	, extraction, and ad nderstanding for t s, the estimation c energy saving, and	sorptior the cou of the e I the se	rse of co energy de election o	oncentratio emand of f separatio
Skills	<ul> <li>Using the gained knowledge the students can select a reasonable syst boundary for a given separation process and can close the associated ener and material balances</li> <li>The students can use different graphical methods for the designing or separation process and define the amount of theoretical stages required</li> <li>They can select and design a basic type of thermal separation process for given case based on the advantages and disadvantages of the process</li> <li>The students are capable to obtain independently the needed mate properties from appropriate sources (diagrams and tables)</li> <li>They can calculate continuous and discontinuous processes</li> <li>The students are able to prove their theoretical knowledge in experimental lab work.</li> <li>The students are able to discuss the theoretical background and the control of the experimental work with the teachers in colloquium.</li> <li>The students are capable of linking their gained knowledge with the content other lectures and use it together for the solution of technical problems. Other lectures such as thermodynamics, fluid mechanics and chemical engineering.</li> </ul>		signing of equired process for material dge in the the content of lems. Other		
Personal Competence					
	The students can work techni				

	combined results in the tutorial
Social Competence	<ul> <li>The students are able to carry out practical lab work in small groups and organize a functional division of labor between them. They are able to discuss their results and to document them scientifically in a report.</li> </ul>
Autonomy	<ul> <li>The students are capable to obtain the needed information from suitable sources by themselves and assess their quality</li> <li>The students can proof the state of their knowledge with exam resembling assignments and in this way control their learning process</li> </ul>
Workload in Hours	Independent Study Time 96, Study Time in Lecture 84
Credit points	6
Course achievement	None
Examination	Written exam
Examination duration and scale	120 minutes; theoretical questions and calculations
the Following	General Engineering Science (German program, 7 semester): Specialisation Process Engineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Bioprocess Engineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Energy and Environmental Engineering: Compulsory Bioprocess Engineering: Core qualification: Compulsory Energy and Environmental Engineering: Core qualification: Compulsory General Engineering Science (English program, 7 semester): Specialisation Bioprocess Engineering: Compulsory General Engineering Science (English program, 7 semester): Specialisation Energy and Environmental Engineering: Compulsory General Engineering Science (English program, 7 semester): Specialisation Process Engineering: Compulsory Process Engineering: Core qualification: Compulsory

Course L0118: The	rmal Separation Processes
Тур	Lecture
Hrs/wk	2
СР	2
<b>Workload in Hours</b>	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.  <ul> <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> </li> </ul>

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

Course L0141: The	rmal Separation Processes
Тур	Recitation Section (large)
Hrs/wk	1
СР	1
<b>Workload in Hours</b>	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: Sep	aration Processes		
Тур	Practical Course		
Hrs/wk	1		
СР			
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14		
Lecturer	Prof. Irina Smirnova		
Language	DE/EN		
Cycle	WiSe		
	The students work on eight different experiments in this practical course. For every one of the eight experiments, a colloquium takes place in which the students explain and discuss the theoretical background and its translation into practice with staff and fellow students.		
	The students work small groups with a high degree of division of labor. For every experiment, the students write a report. They receive instructions in terms of scientific writing as well as feedback on their own reports and level of scientific writing so they can increase their capabilities in this area.		
	Topics of the practical course:		
	<ul> <li>Introduction in the thermal process engineering and to the main features of separation processes</li> </ul>		
Content	<ul> <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,</li> </ul>		
	<ul> <li>R. Goedecke (Hisg.): 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>		

Prof. Irina Smirnova   Professional Competence	Module M0538	8: Heat and Mass Transfe	r		
leat and Mass Transfer (L0101) Lecture 2 2 2 Recitation Section 2 2 Recitation Section 2 2 Recitation Section 2 2 Recitation Section 3 2 Recommends	Courses				
Module Responsible Admission Requirements Recommended Previous Knowledge Educational Objectives Professional Competence  • The students are capable of explaining qualitative and determining quantitative heat transfer in procedural apparatus (e. g. heat exchange chemical reactors). • They are capable of distinguish and characterize different kinds of heat transfer methories.  Knowledge  Knowledge  Knowledge  **Nowledge**  **Nowledge**  **Nowledge**  **They are apable to distinguish and characterize different kinds of heat transfer mechanisms namely heat conduction, heat transfer and thermaradiation. • The students have the ability to explain the physical basis for mass transfer in detail and to describe mass transfer qualitative and quantitative by usin suitable mass transfer theories. • They are able to depict the analogy between heat- and mass transfer and to describe complex linked processes in detail.  • The students are able to set reasonable system boundaries for a give transport problem by using the gained knowledge and to balance the corresponding energy and mass flow, respectively. • They are capable to solve specific heat transfer problems (e.g. heate chemical reactors, temperature alteration in fluids) and to calculate the corresponding heat flows.  • Using dimensionless quantities, the students can execute scaling up of technical processes of apparatus. • They are able to distinguish between diffusion, convective mass transition and mass transfer. They can use this knowledge for the description and design of apparatus (e.g. extraction column, rectification column). • In this context, the students are capable to choose and design fundamentar types of heat and mass exchanger for a specific application considering their advantages and disadvantages, respectively. • In addition, they can calculate both, steady-state and non-steady-stat processes in procedural apparatus. • The students are capable to connect their knowledge obtained in thit course with knowledge of other courses (in particular the course	Heat and Mass Transfe	er (L0102)	Lecture Recitation (small) Recitation	2 Section 1	2
Admission Requirements  Recommended Previous Knowledge: Technical Thermodynamics Professional Objectives  Professional Competence  • The students are capable of explaining qualitative and determining quantitative heat transfer in procedural apparatus (e. g. heat exchange chemical reactors).  • They are capable of distinguish and characterize different kinds of heat transfer mechanisms namely heat conduction, heat transfer and thermer radiation.  The students have the ability to explain the physical basis for mass transfer in detail and to describe mass transfer qualitative and quantitative by usin suitable mass transfer theories.  • They are able to depict the analogy between heat- and mass transfer and the describe complex linked processes in detail.  • The students are able to solve specific heat transfer problems (e.g. heate chemical reactors, temperature alteration in fluids) and to calculate the corresponding heat flows.  • Using dimensionless quantities, the students can execute scaling up to technical processes or apparatus.  • They are able to distinguish between diffusion, convective mass transfer and the corresponding heat flows.  • Using dimensionless quantities, the students can execute scaling up to technical processes or apparatus.  • They are able to distinguish between diffusion, convective mass transfer and mass transfer. They can use this knowledge for the description and design of apparatus (e.g. extraction column, rectification column).  In this context, the students are capable to choose and design fundamenta types of heat and mass exchanger for a specific application considering the advantages and disadvantages, respectively.  • In addition, they can calculate both, steady-state and non-steady-stat processes in procedural apparatus.  • The students are capable to connect their knowledge obtained in this course with knowledge of other courses (in particular the course thermodynamics, fluid mechanics and chemical process engineering) to solv concrete technical problems.	Module Responsible	Prof. Irina Smirnova	(idige)		
Recommended Previous Knowledge  Educational Objectives  Professional Competence  • The students are capable of explaining qualitative and determining quantitative heat transfer in procedural apparatus (e. g. heat exchange chemical reactors).  • They are capable of distinguish and characterize different kinds of heat transfer mechanisms namely heat conduction, heat transfer and thermal radiation.  **Knowledge**  Knowledge**  **Knowledge**  **In students have the ability to explain the physical basis for mass transfer in detail and to describe mass transfer qualitative and quantitative by usin suitable mass transfer theories.  • They are able to depict the analogy between heat- and mass transfer and the describe complex linked processes in detail.  • The students are able to set reasonable system boundaries for a give transport problem by using the gained knowledge and to balance the corresponding energy and mass flow, respectively.  • They are capable to solve specific heat transfer problems (e.g. heate chemical reactors, temperature alteration in fluids) and to calculate the corresponding heat flows.  • Using dimensionless quantities, the students can execute scaling up of the complex of the description and mass transfer. They can use this knowledge for the description and mass transfer. They can use this knowledge for the description and mass transfer. They can use this knowledge for the description and mass transfer. They can use this knowledge for the description and edigin of apparatus (e.g. extraction column, rectification column).  • In this context, the students are capable to choose and design fundamented the advantages and disadvantages, respectively.  • In addition, they can calculate both, steady-state and non-steady-state processes in procedural apparatus.  • The students are capable to connect their knowledge obtained in this course with knowledge of other courses (In particular the course thermodynamics, fluid mechanics and chemical process engineering) to solv concrete technical process engineeri	Admission	] 			
Professional Competence  • The students are capable of explaining qualitative and determining quantitative heat transfer in procedural apparatus (e. g. heat exchanges chemical reactors).  • They are capable of distinguish and characterize different kinds of heat transfer mechanisms namely heat conduction, heat transfer and thermal radiation.  **The students have the ability to explain the physical basis for mass transfer in detail and to describe mass transfer qualitative and quantitative by using suitable mass transfer theories.  • They are able to depict the analogy between heat- and mass transfer and the describe complex linked processes in detail.  • The students are able to set reasonable system boundaries for a givent transport problem by using the gained knowledge and to balance the corresponding energy and mass flow, respectively.  • They are capable to solve specific heat transfer problems (e.g. heater chemical reactors, temperature alteration in fluids) and to calculate the corresponding heat flows.  • Using dimensionless quantities, the students can execute scaling up to technical processes or apparatus.  • They are able to distinguish between diffusion, convective mass transition and mass transfer. They can use this knowledge for the description and design of apparatus (e.g. extraction column, rectification column).  • In this context, the students are capable to choose and design fundamental types of heat and mass exchanger for a specific application considering their advantages and disadvantages, respectively.  • In addition, they can calculate both, steady-state and non-steady-state processes in procedural apparatus.  • The students are capable to connect their knowledge obtained in this course with knowlegde of other courses (in particular the course thermodynamics, fluid mechanics and chemical process engineering) to solve concrete technical problems.	Recommended Previous	-	ynamics		
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quantitative heat transfer in procedural apparatus (e. g. heat exchanged chemical reactors).  They are capable of distinguish and characterize different kinds of heat transfer mechanisms namely heat conduction, heat transfer and thermal radiation.  The students have the ability to explain the physical basis for mass transfer in detail and to describe mass transfer qualitative and quantitative by usin suitable mass transfer theories.  They are able to depict the analogy between heat- and mass transfer and the describe complex linked processes in detail.  They are capable to solve specific heat transfer problems (e.g. heate chemical reactors, temperature alteration in fluids) and to calculate the corresponding heat flows.  Using dimensionless quantities, the students can execute scaling up technical processes or apparatus.  They are able to distinguish between diffusion, convective mass transitio and mass transfer. They can use this knowledge for the description and design of apparatus (e.g. extraction column), rectification column).  In this context, the students are capable to choose and design fundamenta types of heat and mass exchanger for a specific application considering thei advantages and disadvantages, respectively.  In addition, they can calculate both, steady-state and non-steady-stat processes in procedural apparatus.  The students are capable to connect their knowledge obtained in this course with knowlegde of other courses (In particular the course thermodynamics, fluid mechanics and chemical process engineering) to solv concrete technical problems.					
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	Skills	transport problem by using corresponding energy and ma  They are capable to solve chemical reactors, temperate corresponding heat flows.  Using dimensionless quantiti technical processes or apparate.  They are able to distinguish and mass transfer. They can design of apparatus (e.g. extrates) in this context, the students at types of heat and mass exchate advantages and disadvantage.  In addition, they can calculate processes in procedural apparates.  The students are capable course with knowlegde of thermodynamics, fluid mechanical and the solution of the students.	the gained knows flow, respective specific heat tracer alteration in the student tus. The student tus are the student tus are capable to changer for a specific s, respectively. The student tus are capable to changer for a specific s, respectively. The state should be student to connect their forms of the state should be student to connect the state of the state should be specifically as the state should be specifically as the state of the state should be specifically as the state of the state o	owledge and to yely.  ansfer problems (  fluids) and to constant of the description column)  noose and design of the description constant of t	balance the decay heated alculate the caling up of ss transition and fundamental dering their steady-state ined in this the courses

Personal Competence			
Social Competence	<ul> <li>The students are capable to work on subject-specific challenges in teams and to present the results orally in a reasonable manner to tutors and other students.</li> </ul>		
Autonomy	<ul> <li>The students are able to find and evaluate necessary information from suitable sources</li> <li>They are able to prove their level of knowledge during the course with accompanying procedure continuously (clicker-system, exam-like assignments) and on this basis they can control their learning processes.</li> </ul>		
<b>Workload in Hours</b>	Independent Study Time 124, Study Time in Lecture 56		
Credit points	6		
Course achievement	None		
Examination	Written exam		
Examination duration and scale	120 minutes; theoretical questions and calculations		
Assignment for the Following Curricula	General Engineering Science (German program, 7 semester): Specialisation Process Engineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Bioprocess Engineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Energy and Environmental Engineering: Compulsory Bioprocess Engineering: Core qualification: Compulsory Energy and Environmental Engineering: Core qualification: Compulsory General Engineering Science (English program, 7 semester): Specialisation Bioprocess Engineering: Compulsory General Engineering Science (English program, 7 semester): Specialisation Energy and Environmental Engineering: Compulsory General Engineering Science (English program, 7 semester): Specialisation Process Engineering: Compulsory Technomathematics: Specialisation III. Engineering Science: Elective Compulsory Process Engineering: Core qualification: Compulsory		

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

Course L0102: Heat and Mass Transfer		
Тур	Recitation Section (small)	
Hrs/wk	1	
СР	2	
<b>Workload in Hours</b>	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: Hea	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	

Courses				
Title		Tun	Uro/wis	CP
Informatics for Process	Engineers (L0836)	<b>Typ</b> Lecture	Hrs/wk 2	<b>CP</b> 2
Informatics for Process	_	Recitation	Section 2	2
Numeric and Matlab (L	-	(small) Practical Cour	se 2	2
Module Responsible	Dr. Marcus Venzke			
Admission Requirements	None			
Recommended Previous Knowledge	Basic knowledge in using MS Windows.			
Educational Objectives	After taking part successfully, stu	dents have reached t	the following learr	ning results
Professional Competence Knowledge				
Skills	Students are capable of object-o Java and of solving mathematic q Students are capable of developi questions.	uestions by using Ma	tlab.	
Personal Competence Social Competence	Students are able to work out solu	utions together in sm	all groups.	
Autonomy	Students are able to assess acqui	red skills by applying	it in practice.	
	Independent Study Time 96, Stud	y Time in Lecture 84		
Credit points Course achievement				
Examination	Written exam			
Examination duration and scale				
the Following	General Engineering Science (Ge and Enviromental Engineering: El- General Engineering Science (Ger Engineering: Elective Compulsory Bioprocess Engineering: Core qua Energy and Environmental Engine General Engineering Science (En and Enviromental Engineering: El-	ective Compulsory man program, 7 sem lification: Compulsory ering: Core qualificat glish program, 7 sen	nester): Specialisa y tion: Compulsory	ation Proce

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

Process Engineering: Core qualification: Compulsory

Course L0836: Info	rmatics for Process Engineers
Тур	Lecture
Hrs/wk	2
СР	2
<b>Workload in Hours</b>	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Dr. Marcus Venzke
Language	DE
Cycle	SoSe
Content	<ul> <li>Introduction to object-oriented modelling and programming exemplified with Java</li> <li>Objects, classes</li> <li>Methods, properties</li> <li>Inheritance</li> <li>Basics of the language Java</li> <li>Sample application: Simulation of an electricity network</li> <li>2D graphics</li> <li>Events and Controls</li> </ul>
Literature	Campione, Mary; Walrath, Kathy: The Java Tutorial - A practical guide for programmers. Addison-Wesley, Reading, Massachusets, 1998. Bibliothek: TII 978  Krüger, Guido; Hansen, Heiko: Handbuch der Java-Programmierung. 3. Auflage Addison-Wesley, 2002. http://www.javabuch.de/  Krüger, Guido: Go to Java 2. Addison-Wesley Verlag, Bonn, 1999. Bibliothek: TII 717  Cowell, John: Essential Java 2 fast. Springer Verlag, London, 1999. Bibliothek: TII 942  Java SE 7 Documentation http://docs.oracle.com/javase/7/docs/  Java Platform, Standard Edition 7 API Specification http://docs.oracle.com/javase/7/docs/api/

Course L0837: Info	rmatics for Process Engineers
Тур	Recitation Section (small)
Hrs/wk	2
СР	2
<b>Workload in Hours</b>	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Dr. Marcus Venzke
Language	
Cycle	SoSe
Content	In the lab, the content from the lecture is practiced and deepened with practical assignments. Every week one or two programming tasks are assigned. These are solved by the students on computers independently, coached by a tutor.
	Campione, Mary; Walrath, Kathy: The Java Tutorial - A practical guide for programmers. Addison-Wesley, Reading, Massachusets, 1998. Bibliothek: TII 978  Krüger, Guido; Hansen, Heiko: Handbuch der Java-Programmierung. 3. Auflage Addison-Wesley, 2002. http://www.javabuch.de/
Literature	Krüger, Guido: Go to Java 2. Addison-Wesley Verlag, Bonn, 1999. Bibliothek: TII 717
	Cowell, John: Essential Java 2 fast. Springer Verlag, London, 1999. Bibliothek: TII 942
	Java SE 7 Documentation http://docs.oracle.com/javase/7/docs/
	Java Platform, Standard Edition 7 API Specification http://docs.oracle.com/javase/7/docs/api/

Course L0125: Numeric and Matlab		
Тур	Practical Course	
Hrs/wk	2	
СР	2	
<b>Workload in Hours</b>	Independent Study Time 32, Study Time in Lecture 28	
Lecturer	Prof. Siegfried Rump, Weitere Mitarbeiter	
Language	DE	
Cycle	SoSe	
Content	<ol> <li>Programming in Matlab</li> <li>Numerical methods for systems of nonlinear equations</li> <li>Basics in computer arithmetic</li> <li>Linear and nonlinear optimization</li> <li>Condition of problems and algorithms</li> <li>Verified numerical results with INTLAB</li> </ol>	
Literature	Literatur (Software-Teil):  1. Moler, C., Numerical Computing with MATLAB, SIAM, 2004 2. The Math Works, Inc., MATLAB: The Language of Technical Computing, 2007 3. Rump, S. M., INTLAB: Interval Labority, http://www.ti3.tu-harburg.de 4. Highham, D. J.; Highham, N. J., MATLAB Guide, SIAM, 2005	

Module M0670	0: Particle Tec	hnology and S	olids Proces	s Engine	ering
Courses					
Title Particle Technology I (I			Typ Lecture Recitation Sect	Hrs/wk 2	<b>CP</b> 3
Particle Technology I (I			(small)	-	1
Particle Technology I (I	•		Practical Course	2	2
		n			
Admission Requirements	<u> </u>				
Recommended Previous Knowledge	keine				
Educational Objectives	After taking part suc	ccessfully, students h	ave reached the fo	llowing learn	ing results
Professional Competence					
Knowledge	<ul> <li>After successful completion of the module students are able to</li> <li>name and explain processes and unit-operations of solids process engineering,</li> <li>characterize particles, particle distributions and to discuss their bulk properties</li> </ul>				
Skills	<ul> <li>Students are able to</li> <li>choose and design apparatuses and processes for solids processing according to the desired solids properties of the product</li> <li>asses solids with respect to their behavior in solids processing steps</li> <li>document their work scientifically.</li> </ul>				
Personal Competence					
Social Competence	scientific personal a	able to discuss scier and to develop solutio	ns for technical-sci	entific issues	in a group.
Autonomy	independently.	to analyze and s	olve questions re	garding sol	id particles
<b>Workload in Hours</b>	Independent Study	Time 110, Study Time	e in Lecture 70		
Credit points	6				
Course achievement	CompulsorBonus Yes None	<b>Form</b> Written elaborati		<b>ption</b> Berichte (p icht) à 5-10 9	
Examination	Written exam				
Examination duration and scale	90 minutes				
Assignment for	Engineering: Compu General Engineering Bioprocess Engineer General Engineering and Enviromental Engineering	ng Science (Germa	n program, 7 se rogram, 7 semeste ory	mester): Sp	pecialisation

the Following	Energy and Environmental Engineering: Core qualification: Compulsory					
Curricula	General Engineering Science (English program, 7 semester): Specialisation					
	Bioprocess Engineering: Compulsory					
	General Engineering Science (English program, 7 semester): Specialisation Energy					
	and Enviromental Engineering: Compulsory					
	General Engineering Science (English program, 7 semester): Specialisation Process					
	Engineering: Compulsory					
	Process Engineering: Core qualification: Compulsory					

Course L0434: Part	ticle Technology I
Тур	Lecture
Hrs/wk	2
СР	3
<b>Workload in Hours</b>	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Prof. Stefan Heinrich
Language	DE
Cycle	SoSe
Content	<ul> <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		
<b>Workload in Hours</b>	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: Part	ticle Technology I
Тур	Practical Course
Hrs/wk	2
СР	2
<b>Workload in Hours</b>	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 Mod2s	9: Foundations of Manage	illelit		
Courses				
Title		Тур	Hrs/wk	СР
Management Tutorial	(L0882)	Recitation (small)	Section 2	3
Introduction to Manage		Lecture	3	3
Module Responsible	Prof. Christoph Ihl			
Admission Requirements				
Knowledge	Basic Knowledge of Mathematics and	Business		
Educational Objectives		ts have reached t	the following learn	ing results
Professional Competence				
Knowledge	<ul> <li>After taking this module, students know the important basics of many different areas in Business and Management, from Planning and Organisation to Marketing and Innovation, and also to Investment and Controlling. In particular they are able to</li> <li>explain the differences between Economics and Management and the subdisciplines in Management and to name important definitions from the field of Management</li> <li>explain the most important aspects of and goals in Management and name the most important aspects of entreprneurial projects</li> <li>describe and explain basic business functions as production, procurement and sourcing, supply chain management, organization and human ressource management, information management, innovation management and marketing</li> <li>explain the relevance of planning and decision making in Business, esp. in situations under multiple objectives and uncertainty, and explain some basic methods from mathematical Finance</li> <li>state basics from accounting and costing and selected controlling methods.</li> </ul>			
Skills	Students are able to analyse busi (organization, objectives, strategies project in a team. In particular, they are analyse Management goals an analyse organisational and sta apply methods for decision uncertainty and under risk analyse production and processystems analyse and apply basic method select and apply basic method problems apply basic methods from accomproblems	etc.) and to cause able to d structure them ff structures of comaking under curement system ads of marketing ods from mather	appropriately ompanies multiple object and Business	epreneurship ives, unde information predefined
Personal Competence	Students are able to			
	<ul><li>work successfully in a team of</li><li>to apply their knowledge from</li></ul>		entrepreneurship	project and
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Social Competence	write a coherent report on the project  to communicate appropriately and  to cooperate respectfully with their fellow students.				
Autonomy	<ul> <li>Students are able to</li> <li>work in a team and to organize the team themselves</li> <li>to write a report on their project.</li> </ul>				
<b>Workload in Hours</b>	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	several written exams during the semester				
the Following	General Engineering Science (German program, 7 semester): Core qualification: Compulsory Civil- and Environmental Engineering: Core qualification: Compulsory Civil- and Environmental Engineering: Specialisation Civil Engineering: Elective Compulsory Civil- and Environmental Engineering: Specialisation Water and Environment: Elective Compulsory Civil- and Environmental Engineering: Specialisation Water and Environment: Elective Compulsory Civil- and Environmental Engineering: Specialisation Traffic and Mobility: Elective Compulsory Bioprocess Engineering: Core qualification: Compulsory Bioprocess Engineering: Core qualification: Compulsory Data Science: Core qualification: Compulsory Electrical Engineering: Core qualification: Compulsory Energy and Environmental Engineering: Core qualification: Compulsory General Engineering Science (English program, 7 semester): Specialisation Electrical Engineering: Compulsory General Engineering Science (English program, 7 semester): Specialisation Civil Engineering: Compulsory General Engineering: Compulsory General Engineering: Compulsory General Engineering: Compulsory General Engineering Science (English program, 7 semester): Specialisation Energy and Environmental Engineering: Compulsory General Engineering Science (English program, 7 semester): Specialisation Computer Science: Compulsory General Engineering Science (English program, 7 semester): Specialisation Mechanical Engineering, Focus Biomechanics: Compulsory General Engineering Science (English program, 7 semester): Specialisation Mechanical Engineering, Focus Biomechanics: Compulsory General Engineering Science (English program, 7 semester): Specialisation Mechanical Engineering, Focus Aircraft Systems Engineering: Compulsory General Engineering, Focus Materials in Engineering Sciences: Compulsory General Engineering, Focus Mechanical Engineering: Specialisation Mechanical Engineering, Focus Materials in Engineering Sciences: Compulsory General Engineering Science (English program, 7 semester): Specialisation Mec				

Mechatronics: Core qualification: Compulsory

Orientierungsstudium: Core qualification: Elective Compulsory

Naval Architecture: Core qualification: Compulsory Technomathematics: Core qualification: Compulsory Process Engineering: Core qualification: Compulsory

Course L0882: Management Tutorial				
Тур	Recitation Section (small)			
Hrs/wk	2			
СР	3			
<b>Workload in Hours</b>	Independent Study Time 62, Study Time in Lecture 28			
Lecturer	Prof. Christoph Ihl, Katharina Roedelius, Tobias Vlcek			
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 self-selected projects that focus on the elaboration of an innovative business idea from the point of view of an established company or a startup. Again, the business knowledge from the lecture should come to practical use. The group projects are guided by a mentor.			
Literature	Relevante Literatur aus der korrespondierenden Vorlesung.			

Course L0880: Intro	oduction to Management				
	Lecture				
Hrs/wk					
СР					
Workload in Hours	Independent Study Time 48, Study Time in Lecture 42				
	Prof. Christoph Ihl, Prof. Thorsten Blecker, Prof. Christian Lüthje, Prof. Christian Ringle, Prof. Kathrin Fischer, Prof. Cornelius Herstatt, Prof. Wolfgang Kersten, Prof. Matthias Meyer, Prof. Thomas Wrona				
Language	DE				
Cycle	WiSe/SoSe				
Content	<ul> <li>Introduction to Business and Management, Business versus Economics, relevant areas in Business and Management</li> <li>Important definitions from Management,</li> <li>Developing Objectives for Business, and their relation to important Business functions</li> <li>Business Functions: Functions of the Value Chain, e.g. Production and Procurement, Supply Chain Management, Innovation Management, Marketing and Sales 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 M0539: Process and Plant Engineering I						
Courses					_	
<b>Title</b> Process and Plant Engi	ineering I (I 0005)		<b>Typ</b> Lecture	Hrs/wl	<b>CP</b> 2	
Process and Plant Engi	_		Recitation	Section <sub>1</sub>	2	
Process and Plant Engi	fileering ( (L0090)		(large)	-	2	
Process and Plant Engi	neering I (L1214)		Recitation (small)	Section 1	2	
Module Responsible	Prof. Mirko Skiborowski					
Admission Requirements	None					
Recommended	unit operation of therma	al an dmechanical	separation p	rocesses		
Previous Knowledge	chemical reactor eingine	eering				
Educational Objectives	After taking part succes	sfully, students ha	ave reached	the following lea	rning results	
Professional						
Competence	i					
	students can:					
	classify and formulate blobal balance equations of chemical processes					
Knowledae	specify linear component equations of complex chemical processes					
	explain linear regression and data reconcilliation problems					
	explain pfd-diagrams					
	students are capable of					
	- formulation of mass and energy balance equations and estimation of product streams					
Skills	- estimation of component streams of chemical plants using linear component balance models					
1	- solution of data reconcilliation tasks					
	- conduction of process synthesis					
	- economic evaluation o	f processes and th	ne estimatior	of production c	osts	
Personal						
Competence	<u>.</u>					
Social Competence Autonomy	i					
	IIndependent Study Time 124, Study Time in Lecture 56					
Credit points	!					
-	Compulsor <b>B</b> onus	Form	D	escription		
Course achievement		Subject theore practical work		•		
Examination	Written exam					
Examination						
duration and scale	120 Min. lectures notes and books					
	General Engineering Science (German program, 7 semester): Specialisation Process					

	Engineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Bioprocess Engineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Energy
Assignment for	and Enviromental Engineering: Elective Compulsory
the Following	Bioprocess Engineering: Core qualification: Compulsory
Curricula	General Engineering Science (English program, 7 semester): Specialisation
	Bioprocess Engineering: Compulsory
	General Engineering Science (English program, 7 semester): Specialisation Energy
	and Enviromental Engineering: Elective Compulsory
	General Engineering Science (English program, 7 semester): Specialisation Process
	Engineering: Compulsory
	Process Engineering: Core qualification: Compulsory

Course L0095: Pro	cess and Plant Engineering I			
Тур	Lecture			
Hrs/wk	2			
СР	2			
<b>Workload in Hours</b>	Independent Study Time 32, Study Time in Lecture 28			
Lecturer	Prof. Mirko Skiborowski			
Language	DE			
Cycle	SoSe			
Content	1. Introduction Structure and operation of production plants Operational business process Technical process design Motivation and targets of process development Life cycle of production plants 2. Engineering methods and tools Mass and energy balances Strategies of process synthesis Graphical representation of processes Multidimensional regression Data reconciliation and data validation 3. Process Synthesis Decision levels Experimental process development Reactor synthesis Synthesis of separation processes (process alternatives and criteria for selection) Integration of reaction systems/separation systems (interactions, recycle streams) 4. Process safety 5. Cost estimation of production plants Production costs, capital costs, economic evaluation			
	S.D. Barnicki, J.R. Fair, Ind. End. Chem., 29(1990), S. 421, Ind. End. Chem., 31(1992), S. 1679			
	H. Becker, S. Godorr, H. Kreis, Chemical Engineering, January 2001, S. 68-74			
	Behr, W. Ebbers, N. Wiese, ChemIngTech. 72(2000)Nr. 10, S.1157			
	E. Blass, Entwicklung verfahrenstechnischer Prozesse, Springer-Verlag, 2. Auflage 1997			
	M. H. Bauer, J. Stichlmair, ChemIngTech., 68(1996), Nr. 8, 911-916			
	R. Dittmeyer, W. Keim, G. Kreysa, A. Oberholz, Chemische Technik. Prozesse und			

### Produkte,

Band 2, Neue Technologien, 5. Auflage, Wiley-VCH GmbH&Co.KGaA, Weinheim, 2004

- J.M. Douglas, Conceptual Design of Chemical Processes, Mc Graw-Hill, NY, 1988
- G. Fieg, Inz. Chem. Proc., 5(1979), S.15-19
- G. Fieg, G. Wozny, L. Jeromin, Chem. Eng. Technol. 17(1994),5, 301-306
- G. Fieg, Heat and Mass Transfer 32(1996), S. 205-213
- G. Fieg, Chem. Eng. Processing, Vol. 41/2(2001), S. 123-133
- U.H. Felcht, Chemie eine reife Industrie oder weiterhin Innovationsmotor, Universitätsbuchhandlung Blazek und Bergamann, Frankfurt, 2000

## Literature

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 Typ Recitation Section (large) Hrs/wk 1 CP 2 Workload in Hours Independent Study Time 46, Study Time in Lecture 14 Lecturer Prof. Mirko Skiborowski, Dr. Thomas Waluga Language DE Cycle SoSe Content See interlocking course Literature See interlocking course

Course L1214: Process and Plant Engineering I		
Тур	Recitation Section (small)	
Hrs/wk	1	
СР	2	
<b>Workload in Hours</b>	Independent Study Time 46, Study Time in Lecture 14	
Lecturer	Prof. Mirko Skiborowski, Dr. Thomas Waluga	
Language	DE	
Cycle	SoSe	
Content	See interlocking course	
Literature	See interlocking course	

Module M1274	4: Environmental Techno	logy		
Courses				
Title Environmental Assessr		<b>Typ</b> Lecture Recitation	Hrs/wk 2 Section 1	<b>CP</b> 2
Environmental Assessr	ment (L1054)	(small)	1	1
Module Responsible	Prof. Martin Kaitschmitt			
Admission Requirements				
Recommended Previous Knowledge	Fundamentals of inorganic/organic of	chemistry and biolo	ogy	
Educational Objectives	After taking part successfully, stude	nts have reached t	he following learn	ing results
Professional				
Competence		lo tho -t	andea la desetta l	n ovul a ala: - 1
Knowledge	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.			
Skills	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 EcoInvent. After finishing the course the students have the competence to critically judge research results or other publications on environmental impacts.			
Personal Competence				
Social Competence	The students are able to discuss the various technical and scientific tasks, both subject-specific and multidisciplinary. They are able to develop jointly different solutions and to discuss their theoretical or practical implementation. Due to the selected lecture topics, the students receive insights into the multi-layered issues of the environment protection and the concept of sustainability. Their sensitivity and consciousness towards these subjects are raised and which helps to raise their awareness of their future social responsibilities in their role as engineers.			
Autonomy	The students learn to research, process and present a scientific topic independently They are able to carry out independent scientific work. They can solve ar environmental problem in a business context and are able to judge results of other publications.			
Workload in Hours	Independent Study Time 48, Study 1	Fime in Lecture 42		
Credit points				
Course achievement	None			
Examination	Written exam			
Examination				

duration and scale	1 hour written exam
Assignment for the Following	General Engineering Science (German program, 7 semester): Specialisation Energy and Enviromental Engineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Bioprocess Engineering: Elective Compulsory General Engineering Science (German program, 7 semester): Specialisation Process Engineering: Elective Compulsory Bioprocess Engineering: Core qualification: Elective Compulsory Energy and Environmental Engineering: Core qualification: Compulsory General Engineering Science (English program, 7 semester): Specialisation Bioprocess Engineering: Elective Compulsory General Engineering Science (English program, 7 semester): Specialisation Energy and Enviromental Engineering: Compulsory General Engineering Science (English program, 7 semester): Specialisation Process Engineering: Elective Compulsory Process Engineering: Core qualification: Elective Compulsory

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

Course L1054: Environmental Assessment			
Тур	Recitation Section (small)		
Hrs/wk	1		
СР	1		
<b>Workload in Hours</b>	Independent Study Time 16, Study Time in Lecture 14		
Lecturer	Prof. Martin Kaltschmitt		
Language	DE		
Cycle	SoSe		
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		

# **Specialization Computer Science**

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	L: Discrete Algebraic Structu	ıres		
Courses				
<b>Title</b> Discrete Algebraic Stru	uctures (L0164)	<b>Typ</b> Lecture	Hrs/wk 2	<b>CP</b> 3
Discrete Algebraic Stru	uctures (L0165)	Recitation (small)	Section 2	3
Module Responsible	Prof. Karl-Heinz Zimmermann			
Admission Requirements	None			
Recommended Previous Knowledge	Mathematics from High School.			
Educational Objectives	After taking part successfully, students h	ave reached t	he following lear	rning results
Professional Competence				
Knowledge	The students know the important basics of discrete algebraic structures including elementary combinatorial structures, monoids, groups, rings, fields, finite fields, and vector spaces. They also know specific structures like sub sum-, and quotient structures and homomorphisms.			
Skills	Students are able to formalize and analyze basic discrete algebraic structures.			
Personal Competence				
Social Competence	Students are able to solve specific problems alone or in a group and to present the results accordingly.			
Autonomy	Students are able to acquire new know associate the acquired knowledge to other		ecific standard	books and to
Workload in Hours	Independent Study Time 124, Study Time	e in Lecture 56	5	
Credit points	6			
Course achievement	None			
Examination	Written exam			
Examination duration and scale				
Assignment for the Following Curricula	General Engineering Science (Germa Computer Science: Compulsory Computer Science: Core qualification: Co Data Science: Core qualification: Compul General Engineering Science (English Computer Science: Compulsory Computational Science and Engineering: Orientierungsstudium: Core qualifications	mpulsory sory n program, Core qualifica	7 semester): tion: Compulsor	Specialisation

Course L0164: Discrete Algebraic Structures		
Тур	Lecture	
Hrs/wk	2	
СР	3	
<b>Workload in Hours</b>	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	
<b>Workload in Hours</b>	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	

Module M0730	0: Computer Engineerin	g		
Courses				
Title Computer Engineering		<b>Typ</b> Lecture Recitation	Hrs/wk 3 Section 1	<b>CP</b> 4
Computer Engineering	(LU324)	(small)	1	2
- Responsible	Prof. Heiko Falk			
Admission Requirements	None			
Recommended Previous Knowledge	Basic knowledge in electrical engi	neering		
Educational Objectives	LATTOR FAKING NART CHECKDECTHING CTH	dents have reached t	he following learn	ing results
Professional Competence				
Knowledge	<ul> <li>This module deals with the foundations of the functionality of computing systems. It covers the layers from the assembly-level programming down to gates. The module includes the following topics: <ul> <li>Introduction</li> <li>Combinational logic: Gates, Boolean algebra, Boolean functions, hardware synthesis, combinational networks</li> <li>Sequential logic: Flip-flops, automata, systematic hardware design</li> <li>Technological foundations</li> <li>Computer arithmetic: Integer addition, subtraction, multiplication and division</li> <li>Basics of computer architecture: Programming models, MIPS single-cycle architecture, pipelining</li> <li>Memories: Memory hierarchies, SRAM, DRAM, caches</li> <li>Input/output: I/O from the perspective of the CPU, principles of passing data, point-to-point connections, busses</li> </ul> </li></ul>			
Skills	The students perceive computer sidentify the internal structure and the students can analyze, how his based on a collection of few and between and to explain the disystems - from gates and circuits.  After successful completion of the interdependencies between a physical on it. In particular, they shall unsoftware has on the hardware language down to gates. This way these low abstraction levels hapropose feasible options.	d the physical comp ghly specific and indi simple components. fferent abstraction up to complete proce the module, the stu- visical computer systed derstand the consequence. Incremental consequence, they will be enable	osition of computers vidual computers. They are able to layers of today's essors.  dents are able tom and the softwall uences that the layers from the document of the column of the evaluate the	cer systems. can be built distinguish computing judge the re executed execution of e assembly impact that
Personal Competence Social Competence		r problems alone or i	n a group and to	present the
Autonomy	Students are able to acquire r associate this knowledge with oth		n specific literat	ure and to
	Independent Study Time 124, Stu	dy Time in Lecture 56	5	
Credit points				

	CompulsorBonus	Form	Description
achievement	Yes 10 %	Excercises	
Examination	Written exam		
Examination duration and scale	90 minutes, contents of	course and labs	
the Following	Computer Science: Com General Engineering Bioprocess Engineering General Engineering Sc Architecture: Compulso General Engineering Electrical Engineering Electrical Engineering General Engineering Biomedical Engineering General Engineering General Engineering General Engineering General Engineering General Engineering General Engineering Mechanical Engineering General Engineering Mechanical Engineering General Engineering Mechanical Engineering General Engineering General Engineering Mechanical Engineering	science (German progry Science (German progry Science (German progry Science (German progression (German progression (German progression (German progression (German progry Science (German progry Science (German progry Science (German progry Science (German progression (German progressi	program, 7 semester): Specialisation Process program, 7 semester): Specialisation cs: Compulsory program, 7 semester): Specialisation cs: Compulsory program, 7 semester): Specialisation tems Engineering: Compulsory program, 7 semester): Specialisation Engineering Sciences: Compulsory program, 7 semester): Specialisation Mechanical Engineering: Compulsory program, 7 semester): Specialisation velopment and Production: Compulsory program, 7 semester): Specialisation Civi pulsory compulsory compulsory program, 7 semester): Specialisation program, 7 semester): Specialisation program, 7 semester): Specialisation program, 7 semester): Specialisation velopment and Production program, 7 semester): Specialisation program, 7 semester): Specialisation program, 7 semester): Specialisation velopment and Production velopment and
•		[298]	

General Engineering Science (English program, 7 semester): Specialisation Mechanical Engineering, Focus Theoretical Mechanical Engineering: Compulsory General Engineering Science (English program, 7 semester): Specialisation Naval Architecture: Compulsory
General Engineering Science (English program, 7 semester): Specialisation Process Engineering: Compulsory
General Engineering Science (English program, 7 semester): Specialisation Biomedical Engineering: Compulsory
Computational Science and Engineering: Core qualification: Compulsory
Mechatronics: Core qualification: Compulsory
Technomathematics: Specialisation II. Informatics: Elective Compulsory

Course L0321: Com	puter Engineering
Тур	Lecture
Hrs/wk	3
СР	4
<b>Workload in Hours</b>	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					
<b>Workload in Hours</b>	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				
-	formal Languages (L0332)	<b>Typ</b> Lecture Recitation	Hrs/wk 2 Section 2	4
Automata Theory and F	formal Languages (L0507)	(small)	2	2
	Prof. Tobias Knopp			
Admission Requirements	None			
	Participating students should be at	le to		
Recommended	- specify algorithms for simple c computational problems	ata structures (si	uch as, e.g., arra	ays) to solv
	- apply propositional logic and p mathematical proofs	redicate logic for	specifying and ι	ınderstandir
	- apply the knowledge and skills ta	ught in the module	Discrete Algebra	ic Structure
Educational Objectives	After taking part successfully, stud	ents have reached	the following lear	ning results
Professional Competence				
Knowledge	Students can explain syntax, ser logic, and they are able to give all can show correspondences to E application problems are hard to a the students can motivate predidecision problems for this repunification and resolution for solutions of temporal logic, and identicourse can define various kinds of logic and formal grammars. The selection problems students can narmore expressive than determinist and more expressive than determinist transform decision problems w.r.t. formalisms. They understand the whereas others are best suited for can describe the relationships be grammars.	gorithms for solving oolean algebra. Sepresent with processed logic, and described for solving the predicated, semantics, and sepresed for their application finite automata and pectrum that study of their automata and those formalism. They are also expressivity, and the some formalism into the some formalism into the sexpressivity and the sex	g decision proble Students can de positional logic, a lefine syntax, se alism. Students decision problem areas. The particular can identify redents can explain and pushdown for which nonder able to demor d, in addition, decision problem ms easily inducts and their proper	ims. Studentscribe which ind therefore mantics, as can explait explains for various with the students can with the calgorithm ties. Students to the calgorithm ties. Students can with the calgorithm ties.
Skills	Students can apply propositional given set of formulas. Students a propositional logic, predicate logic They can evaluate which formal problem, and they can demonst problems to specific formulas. automata into deterministic ones versa. They can show how parse language emptiness problem in cas	nalyze application, or temporal logi sm is best suite rate the application Students can als or derive grammes work, and they	n problems in or c formulas to rep d for a particula on of algorithms o transform nor nars from autom can apply algori	der to derionesent then application for decision deterministate and visate and visue to deterministate and visue and visue to deterministate and visue and visue and visue
Personal Competence				

Social Competence	
Autonomy	
<b>Workload in Hours</b>	Independent Study Time 124, Study Time in Lecture 56
Credit points	6
Course achievement	None
Examination	Written exam
Examination duration and scale	90 min
Assignment for the Following Curricula	Congral Engineering Science (English program 7 computer): Specialisation

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Course L0332: Auto	omata Theory and Formal Languages
Тур	Lecture
Hrs/wk	2
СР	4
<b>Workload in Hours</b>	Independent Study Time 92, Study Time in Lecture 28
Lecturer	Prof. Tobias Knopp
Language	EN
Cycle	SoSe
Content	<ol> <li>Propositional logic, Boolean algebra, propositional resolution, SAT-2KNF</li> <li>Predicate logic, unification, predicate logic resolution</li> <li>Temporal Logics (LTL, CTL)</li> <li>Deterministic finite automata, definition and construction</li> <li>Regular languages, closure properties, word problem, string matching</li> <li>Nondeterministic automata:         <ul> <li>Rabin-Scott transformation of nondeterministic into deterministic automata</li> <li>Epsilon automata, minimization of automata, elimination of e-edges, uniqueness of the minimal automaton (modulo renaming of states)</li> </ul> </li> <li>Myhill-Nerode Theorem:         <ul> <li>Correctness of the minimization procedure, equivalence classes of strings induced by automata</li> <li>Pumping Lemma for regular languages:</li></ul></li></ol>

	<ol> <li>Chomsky normal form</li> <li>CYK algorithm for deciding the word problem for context-free grammrs</li> <li>Deterministic pushdown automata</li> <li>Deterministic vs. nondeterministic pushdown automata:         Application for parsing, LL(k) or LR(k) grammars and parsers vs. deterministic pushdown automata, compiler compiler     </li> <li>Regular grammars</li> <li>Outlook: Turing machines and linear bounded automata vs general and context-sensitive grammars</li> <li>Chomsky hierarchy</li> <li>Mealy- and Moore automata:         Automata with output (w/o accepting states), infinite state sequences, automata networks     </li> <li>Omega automata: Automata for infinite input words, Büchi automata, representation of state transition systems, verification w.r.t. temporal logic specifications (in particular LTL)     </li> <li>LTL safety conditions and model checking with Büchi automata, relationships between automata and logic</li> </ol>
	22. Fixed points, propositional mu-calculus  23. Characterization of regular languages by monadic second-order logic (MSO)
Literature	<ol> <li>Logik für Informatiker Uwe Schöning, Spektrum, 5. Aufl.</li> <li>Logik für Informatiker Martin Kreuzer, Stefan Kühling, Pearson Studium, 2006</li> <li>Grundkurs Theoretische Informatik, Gottfried Vossen, Kurt-Ulrich Witt, Vieweg-Verlag, 2010.</li> <li>Principles of Model Checking, Christel Baier, Joost-Pieter Katoen, The MIT Press, 2007</li> </ol>

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

Courses									
Title Embedded Systems (L	0805)		<b>Typ</b> Lecture	Hrs/w	vk CP				
Embedded Systems (L			Recitation (small)	Section 1	2				
Module Responsible	i Prof. Heiko Faik								
Admission Requirements	INONE								
Recommended Previous Knowledge	Computer Engineering								
Educational Objectives	After taking part succe	ssfully, students h	ave reached	the following le	earning results				
Professional Competence									
	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, commor 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).								
Knowledge	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 so results accordingly.	olve similar proble	ems alone or	in a group and	I to present th				
Autonomy	Students are able to associate this knowledge			m specific lite	erature and t				
Workload in Hours	Independent Study Tim	ie 124, Study Time	e in Lecture 5	6					
Credit points	6								
Course achievement		Form Subject theore practical work		escription					
Examination	Written exam								
Examination	90 minutes, contents o	f course and labs							

General Engineering Science (German program, 7 semester): Specialisation
Computer Science: Elective Compulsory General Engineering Science (German program, 7 semester): Specialisation Computer Science: Compulsory
Computer Science: Compulsory  Computer Science: Specialisation Computer and Software Engineering: Elective  Compulsory
Computer Science: Specialisation I. Computer and Software Engineering: Elective Compulsory
 Electrical Engineering: Core qualification: Elective Compulsory Engineering Science: Specialisation Mechatronics: Elective Compulsory
Aircraft Systems Engineering: Specialisation Avionic Systems: Elective Compulsory General Engineering Science (English program, 7 semester): Specialisation
Computer Science: Elective Compulsory General Engineering Science (English program, 7 semester): Specialisation
Mechatronics: Elective Compulsory Computational Science and Engineering: Core qualification: Compulsory
Mechatronics: Specialisation System Design: Elective Compulsory  Mechatronics: Specialisation Intelligent Systems and Robotics: Elective Compulsory  Microsloctronics, and Microslystems: Specialisation, Embedded Systems: Elective
Microelectronics and Microsystems: Specialisation Embedded Systems: Elective Compulsory

Course L0805: Emb	pedded Systems
Тур	Lecture
Hrs/wk	3
СР	4
<b>Workload in Hours</b>	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<sup>nd</sup> Edition, Springer, 2012., Springer, 2012.</li> </ul>

Course L0806: Embedded Systems						
Тур	Recitation Section (small)					
Hrs/wk	1					
СР	2					
<b>Workload in Hours</b>	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 M0852	2: Gr	raph <sup>-</sup>	Theo	ry a	nd (	Optin	niza	ition					
Courses													
<b>Title</b> Graph Theory and Opti	imizati	on (L104	16)				L	<b>yp</b> ecture			Hrs	/wk	<b>CP</b> 3
Graph Theory and Opti	imizati	on (L104	17)					lecitatior small)	1	Sectio	n 2		3
Module Responsible	Prof.	Anusch	Taraz										
Admission Requirements	None												
Recommended Previous Knowledge	•	Discre Mathe	te Alge matics		Struc	tures							
Educational Objectives	After	taking <sub>l</sub>	part suc	ccessi	fully, s	students	s hav	e reach	ed th	ne follo	wing	learn	ing results
Professional Competence													
Knowledge	•	They a Studer capab	are able nts can le of illu	e to ex discu ustrat	xplain uss log ing th	them u gical co ese con	ising nnec inect	approp	riate etwee h the	examples the example the examples the example the exa	oles. se coi	ncept	ptimization s. They are s.
Skills	<ul> <li>Students can model problems in Graph Theory and Optimization with the help of the concepts studied in this course. Moreover, they are capable of solving them by applying established methods.</li> <li>Students are able to discover and verify further logical connections between the concepts studied in the course.</li> <li>For a given problem, the students can develop and execute a suitable approach, and are able to critically evaluate the results.</li> </ul>												
Personal Competence													
Social Competence		mathe In doir their	ematics ng so, t cooper	as a they o ating	comm can co partn	non lang ommuni ers. Mo	juago cate oreov	e. new co	ncep / car	ts acc	ording	g to t	able to uso he needs o es to chec
Autonomy		on the get he Studer	eir own elp in so nts hav	. They olving ve dev	y can them velope	specify ed suffic	ope	n questi	ons	precise	ely an	id kno	ex concept ow where to k for longe
Workload in Hours	Indep	endent	Study	Time	124, 9	Study Ti	ime i	n Lectui	re 56				
Credit points	6												
Course achievement	None												

Examination	Written exam
Examination duration and scale	120 min
_	General Engineering Science (German program, 7 semester): Specialisation Computer Science: Compulsory Computer Science: Core qualification: Compulsory Computer Science: Core qualification: Compulsory Data Science: Core qualification: Compulsory
	General Engineering Science (English program, 7 semester): Specialisation Computer Science: Compulsory Logistics and Mobility: Specialisation Engineering Science: Elective Compulsory Technomathematics: Specialisation I. Mathematics: Elective Compulsory

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

Course L1047: Graph Theory and Optimization		
Тур	Recitation Section (small)	
Hrs/wk	2	
СР	3	
<b>Workload in Hours</b>	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 M0553: Objectoriented Programming, Algorithms and Data Structures

Courses				
Title		Тур	Hrs/wk	СР
(L0131)	mming, Algorithms and Data Structures	Lecture	4	4
Objectoriented Program (L0132)	mming, Algorithms and Data Structures	Recitation (small)	Section 1	2
Module Responsible	i Prof. Roif-Rainer Gridat			
Admission Requirements	None			
	This lecture requires proficiency in the		ıage. For further r	equirements
Previous Knowledge	please refer to the German description	on.		
Educational Objectives	After taking part successfully, studen	ts have reached	the following learr	ning results
Professional				
Competence				
	Students can explain the essentials architecture with reference to existin			
Knowledge	Students can describe fundamental assess the complexity of important a			
GL VIII	Students are able to  Design software using given and polymorphism Carry out software developed	- ,		
Skills	systems and Google Test  Sort and search for data efficie  Assess the complexity of algor			
Personal				
Competence	l Students can work in teams and com	municate in foru	ms.	 
Social Competence				
Autonomy	Students are able to solve programm SVN Repository and Google Test indweeks.			
	Independent Study Time 110, Study	Time in Lecture 7	<u>'0</u>	
Credit points	<u>  6</u> 			Ī
Course achievement	None			
Examination	Written exam			
Examination duration and	60 Minutes, Content of Lecture, exerc	cises and materia	al in StudIP	

scale	,					
	General Engineering Science (German program, 7 semester):	Specialisation				
	Computer Science: Elective Compulsory					
Assignment for	Electrical Engineering: Core qualification: Compulsory					
the Following	General Engineering Science (English program, 7 semester):	Specialisation				
Curricula Computer Science: Compulsory						
	Logistics and Mobility: Specialisation Engineering Science: Elective Compulsory					
	Orientierungsstudium: Core qualification: Elective Compulsory					

Course L0131: Obje	ectoriented Programming, Algorithms and Data Structures
Тур	Lecture
Hrs/wk	4
СР	4
<b>Workload in Hours</b>	Independent Study Time 64, Study Time in Lecture 56
Lecturer	Prof. Rolf-Rainer Grigat
Language	DE
Cycle	SoSe
Content	<ul> <li>Object oriented analysis and design: <ul> <li>Objectoriented programming in C++ and Java</li> <li>generic programming</li> <li>UML</li> <li>design patterns</li> </ul> </li> <li>Data structures and algorithmes: <ul> <li>complexity of algorithms</li> <li>searching, sorting, hash tables,</li> <li>stack, queues, lists,</li> <li>trees (AVL, heap, 2-3-4, Trie, Huffman, Patricia, B),</li> <li>sets, priority queues,</li> <li>directed and undirected graphs (spanning trees, shortest and longest path)</li> </ul> </li> </ul>
Literature	Skriptum

Course L0132: Objectoriented Programming, Algorithms and Data Structures		
Тур	Recitation Section (small)	
Hrs/wk	1	
СР	2	
<b>Workload in Hours</b>	Independent Study Time 46, Study Time in Lecture 14	
Lecturer	Prof. Rolf-Rainer Grigat	
Language	DE	
Cycle	SoSe	
Content	See interlocking course	
Literature	See interlocking course	

Courses				
Title	10422)	Typ	Hrs/wk	
Signals and Systems (I Signals and Systems (I		Lecture Recitation	3 Section <sub>2</sub>	4 2
		(small)	_	_
Module Responsible	Prof. Gerhard Bauch			
Admission Requirements	INONE			
	Mathematics 1-3			
Previous	The modul is an introduction to the thecin maths as covered by the moduls Matl with spectral transformations (Fourier s is useful but not required.	nematik 1-3 is	s expected. Furth	er experienc
Educational Objectives	IAHERTAKING NARI SHR ESSIHIV SHIGENIS R	nave reached	the following lea	rning results
Professional Competence				
	The students are able to classify and describe signals and linear time-invariant (LTI) systems using methods of signal and system theory. They are able to apply the fundamental transformations of continuous-time and discrete-time signals and systems. They can describe and analyse deterministic signals and systems mathematically in both time and image domain. In particular, they understand the effects in time domain and image domain which are caused by the transition of a continuous-time signal to a discrete-time signal.			
Skills	The students are able to describe and analyse deterministic signals and linear time invariant systems using methods of signal and system theory. They can analyse ar design basic systems regarding important properties such as magnitude and phase response, stability, linearity etc They can assess the impact of LTI systems on the signal properties in time and frequency domain.			
Personal Competence				
	The students can jointly solve specific p	roblems.		
·	The students are able to acquire relev sources. They can control their level of solving tutorial problems, software tools	ant informati of knowledge	during the lect	
Workload in Hours	Independent Study Time 110, Study Tim	e in Lecture 7	70	
Credit points	6			
Course achievement				
Examination	Written exam			
Examination duration and scale	90 min			
	General Engineering Science (German Compulsory Computer Science: Core qualification: Co Data Science: Core qualification: Compu Electrical Engineering: Core qualification	ompulsory Isory		qualification

		Engineering er Science: Cor		(English	program,	7	semester):	Specialisation
								Specialisation
		cal Engineerin						
Assignment for				_				Specialisation
the Following	Mechanic	cal Engineerin	g, Focus E	nergy Sys	tems: Com	puls	sory	
Curricula	General	Engineering	Science	(English	program,	7	semester):	Specialisation
	Mechanic	cal Engineerin	g, Focus A	ircraft Sys	stems Engir	ieei	ing: Compul	sory
	General	Engineering	Science	(English	program,	7	semester):	Specialisation
	Mechanic	cal Engineerin	g, Focus M	laterials ir	n Engineerir	ng S	Sciences: Cor	npulsory
	General	Engineering	Science	(English	program,	7	semester):	Specialisation
	Mechanic	Mechanical Engineering, Focus Mechatronics: Compulsory						
	General	Engineering	Science	(English	program,	7	semester):	Specialisation
	Mechanical Engineering, Focus Theoretical Mechanical Engineering: Compulsory							
	General Engineering Science (English program, 7 semester): Specialisation Process							
	Engineer	Engineering: Compulsory						
	General	Engineering	Science	(English	program,	7	semester):	Specialisation
		al Engineering						•
	Computa	tional Science	and Engi	neering: C	ore qualific	atio	n: Compulso	ry
		onics: Core qu					·	-
		nathematics: S		•	•	ien	ce: Elective (	Compulsory

qyT	Lecture
Hrs/wk	
СР	
Workload in Hours	Independent Study Time 78, Study Time in Lecture 42
	Prof. Gerhard Bauch
Language	
Cycle	
	Introduction to signal and system theory  Signals  Classification of signals  Analog and digital signals  Deterministic and random signals  Description of LTI systems by differential equations or difference equations, respectively  Basic properties of signals and operations on signals  Elementary signals  Distributions (Generalized Functions)  Power and energy of signals  Correlation functions of deterministic signals  Autocorrelation function  Crosscorrelation function  Orthogonal signals  Applications of correlation  Linear time-invariant (LTI) systems  Linearity  Time-invariance  Description of LTI systems by impulse response and frequency response  Convolution  Convolution  Convolution and correlation  Properties of LTI-systems  Stable systems  Memoryless systems  Memoryless systems  Fourier Series and Fourier Transform  Fourier Transform of continuous-time signals, discrete-time signals

periodic signals, non-periodic signals • Properties of the Fourier transform • Fourier transform of some basic signals Parseval's theorem Analysis of LTI-systems and signals in the frequency domain Frequency response, magnitude response and phase response Transmission factor, attenuation, gain Frequency-flat and frequency-selective LTI-systems Bandwidth definitions o Basic types of systems (filters), lowpass, highpass, bandpass, bandstop systems Phase delay and group delay Linear-phase systems Distortion-free systems Content • Spectrum analysis with limited observation window: Leakage effect Laplace Transform Relation of Fourier transform and Laplace transform Properties of the Laplace transform Laplace transform of some basic signals Analysis of LTI-systems in the s-domain Transfer function of LTI-systems • Relation of Laplace transform, magnitude response and phase response Analysis of LTI-systems using pole-zero plots Allpass filters Minimum-phase, maximum-phase and mixed phase filters Stable systems Sampling Sampling theorem · Reconstruction of continuous-time signals in frequency domain and time domain Oversampling Aliasing Sampling with pulses of finite duration, sample and hold Decimation and interpolation Discrete-Time Fourier Transform (DTFT) Relation of Fourier transform and DTFT Properties of the DTFT Discrete Fourier Transform (DFT) Relation of DTFT and DFT Cyclic properties of the DFT DFT matrix Zero padding Cyclic convolution Fast Fourier Transform (FFT) • Application of the DFT: Orthogonal Frequency Division Multiplex (OFDM) Z-Transform Relation of Laplace transform, DTFT, and z-transform Properties of the z-transform Z-transform of some basic discrete-time signals Discrete-time systems, digital filters FIR and IIR filters Z-transform of digital filters • Analysis of discrete-time systems using pole-zero plots in the z-domain Stability Allpass filters • Minimum-phase, maximum-phase and mixed-phase filters Linear phase filters T. Frey , M. Bossert , Signal- und Systemtheorie, B.G. Teubner Verlag 2004 K. Kammeyer, K. Kroschel, Digitale Signalverarbeitung, Teubner Verlag.

# Literature

- B. Girod ,R. Rabensteiner , A. Stenger , Einführung in die Systemtheorie, B.G. Teubner, Stuttgart, 1997
- J.R. Ohm, H.D. Lüke , Signalübertragung, Springer-Verlag 8. Auflage, 2002
- S. Haykin, B. van Veen: Signals and systems. Wiley.
- Oppenheim, A.S. Willsky: Signals and Systems. Pearson.
- Oppenheim, R. W. Schafer: Discrete-time signal processing. Pearson.

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

Courses				
<b>Title</b> Stochastics (L0777)		<b>Typ</b> Lecture	Hrs/wk	<b>CP</b> 4
Stochastics (L0778)		Recitation (small)	Section 2	2
Responsible	Prof. Marko Lindher			
Admission Requirements	None			
Recommended Previous Knowledge	<ul> <li>Discrete algebraic structures</li> </ul>	(combinatorics)		
Educational Objectives	After taking part successfully, stude	ents have reached t	he following lear	ning results
Professional Competence				
Knowledge	Students can explain the main de definitions of modeling elemen independence assumptions) used marginal distributions, density functions such as expected values Students can define decision probproblems (based on the chain rule as they are caller, can be analyzed etc. Student can describe the malgorithms for solving decision and Students can also explain basic stars.	ts (random varial in discrete and conctions). Students variance, standablems and explain or Bayesian networ in terms of notions ain ideas of stoch computation probins istical detection an solving decision present in the computation probins is the computation probins in the computation probi	bles, events, ontinuous setting can describe or deviation, an algorithms for sks). Algorithms, or such as bias of a stic processes lem for stochastid estimation tech oblems, and the	dependence (js (joint archaracterist) dependent olving the sor estimator and explatic processed in iques.
Skills	whether approximation techniques i.e., students can derive estimate reliable.			
Personal Competence				
Social Competence	- Students are able to work to heterogeneously composed teams background knowledge) and to exercise class).	(i.e., teams from	different study p	rograms ar
	- Students are capable of checking own. They can specify open questions them.			
Autonomy	- Students can put their knowledge	in relation to the co	ntents of other le	ectures.
	- Students have developed suffic periods in a goal-oriented manner of		be able to wo	rk for long
Workload in Hours	Independent Study Time 124, Study	/ Time in Lecture 56	5	
Credit points				
Course	None			
achievement	1			

duration and scale	
Assignment for the Following Curricula	General Engineering Science (German program, 7 semester): Specialisation Computer Science: Compulsory Computer Science: Core qualification: Compulsory Data Science: Core qualification: Compulsory General Engineering Science (English program, 7 semester): Specialisation Computer Science: Compulsory Computational Science and Engineering: Core qualification: Compulsory Computational Science and Engineering: Core qualification: Compulsory Logistics and Mobility: Specialisation Engineering Science: Elective Compulsory Theoretical Mechanical Engineering: Core qualification: Elective Compulsory

Course L0777: Stoo	chastics
	Lecture
Hrs/wk	
CP	
	Independent Study Time 92, Study Time in Lecture 28
	Dr. Christian Seifert
Language	
Cycle	
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>Practical representations for joint probabilities</li> <li>Bayessche Netzwerke</li> <li>Semantik, Entscheidungsprobleme, exakte und approximative Algorithmen</li> <li>Stochastic processes</li> <li>Stationarity, ergodicity</li> <li>Correlations</li> <li>Dynamic Bayesian networks, Hidden Markov networks, Kalman filters, queues</li> </ul>
	<ul> <li>Detection &amp; estimation</li> <li>Detectors</li> <li>Estimation rules and procedures</li> <li>Hypothesis and distribution tests</li> <li>Stochastic regression</li> </ul>
Literature	<ol> <li>Methoden der statistischen Inferenz, Likelihood und Bayes, Held, L., Spektrum 2008</li> <li>Stochastik für Informatiker, Dümbgen, L., Springer 2003</li> <li>Statistik: Der Weg zur Datenanalyse, Fahrmeir, L., Künstler R., Pigeot, I, Tutz, G., Springer 2010</li> <li>Stochastik, Georgii, HO., deGruyter, 2009</li> <li>Probability and Random Processes, Grimmett, G., Stirzaker, D., Oxford University Press, 2001</li> <li>Programmieren mit R, Ligges, U., Springer 2008</li> </ol>

Course L0778: Stochastics		
Тур	Recitation Section (small)	
Hrs/wk	2	
СР	2	
<b>Workload in Hours</b>	Independent Study Time 32, Study Time in Lecture 28	
Lecturer	Dr. Christian Seifert	
Language	DE/EN	
Cycle	SoSe	
Content	See interlocking course	
Literature	See interlocking course	

Courses					
Title			Тур	Hrs/wk	СР
Functional Programming (L0624)			Lecture	2	2
Functional Programmir	ng (L0625)		Recitation (large)	Section 2	2
Functional Programming (L0626)			Recitation (small)	Section 2	2
Module Responsible	Prof. Sibylle Schupp				
Admission Requirements	LNIANA				
Recommended Previous Knowledge	Discrete mathematics at high-school level				
Educational Objectives	After taking part succe	ssfully, students l	nave reached	the following learn	ing 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 nature specification and deverse different language consimplementations level, rewrite them in a contassess the quality of the	elop a functional structs, make co and justify their trolled way. They	program in a nscious select choice. They design and	structured way. I tions both at speci analyze given pr implement unit te	They asses fication ar ograms ar sts and ca
Personal Competence					
Social Competence	Students practice peer programming with varying peers. They explain problems and				
Autonomy	In programming labs, students learn under supervision (a.k.a. "Betreuted Programmieren") the mechanics of programming. In exercises, they develop solutions individually and independently, and receive feedback.				
Workload in Hours	Independent Study Tim	ne 96, Study Time	in Lecture 84	ļ.	
Credit points					
Course achievement	CompulsorBonus Yes 15 %	<b>Form</b> Excercises		Description	
Examination	Written exam				
Examination duration and scale	90 min				
	General Engineering Computer Science: Elec Computer Science: Cor Data Science: Core qua	ctive Compulsory e qualification: Co	ompulsory	7 semester): Sp	pecialisatio

	Data Science: Technical Complementary Course: Elective Compulsory Engineering Science: Specialisation Mechatronics: Elective Compulsory				
Assignment for	General Engineering Science (English program, 7 semester): Specialisation Computer Science: Elective Compulsory				
Curricula	General Engineering Science (English program, / semester): Specialisation				
	Mechatronics: Elective Compulsory				
	Computational Science and Engineering: Specialisation I. Computer Science: Elective Compulsory				
	Computational Science and Engineering: Specialisation Computer Science: Elective				
	Compulsory Technomathematics: Specialisation II. Informatics: Elective Compulsory				

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

Course L0625: Fun	ctional Programming
Тур	Recitation Section (large)
Hrs/wk	2
СР	2
<b>Workload in Hours</b>	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: Fund	ctional Programming
Тур	Recitation Section (small)
Hrs/wk	2
СР	2
<b>Workload in Hours</b>	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Prof. Sibylle Schupp
Language	EN
Cycle	WiSe
	<ul> <li>Functions, Currying, Recursive Functions, Polymorphic Functions, Higher-Order Functions</li> <li>Conditional Expressions, Guarded Expressions, Pattern Matching, Lambda Expressions</li> </ul>
Content	<ul> <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 M0834	1: Computernetworks ar	nd Internet Se	curity	
Courses				
•	nd Internet Security (L1098) nd Internet Security (L1099)	<b>Typ</b> Lecture Recitation	Hrs/wk 3 Section 1	<b>CP</b> 5
Module	Prof Androas Timm Giol	(small)		
Responsible Admission Requirements	None			
Recommended Previous Knowledge	Basics of Computer Science			
Educational Objectives	LATTAR TAKING NART CHICCACCTHINA CTHA	ents have reached t	ne following learn	ing results
Professional Competence				
Knowledge	Students are able to explain impor classify them, in order to be able further studies and job.			
Skills	Students are able to analyse com them in different domains.	nmon Internet proto	cols and evaluate	e the use of
Personal Competence				
Social Competence Autonomy	Students can select relevant part and can independently learn and u		nt of professiona	l knowledge
Workload in Hours	I Independent Study Time 124, Stud	ly Time in Lecture 56	<u> </u>	
Credit points	<u> </u>	,		
Course achievement	None			
Examination	Written exam			
Examination duration and scale	120 min			
Assignment for the Following Curricula	General Engineering Science (Computer Science: Elective Computer Science: Core qualification: Electrical Engineering: Core qualification: Electrical Engineering: Core qualification: General Engineering Science (Ecomputer Science: Elective Computer Science: Electiv	ulsory on: Compulsory lective Compulsory cation: Elective Com n Mechatronics: Election English program, ulsory English program, ering: Core qualifica	pulsory ive Compulsory 7 semester): S 7 semester): S tion: Compulsory	pecialisation pecialisation

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

Course L1099: Computer 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 M1578	8: Seminars Computer S	cience		
Courses				
	Computer Science I (L2362) Computer Science II (L2361)	<b>Typ</b> Seminar Seminar	<b>Hrs/wk</b> 2 2	<b>CP</b> 3 3
Module Responsible	Prof. Karl-Heinz Zimmermann			
Admission Requirements	INODA			
Recommended Previous Knowledge	Basic knowledge of Computer Scie	nce and Mathematics	at the Bachelor	s level.
Educational Objectives	After taking part successfully, stud	ents have reached the	e following learn	ing results
Professional Competence				
Knowledge	<ul> <li>explicate a specific topic in the field of Computer Science,</li> <li>describe complex issues,</li> <li>present different views and evaluate in a critical way.</li> </ul>			
Skills	<ul> <li>familiarize in a specific topic of Computer Science in limited time,</li> <li>realize a literature survey on the specific topic and cite in a correct way,</li> <li>elaborate a presentation and give a lecture to a selected audience,</li> <li>sum up the presentation in 10-15 lines,</li> <li>answer questions in the final discussion.</li> </ul>			
Personal Competence	The students are able to			
Social Competence	elaborate and introduce a to     discuss the tonic content	t and structure of the audience, and	the presentatio	
Autonomy	The students are able to  define the task in question i develop the necessary know use appropriate work equipu guided by an instructor critic	rledge, ment, and		
	Independent Study Time 124, Stud	ly Time in Lecture 56		
Credit points	!			
Course achievement	None			
Examination Examination duration and				
scale Assignment for	General Engineering Science (Computer Science: Elective Computer Science: Core qualificati	ılsory	semester): S	pecialisation

the Following	General	Engineering	Science	(English	program,	7	semester):	Specialisation
Curricula	Compute	r Science: Ele	ctive Com	pulsory				
	Computa	tional Science	and Engli	neering: C	ore qualific	atio	n: Compulso	ry

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

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

Courses					
<b>Title</b> Introduction to Control	Systems (L0654)	<b>Typ</b> Lecture	Hrs/wk	<b>CP</b> 4	
Introduction to Control	Systems (L0655)	Recitation (small)	Section 2	2	
Module Responsible	Prof. Herbert Werner				
Admission Requirements	None				
Recommended Previous Knowledge	Representation of signals and systems in time and frequency domain, Laplace transform				
Educational Objectives	After taking part successfully, students have reached the following learning results				
Professional Competence					
Knowledge	<ul> <li>Students can represent dynamic system behavior in time and frequency domain, and can in particular explain properties of first and second order systems</li> <li>They can explain the dynamics of simple control loops and interpret dynamics properties in terms of frequency response and root locus</li> <li>They can explain the Nyquist stability criterion and the stability marging derived from it.</li> <li>They can explain the role of the phase margin in analysis and synthesis of control loops</li> <li>They can explain the way a PID controller affects a control loop in terms of infrequency response</li> <li>They can explain issues arising when controllers designed in continuous time domain are implemented digitally</li> </ul>				
Skills	<ul> <li>Students can transform models of linear dynamic systems from time frequency domain and vice versa</li> <li>They can simulate and assess the behavior of systems and control loops</li> <li>They can design PID controllers with the help of heuristic (Ziegler-Nicho tuning rules</li> <li>They can analyze and synthesize simple control loops with the help of rolocus and frequency response techniques</li> <li>They can calculate discrete-time approximations of controllers designed continuous-time and use it for digital implementation</li> <li>They can use standard software tools (Matlab Control Toolbox, Simulink) for carrying out these tasks</li> </ul>				
Personal Competence		wraupa ta jainthu aa	lua tachnical pro	ablamas ar	
Social Competence	Students can work in small of experimentally validate their con Students can obtain information documentation, experiment guidents	troller designs n from provided sou	irces (lecture no	tes, softwai	
	They can assess their knowledge in weekly on-line tests and thereby control the learning progress.				

<b>Workload in Hours</b>	Independent Study Time 124, Study Time in Lecture 56
Credit points	6
Course achievement	None
Examination	Written exam
Examination duration and scale	120 min
the Following	General Engineering Science (German program, 7 semester): Core qualification: Compulsory Bioprocess Engineering: Core qualification: Compulsory Computer Science: Specialisation Computational Mathematics: Elective Compulsory Data Science: Core qualification: Elective Compulsory Electrical Engineering: Core qualification: Compulsory Energy and Environmental Engineering: Core qualification: Compulsory Engineering Science (English program, 7 semester): Specialisation Electrical Engineering: Compulsory General Engineering Science (English program, 7 semester): Specialisation Civil Engineering: Compulsory General Engineering Science (English program, 7 semester): Specialisation Bioprocess Engineering: Compulsory General Engineering: Compulsory General Engineering: Compulsory General Engineering: Compulsory General Engineering Science (English program, 7 semester): Specialisation Energy and Enviromental Engineering: Compulsory General Engineering Science (English program, 7 semester): Specialisation Computer Science: Compulsory General Engineering Science (English program, 7 semester): Specialisation Mechanical Engineering, Focus Biomechanics: Compulsory General Engineering, Science (English program, 7 semester): Specialisation Mechanical Engineering, Focus Energy Systems: Compulsory General Engineering, Science (English program, 7 semester): Specialisation Mechanical Engineering, Focus Materials in Engineering: Compulsory General Engineering, Focus Materials in Engineering: Compulsory General Engineering, Focus Mechatronics: 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 Mechatronics: Compulsory General Engineering Science (English program, 7 semester): Specialisation Mechanical Engineering Science (English program, 7 semester): Specialisation Mechanical Engineering Science (English program, 7 semester): Specialisation Mec

Course L0654: Intro	oduction to Control Systems
Тур	Lecture
Hrs/wk	
СР	4
Workload in Hours	Independent Study Time 92, Study Time in Lecture 28
	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	
<b>Workload in Hours</b>	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 M0662	2: Numerical Mathematic	cs I			
Courses					
<b>Title</b> Numerical Mathematic		<b>Typ</b> Lecture Recitation (small)	Hrs/wk 2 Section 2	<b>CP</b> 3	
Module Responsible	Prof. Sabine Le Borne				
Admission Requirements	None				
Recommended Previous Knowledge	Linear Algebra I + II for Tech		man or english) <b>o</b>	<b>r</b> Analysis &	
Educational Objectives	After taking part successfully, stude	ents have reached t	he following learn	ing results	
Professional Competence	Students are able to  • name numerical methods for interpolation, integration, least squares problems, eigenvalue problems, nonlinear root finding problems and to				
Knowledge	<ul> <li>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 respeto computational and storage complexitx.</li> </ul>				
Skills	<ul> <li>Students are able to</li> <li>implement, apply and compare numerical methods using MATLAB,</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					
	Students are able to				
Social Competence	<ul> <li>work together in heterogether different study programs a foundations and support e implementation of algorithm</li> </ul>	nd background kno ach other with pra	owledge), explain	theoretical	
	Students are capable				
Autonomy	<ul> <li>to assess whether the supporting theoretical and practical excercises are better solved individually or in a team,</li> <li>to assess their individual progess and, if necessary, to ask questions and seek help.</li> </ul>				
Workload in Hours	Independent Study Time 124, Study	y Time in Lecture 56	5		
Credit points	!				
Course achievement	None				
	Written exam				
Examination					

duration and scale					
	General Engineering Science (German program, 7 semester): Specialisation				
	Computer Science: Compulsory				
	General Engineering Science (German program, 7 semester): Specialisation				
	Mechanical Engineering, Focus Materials in Engineering Sciences: Compulsory				
	General Engineering Science (German program, 7 semester): Specialisation				
	Biomedical Engineering: Compulsory				
	General Engineering Science (German program, 7 semester): Specialisation				
	Mechanical Engineering, Focus Biomechanics: Compulsory				
	General Engineering Science (German program, 7 semester): Specialisation				
	Mechanical Engineering, Focus Theoretical Mechanical Engineering: Compulsory				
	Bioprocess Engineering: Specialisation A - General Bioprocess Engineering: Elective				
	Compulsory				
	Computer Science: Specialisation Computational Mathematics: Elective Compulsory				
	Computer Science: Specialisation II. Mathematics and Engineering Science: Elective				
	Compulsory				
	Data Science: Core qualification: Compulsory				
	Electrical Engineering: Core qualification: Elective Compulsory				
	Engineering Science: Core qualification: Compulsory				
	General Engineering Science (English program, 7 semester): Specialisation				
Assignment for	Mechanical Engineering, Focus Theoretical Mechanical Engineering: Elective				
the Following	Compulsory				
Curricula	General Engineering Science (English program, 7 semester): Core qualification:				
	Compulsory				
	General Engineering Science (English program, 7 semester): Specialisation				
	Computer Science: Compulsory				
	General Engineering Science (English program, 7 semester): Specialisation				
	Mechanical Engineering, Focus Biomechanics: Compulsory				
	General Engineering Science (English program, 7 semester): Specialisation				
	Mechanical Engineering, Focus Materials in Engineering Sciences: Compulsory				
	General Engineering Science (English program, 7 semester): Specialisation				
	Mechanical Engineering, Focus Theoretical Mechanical Engineering: Compulsory				
	General Engineering Science (English program, 7 semester): Specialisation				
	Biomedical Engineering: Compulsory				
	Computational Science and Engineering: Core qualification: Compulsory				
	Mechanical Engineering: Specialisation Theoretical Mechanical Engineering: Elective				
	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: Num	nerical Mathematics I
Тур	Lecture
Hrs/wk	2
СР	3
<b>Workload in Hours</b>	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Prof. Sabine Le Borne
Language	EN
Cycle	WiSe
Content	<ol> <li>Error analysis: Number representation, error types, conditioning and stability</li> <li>Interpolation: polynomial and spline interpolation</li> <li>Numerical integration and differentiation: order, Newton-Cotes formula, error estimates, Gaussian quadrature, adaptive quadrature, difference formulas</li> <li>Linear systems: LU and Cholesky factorization, matrix norms, conditioning</li> <li>Linear least squares problems: normal equations, Gram.Schmidt and Householder orthogonalization, singular value decomposition, regularization</li> <li>Eigenvalue problems: power iteration, inverse iteration, QR algorithm</li> <li>Nonlinear systems of equations: Fixed point iteration, root-finding algorithms for real-valued functions, Newton and Quasi-Newton methods for systems</li> </ol>
Literature	<ul> <li>Stoer/Bulirsch: Numerische Mathematik 1, Springer</li> <li>Dahmen, Reusken: Numerik für Ingenieure und Naturwissenschaftler, Springer</li> </ul>

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

Courses							
Title			Тур	Hrs/wk	СР		
Computer Architecture	e (L0793)		Lecture	2	3		
Computer Architecture	e (L0794)		Project-/problem- based Learning	2	2		
Computer Architecture	e (L1864)		Recitation Section (small)	on 1	1		
Module Responsible	Prof. Heiko Falk						
Admission Requirements	LNODE						
Recommended Previous Knowledge	Module "Computer Engi	Module "Computer Engineering"					
Educational Objectives		ssfully, students h	ave reached the foll	owing learn	ing results		
Professional Competence							
Knowledge	This module presents advanced concepts from the discipline of computer architecture. In the beginning, a broad overview over various programming models is given, both for general-purpose computers and for special-purpose machines (e.g., signal processors). Next, foundational aspects of the micro-architecture of processors are covered. Here, the focus particularly lies on the so-called pipelining and the methods used for the acceleration of instruction execution used in this context. The students get to know concepts for dynamic scheduling, branch prediction, superscalar execution of machine instructions and for memory hierarchies.						
Skills	The students are able to describe the organization of processors. They know the different architectural principles and programming models. The students examine various structures of pipelined processor architectures and are able to explain their concepts and to analyze them w.r.t. criteria like, e.g., performance or energy efficiency. They evaluate different structures of memory hierarchies, know parallel computer architectures and are able to distinguish between instruction- and datalevel parallelism.						
Personal Competence							
-	Students are able to solve similar problems alone or in a group and to present the results accordingly.						
Autonomy	Students are able to acquire new knowledge from specific literature and to associate this knowledge with other classes.						
Workload in Hours	Independent Study Time	e 110, Study Time	e in Lecture 70				
Credit points							
Course achievement		Form Subject theore practical work	<b>Descrip</b> etical and	otion			
Examination	Written exam						
Examination duration and scale	90 minutes, contents of course and 4 attestations from the PBL "Computer architecture"						
scale	architecture						

the Following	Computer Science: Specialisation Computer and Software Engineering: Elective Compulsory
	Computer Science: Specialisation I. Computer and Software Engineering: Elective Compulsory
	Aircraft Systems Engineering: Specialisation Avionic Systems: Elective Compulsory General Engineering Science (English program, 7 semester): Specialisation Computer Science: Elective Compulsory
	Computational Science and Engineering: Specialisation I. Computer Science: Elective Compulsory
	Computational Science and Engineering: Specialisation Computer Science: Elective Compulsory Microelectronics and Microsystems: Specialisation Embedded Systems: Elective Compulsory

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

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

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

Module M0562	2: Computability and Com	plexity The	ory		
Courses					
	nplexity Theory (L0166) nplexity Theory (L0167)	<b>Typ</b> Lecture Recitation (small)	Hrs/wk 2 Section 2	<b>CP</b> 3	
Module Responsible	Prof. Karl-Heinz Zimmermann				
Admission Requirements	None				
Recommended Previous Knowledge	Discrete Algebraic Structures, Auto Theory.	omata Theory, l	ogic, and Forma	l Language	
Educational Objectives	After taking part successfully, studen	ts have reached	the following learn	ing results	
Professional Competence					
Knowledge	The students known the important machine models of computability, the class of partial recursive functions, universal computability, Gödel numbering of computations, the theorems of Kleene, Rice, and Rice-Shapiro, the concept of decidable and undecidable sets, the word problems for semi-Thue systems, Thue systems, semi-groups, and Post correspondence systems, Hilbert's 10-th problem, and the basic concepts of complexity theory.				
Skills	Students are able to investigate th analyze the complexity of computabl		of sets and funct	ions and to	
Personal Competence					
Social Competence	Students are able to solve specific p results accordingly.	roblems alone or	in a group and to	present the	
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 in Lecture 5	6		
Credit points	6				
Course achievement	None				
Examination	Written exam				
Examination duration and scale					
the Following	General Engineering Science (General Engineering Science (General Engineering Science Computer Science: Core qualification: Elective Science: Core qualification: Elective Engineering Science (Engineering Science Computer Science: Elective Compulsor Computational Science and Engineering Elective Compulsory Technomathematics: Specialisation II	ory : Compulsory :tive Compulsory glish program, ory eering: Specialis	7 semester): Sp sation I. Comput	oecialisation	

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

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

Module M097	1: Operating Systems			
Courses				
<b>Title</b> Operating Systems (L1		<b>Typ</b> Lecture Recitation	Hrs/wk 2 Section 2	<b>CP</b> 3
Operating Systems (L1	.154)	(small)	2	3
Module Responsible	Prof. Volker Turau			
Admission Requirements	None			
Recommended Previous Knowledge	<ul> <li>Experience in using tools relate</li> </ul>	_		as editors,
Educational Objectives	After taking part successfully, students	have reached	the following learn	ing results
Professional				
<b>Competence</b> <i>Knowledge</i>	Students explain the main abstractions and file of operations systems, describe paraphrase the architectural variants o	the process st f operating sy their archited using threads variants of re	tates and their transteems. They give of tures. The particips, conditional value	nsitions, and examples of pants of the riables and
Skills	Students are able to use the POSIX libraries for concurrent programming in a correct and efficient way. They are able to judge the efficiency of a scheduling algorithm for a given scheduling task in a given environment.			
Personal				
Competence Social Competence				
Autonomy	! !			
	Independent Study Time 124, Study Tim	ne in Lecture 5	6	
Credit points	6			
Course achievement	None			
Examination	Written exam			
Examination duration and scale	90 min			
Assignment for the Following Curricula	General Engineering Science (Germa Computer Science: Elective Compulsory Computer Science: Core qualification: C Computer Science: Specialisation I. Co Compulsory General Engineering Science (Englis Computer Science: Elective Compulsory Computational Science and Engineer Elective Compulsory Technomathematics: Specialisation II. In	ompulsory omputer and S sh program, ring: Specialis	oftware Engineeri 7 semester): Sp sation I. Comput	ng: Elective pecialisation

Course L1153: Operating Systems		
Тур	Lecture	
Hrs/wk	2	
СР	3	
<b>Workload in Hours</b>	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	
<b>Workload in Hours</b>	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	2: Software Engi	neering			
Courses					
<b>Title</b> Software Engineering (	(L0627)		Typ Lecture	Hrs/wk	<b>CP</b> 3
Software Engineering	(L0628)		Recitation (small)	Section 2	3
Module Responsible	Prof. Sibylle Schupp				
Admission Requirements	None				
Recommended Previous Knowledge	<ul> <li>Procedural progr</li> </ul>	amming or Function	onal program		
Educational Objectives	After taking part succes	ssfully, students h	ave reached	the following learr	ning results
Professional Competence					
Knowledge	Students explain the perminology and concestructured software detasks of existing largestrategies and devises both. They explain simulanalysis, maintenance,	pts of software en evelopment. They e-scale systems. pecifications or mo ple design patterr	gineering, ar give exam They write odels using d as and the m	nd paraphrase the aples of software test cases for d ifferent notations,	principles of -engineering ifferent test and critique
Skills	For a given task in the sand select an appropr assurance. They design and find errors at differ They integrate compon	iate method. The n tests for realistic rent levels. They a	y choose the c systems, a apply and mo	e proper approach ssess the quality odify non-executa	h for quality of the tests,
Personal Competence					
•	Students practice peer peer. They communicat		ey explain p	roblems and solut	ions to their
Autonomy	Using on-line quizzes assess their level of kr on exercise problems, t	nowledge continuo	ously and ad	just it appropriate	
<b>Workload in Hours</b>	Independent Study Tim	e 124, Study Time	in Lecture 5	6	
Credit points					
Course achievement	CompulsorBonus Yes 15 %	<b>Form</b> Excercises	D	escription	
	Written exam				
Examination duration and scale					
Assignment for the Following Curricula	Computer Science: Fled	ctive Compulsory e qualification: Co Science (English ctive Compulsory	mpulsory program,	7 semester): S	pecialisation

Technomathematics: Specialisation II. Informatics: Elective Compulsory

Course L0627: Soft	ware Engineering
Тур	Lecture
Hrs/wk	2
СР	3
<b>Workload in Hours</b>	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Prof. Sibylle Schupp
Language	EN
Cycle	SoSe
Content	<ul> <li>Software Life Cycle Models (Waterfall, V-Model, Evolutionary Models, IncrementalModels, Iterative Models, Agile Processes)</li> <li>Requirements (Elicitation Techniques, UML Use Case Diagrams, Functional and Non-Functional Requirements)</li> <li>Specification (Finite State Machines, Extended FSMs, Petri Nets, Behavioral UML Diagrams, Data Modeling)</li> <li>Design (Design Concepts, Modules, (Agile) Design Principles)</li> <li>Object-Oriented Analysis and Design (Object Identification, UML Interaction Diagrams, UML Class Diagrams, Architectural Patterns)</li> <li>Testing (Blackbox Testing, Whitebox Testing, Control-Flow Testing, Data-Flow Testing, Testing in the Large)</li> <li>Maintenance and Evolution (Regression Testing, Reverse Engineering, Reengineering)</li> <li>Project Management (Blackbox Estimation Techniques, Whitebox Estimation Techniques, Project Plans, Gantt Charts, PERT Charts)</li> </ul>
Literature	Kassem A. Saleh, Software Engineering, J. Ross Publishing 2009.

Course L0628: Software Engineering		
Тур	Recitation Section (small)	
Hrs/wk	2	
СР	3	
<b>Workload in Hours</b>	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 M0829	9: Foundations of Managen	nent			
Carriera					
Courses		<b>-</b>		11 /1-	CD.
Title	(1,0002)	<b>Typ</b> Recitation	Section	Hrs/wk	СР
Management Tutorial Introduction to Manag		(small)		3	3
		Lecture		3	3
1100 p 01101010					
Admission Requirements	None				
Recommended Previous Knowledge	Basic Knowledge of Mathematics and B	usiness			
Educational Objectives	After taking part successfully, students	have reached	the follo	wing learn	ing results
Professional Competence					
Knowledge	After taking this module, students know the important basics of many different areas in Business and Management, from Planning and Organisation to Marketing and Innovation, and also to Investment and Controlling. In particular they are able to  • explain the differences between Economics and Management and the subdisciplines in Management and to name important definitions from the field of Management  • explain the most important aspects of and goals in Management and name the most important aspects of entreprneurial projects  • describe and explain basic business functions as production, procurement and sourcing, supply chain management, organization and human ressource management, information management, innovation management and marketing  • explain the relevance of planning and decision making in Business, esp. in situations under multiple objectives and uncertainty, and explain some basic methods from mathematical Finance  • state basics from accounting and costing and selected controlling methods.				
Skills Personal Competence	systems      analyse and apply basic methods     select and apply basic methods     problems     apply basic methods from account problems	etc.) and to ca e able to structure them structures of ca making under rement syster s of marketing s from mathe	approprompanie multip	an Entre iately s le object Business finance to	preneurship ives, unde information predefine
, , , , , , , , , , , , , , , , , , ,	Students are able to  work successfully in a team of st to apply their knowledge from the		n entrepr	eneurship	project and

Social Competence	write a coherent report on the project  to communicate appropriately and  to cooperate respectfully with their fellow students.
Autonomy	work in a team and to organize the team themselves     to write a report on their project.
<b>Workload in Hours</b>	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	several written exams during the semester
the Following	General Engineering Science (German program, 7 semester): Core qualification: Compulsory Civil- and Environmental Engineering: Specialisation Civil Engineering: Elective Compulsory Civil- and Environmental Engineering: Specialisation Water and Environment: Elective Compulsory Civil- and Environmental Engineering: Specialisation Water and Environment: Elective Compulsory Civil- and Environmental Engineering: Specialisation Traffic and Mobility: Elective Compulsory Bioprocess Engineering: Core qualification: Compulsory Bioprocess Engineering: Core qualification: Compulsory Computer Science: Core qualification: Compulsory Data Science: Core qualification: Compulsory Electrical Engineering: Core qualification: Compulsory Energy and Environmental Engineering: Core qualification: Compulsory General Engineering Science (English program, 7 semester): Specialisation Electrical Engineering: Compulsory General Engineering Science (English program, 7 semester): Specialisation Civil Engineering: Compulsory General Engineering Science (English program, 7 semester): Specialisation Engineering Engineering: Compulsory General Engineering Science (English program, 7 semester): Specialisation Energy and Environmental Engineering: Compulsory General Engineering Science (English program, 7 semester): Specialisation Computer Science: Compulsory General Engineering Science (English program, 7 semester): Specialisation Mechanical Engineering, Focus Biomechanics: Compulsory General Engineering Science (English program, 7 semester): Specialisation Mechanical Engineering, Focus Biomechanics: 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 Mechatronics: Compulsory General Engineering Science (Englis

Mechatronics: Core qualification: Compulsory

Orientierungsstudium: Core qualification: Elective Compulsory

Naval Architecture: Core qualification: Compulsory Technomathematics: Core qualification: Compulsory Process Engineering: Core qualification: Compulsory

Course L0882: Management Tutorial			
Тур	Recitation Section (small)		
Hrs/wk	2		
СР	3		
<b>Workload in Hours</b>	Independent Study Time 62, Study Time in Lecture 28		
Lecturer	Prof. Christoph Ihl, Katharina Roedelius, Tobias Vlcek		
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 self-selected projects that focus on the elaboration of an innovative business idea from the point of view of an established company or a startup. Again, the business knowledge from the lecture should come to practical use. The group projects are guided by a mentor.		
Literature	Relevante Literatur aus der korrespondierenden Vorlesung.		

Course L0880: Intr	oduction to Management		
Тур	Lecture		
Hrs/wk	3		
СР	3		
Workload in Hours	Independent Study Time 48, Study Time in Lecture 42		
Lecturer	Prof. Christoph Ihl, Prof. Thorsten Blecker, Prof. Christian Lüthje, Prof. Christian Ringle, Prof. Kathrin Fischer, Prof. Cornelius Herstatt, Prof. Wolfgang Kersten, Prof. Matthias Meyer, Prof. Thomas Wrona		
Language	DE		
Cycle	WiSe/SoSe		
Content	<ul> <li>Introduction to Business and Management, Business versus Economics, relevant areas in Business and Management</li> <li>Important definitions from Management,</li> <li>Developing Objectives for Business, and their relation to important Business functions</li> <li>Business Functions: Functions of the Value Chain, e.g. Production and Procurement, Supply Chain Management, Innovation Management, Marketing and Sales         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.		

Courses				
<b>Title</b> Lab Cyber-Physical Sys	stems (L1740)	<b>Typ</b> Project-/problem- based Learning	Hrs/wk	<b>CP</b> 6
Module	<u> </u>	based Learning		
Responsible	Ргот. негко ғатк			
Admission Requirements	INONE			
Recommended Previous Knowledge	Module "Embedded Systems"			
Educational Objectives	After taking part successfully, students have reached the following learning results			
Professional				
Competence	Cyber-Physical Systems (CPS) a environment, via sensors, A/D a particular application areas, highl common. Accordingly, there is a I for CPS - in contrast to classical so	and D/A converters, and y specialized sensors, pro arge variety of different s	l actors. Docessors and pecification	ue to the d actors ar
Knowledge	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 th They understand the interdeper processes which stem from the fasensors, A/D converters, digital enables students to compare modern and limitations, and to decide which be able to apply these technic experiences in hardware-related specification tools and in the area	ndencies between a CPS interacts wo processors, D/A converted delling approaches, to evach technique to use for a ques to practical probled software development	and its ith the envious and actorial ac	surroundir ronment v ors. The la advantage sk. They w obtain fir
Personal				
Competence	Students are able to solve similar	problems alone or in a gi	oup and to	present th
suciai Competence	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, Stud	ly Time in Lecture 56		
Credit points				
Course achievement				
	T			

duration and scale	Execution and documentation of all lab experiments
the Following	General Engineering Science (German program, 7 semester): Specialisation Computer Science: Elective Compulsory Computer Science: Specialisation Computer and Software Engineering: Elective Compulsory Computer Science: Specialisation II. Mathematics and Engineering Science: Elective Compulsory General Engineering Science (English program, 7 semester): Specialisation Computer Science: Elective Compulsory Computational Science and Engineering: Specialisation II. Mathematics & Engineering Science: Elective Compulsory Computational Science and Engineering: Specialisation Computer Science: Elective Compulsory Mechatronics: Specialisation Intelligent Systems and Robotics: Elective Compulsory Mechatronics: Technical Complementary Course: Elective Compulsory

Course L1740: Lab	Cyber-Physical Systems
Тур	Project-/problem-based Learning
Hrs/wk	4
СР	6
<b>Workload in Hours</b>	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>

Module M1062	2: Mathematical Statistics				
Courses					
<b>Title</b> Mathematical Statistics Mathematical Statistics		<b>Typ</b> Lecture Recitation	Section	Hrs/wk 3	<b>CP</b> 4
Module	Prof. Natalie Neumeyer	(small)			
Admission					
Requirements  Recommended  Previous	Mathematical Stochastics				
	Measure Theory and Stochastics				
Objectives	After taking part successfully, students	nave reached	the follow	wing learn	ing results
Professional Competence					
Knowledge	<ul> <li>Students can describe basic consubstitution and Maximum-Likelih optimal unfalsified estimators, distributions, sufficiency and estimation and test problems, to domains and test families. They examples.</li> <li>Students can discuss logical consupable of illustrating these connormal They know proof strategies and consubstitution.</li> </ul>	ood methods optimal test completenes ests in norma are able to e nections betweections with the	for constant for constant for constant for process and all distributions and the constant for co	truction of arametric their app ution and lem using	estimators, probability plication to confidence appropriate s. They are
Skills	<ul> <li>Students can model problems in concepts studied in this course. by applying established methods.</li> <li>Students are able to discover and the concepts studied in the cours</li> <li>For a given problem, the studied approach, and are able to critical</li> </ul>	Moreover, the d verify furthe e. ents can dev	y are ca <sub>l</sub> er logical elop and	pable of s connection	olving them
Personal Competence					
Social Competence	<ul> <li>Students are able to work togomathematics as a common langu</li> <li>In doing so, they can communicatheir cooperating partners. More and deepen the understanding of</li> </ul>	age. Ite new conce Pover, they ca	epts acco	rding to t	he needs of
Autonomy	<ul> <li>Students are capable of checkin on their own. They can specify o get help in solving them.</li> <li>Students have developed sufficie periods in a goal-oriented manne</li> </ul>	pen questions nt persistence	precisel to be a	ly and kno	w where to
	[345]				

Workload in Hours	Independent Study Time 124, Study Time in Lecture 56
Credit points	6
Course achievement	None
Examination	Written exam
Examination duration and scale	120 minutes
the Following	General Engineering Science (German program, 7 semester): Specialisation Computer Science: Elective Compulsory General Engineering Science (English program, 7 semester): Specialisation Computer Science: Elective Compulsory Computational Science and Engineering: Specialisation Computer Science: Elective Compulsory Technomathematics: Specialisation I. Mathematics: Elective Compulsory

Course L1339: Mat	hematical Statistics
Тур	Lecture
Hrs/wk	3
СР	4
<b>Workload in Hours</b>	Independent Study Time 78, Study Time in Lecture 42
Lecturer	Dozenten des Fachbereiches Mathematik der UHH
Language	DE/EN
Cycle	SoSe
Content	<ul> <li>Substitution and Maximum-Likelihood methods for construction of estimators</li> <li>Optimal unfalsified estimators</li> <li>Optimal tests for parametric probability distributions (Neymann-Pearson theory)</li> <li>Sufficiency and completeness and their application to estimation and test problems</li> <li>Tests in normal distribution (e.g. Student's test)</li> <li>Confidence domains and test families</li> </ul>
Literature	<ul> <li>V. K. Rohatgi and A. K. Ehsanes Saleh (2001). An introduction to probability and statistics. Wiley.</li> <li>L. Wasserman (2010). All of statistics: A concise course in statistical inference. Springer.</li> <li>H. Witting (1985). Mathematische Statistik: Parametrische Verfahren bei festem Stichprobenumfang. Teubner.</li> </ul>

Course L1340: Mathematical Statistics	
Тур	Recitation Section (small)
Hrs/wk	1
СР	2
<b>Workload in Hours</b>	Independent Study Time 46, Study Time in Lecture 14
Lecturer	Dozenten des Fachbereiches Mathematik der UHH
Language	DE/EN
Cycle	SoSe
Content	See interlocking course
Literature	See interlocking course

## **Specialization Mechanical Engineering**

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

Graduates have:

- 1) Sound knowledge in the subject areas mathematics, thermodynamics, mechanics, electrical Engineering and computer science.
- 2) A basic knowledge in the field of measurement and control engineering, fluid mechanics and materials science.
- 3) In-depth knowledge in Engineering applications, especially in the selected subject area of focus (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 focus.

Courses				
Polymers and Compos	rials Science II (Advanced Ceramic Materials,	Typ Lecture Lecture Lecture	Hrs/wk 2 2 2	<b>CP</b> 2 2 2
Module Responsible	Prof. Jörg Weißmüller			
Admission Requirements	None			
Recommended Previous Knowledge		mathematics		
Educational Objectives	After taking part successfully, students h	nave reached th	ne following learr	ing results
Professional Competence				
Knowledge	The students have acquired a fundam polymers and can describe this kr knowledge here means specifically the phase diagrams, phase transformations students know about the key aspects of can identify relevant approaches for cable to trace materials phenomena baclaws of nature.	nowledge comissues of aton , corrosion and characterization	nprehensively. Finic structure, mid d mechanical properties on methods for mespecific properties	undament crostructur perties. T naterials a
	The students are able to trace materials and chemical laws of nature. Materia			

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

Module M0598	3: Mechanical Engineeri	ng: Design		
Courses				
Title Typ Hrs/wk C Embodiment Design and 3D-CAD (L0268) Lecture 2 1				
Mechanical Design Pro	ject I (L0695)	Project-/problem- based Learning	3	2
Mechanical Design Pro	ject II (L0592)	Project-/problem- based Learning Project-/problem-	3	2
Team Project Design M	lethodology (L0267)	based Learning	2	1
Module Responsible	Prof. Dieter Krause			
Admission Requirements	None			
Recommended Previous Knowledge	Eundamontals of Matorials 9			
Educational Objectives	After taking part successfully, stud	lents have reached the foll	lowing learn	ing results
Professional Competence				
Knowledge	<ul> <li>After passing the module, students are able to:</li> <li>explain design guidelines for machinery parts e.g. considering load situation, materials and manufacturing requirements,</li> <li>describe basics of 3D CAD,</li> <li>explain basics methods of engineering designing.</li> </ul>			
Skills	After passing the module, students are able to:  • independently create sketches, technical drawings and documentations e.g. using 3D CAD,  • design components based on design guidelines autonomously,  • dimension (calculate) used components,  • use methods to design and solve engineering design tasks systamtically and solution-oriented,  • apply creativity techniques in teams.			
Personal Competence	After passing the module, students	s are able to:		
Social Competence	<ul> <li>develop and evaluate solutions in groups including making and documenting decisions,</li> <li>moderate the use of scientific methods,</li> <li>present and discuss solutions and technical drawings within groups,</li> <li>reflect the own results in the work groups of the course.</li> </ul>			
Autonomy	to estimate their level of knowledge using activating methods within the lectures (e.g. with clickers),     To solve engineering design tasks systematically.			
Workload in Hours	Independent Study Time 40, Study	Time in Lecture 140		
Credit points	6			

	Compulso	r₿onus	Form		Description	
Course	Yes	None	Written elaboration	1	Teamprojekt Konstruktionsme	thodik
achievement	Yes	None	Written elaboration	ı K	Construktionspro	jekt 1
	Yes	None	Written elaboration	ı K	Construktionspro	jekt 2
	Yes	None	Written elaboration	1 3	D-CAD-Praktiku	m
Examination	Written exa	m				
Examination duration and scale	180					
the Following						

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

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

Course L0592: Med	hanical Design Project II
Тур	Project-/problem-based Learning
Hrs/wk	3
СР	2
<b>Workload in Hours</b>	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	<b>Dubbel, Taschenbuch für Maschinenbau</b> , Beitz, W., Küttner, KH, Springer-Verlag.  Maschinenelemente, Band I - III, Niemann, G., Springer-Verlag. <b>Maschinen- und Konstruktionselemente</b> , Steinhilper, W., Röper, R., Springer-Verlag.  Einführung in die DIN-Normen, Klein, M., Teubner-Verlag.  Konstruktionslehre, Pahl, G., Beitz, W., Springer-Verlag.

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

Courses				
Γitle		Тур	Hrs/wk	СР
Mechanics) (L1137)	ons, Analytical Mechanics, Numerical	Lecture	3	3
Mechanics) (L1138)	ons, Analytical Mechanics, Numerical	Recitation (small)	Section 2	2
Mechanics IV (Oscillation Mechanics) (L1139)	ons, Analytical Mechanics, Numerical	Recitation (large)	Section 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, student	s have reached	the following learr	ing results
Professional Competence				
	The students can			
Knowledge	<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			
Skills	<ul> <li>explain the important element model formation, and apply it to apply basic methods to enginee</li> <li>estimate the reach and bound applicable to wider problem set</li> </ul>	o the context of ering problems; aries of the me	their own problem	ıs;
Personal				
Competence Social Competence	The students can work in groups and s	support each ot	ner to overcome di	fficulties.
	Students are capable of determining organize their time and learning based		ngths and weakne	esses and t
Workload in Hours	Independent Study Time 96, Study Tir	ne in Lecture 84	ļ	
Credit points	6			
Course achievement	None			
Examination	Written exam			
Examination duration and scale	120 min			
	General Engineering Science (Gerr	man program.	7 semester): S	pecialisatio

	Architecture: Compulsory					
	nergy Systems: Technical Complementary Course Core Studies: Elective					
	Compulsory					
Assignment for	General Engineering Science (English program, 7 semester): Specialisation					
	Mechanical Engineering: Compulsory					
Curricula	General Engineering Science (English program, 7 semester): Specialisation Naval					
	Architecture: Compulsory					
	General Engineering Science (English program, 7 semester): Specialisation					
	Biomedical Engineering: Compulsory					
	Mechanical Engineering: Core qualification: Compulsory					
	Mechatronics: Core qualification: Compulsory					
	Naval Architecture: Core qualification: Compulsory					
	Technomathematics: Specialisation III. Engineering Science: Elective Compulsory					
	Theoretical Mechanical Engineering: Technical Complementary Course Core Studies:					
	Elective Compulsory					

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

Course L1138: Mechanics IV (Oscillations, Analytical Mechanics, Numerical Mechanics)			
Тур	Recitation Section (small)		
Hrs/wk	2		
СР	2		
<b>Workload in Hours</b>	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: Med	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	D: Fluid Dynamics			
Courses				
Title		Тур	Hrs/wk	СР
Fluid Mechanics (L0454	4)	Lecture	3	4
Fluid Mechanics (L045	5)	Recitation (large)	Section 2	2
Module Responsible	Prof. Thomas Rung			
Admission Requirements	None			
Recommended Previous Knowledge	Sound knowledge of engineering thermodynamics.	mathematics,	engineering me	echanics and
Educational Objectives	After taking part successfully, studen	ts have reached	the following lea	rning results
Professional Competence				
Competence	I Students will have the required sound	l knowledge to 4	explain the gener	al principles of
Knowledge	fluid engineering and physics of fl rationale of flow physics using mathe for the performance analysis and the	uids. Students matical models	can scientificall and are familiar	y outline the with methods
Skills	Students are able to apply fluid-engi the analysis of technical systems. The necessary theoretical calculations f devices on a scientific level.	ne lecture enab	les the student to	carry out all
Personal Competence Social Competence	The students are able to discuss prob	lems and jointly	develop solution	strategies.
Autonomy	The students are able to develop s consistent and crtically analyse result		es for complex p	problems self-
<b>Workload in Hours</b>	Independent Study Time 110, Study T	ime in Lecture	70	
Credit points				
Course achievement	None			
Examination	Written exam			
Examination duration and scale	180 min			
Assignment for the Following Curricula	General Engineering Science (Englis	man program, in program, 7 s glish program, h program, 7 s	7 semester): semester): Specia 7 semester): emester): Specia	Specialisation lisation Naval Specialisation lisation Naval

Biomedical Engineering: Compulsory
Computational Science and Engineering: Specialisation Engineering Sciences:
Elective Compulsory
Mechanical Engineering: Core qualification: Compulsory
Naval Architecture: Core qualification: Compulsory
Technomathematics: Specialisation III. Engineering Science: Elective Compulsory

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

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

Courses							
<b>Title</b> Practical Course: Meas	surement a	and Control Svs	tems (L1119)	<b>Typ</b> Practical Co	urse	Hrs/wk	<b>CP</b> 2
Measurement Technolo		-		Lecture		2	3
Measurement Technolo	ogy for Me	chanical Engin	eering (L1118)	Recitation (large)	Section	1	1
Module Responsible	Prof. Tho	rsten Kern					
Admission Requirements	None						
Recommended Previous Knowledge	Basic kn	owledge of ph	ysics, chemistry a	and electrical	engineeri	ng	
Educational Objectives	After tak	ing part succe	essfully, students	have reached	I the follow	wing learn	ing results
Professional Competence							
	Technolo	gy (Quantitie	name the most is and Units, Und and Systems).				
Knowledge	They can outline the most important measuring methods for different kinds of quantities to be maesured (Electrical Quantities, Temperature, mechanical quantities, Flow, Time, Frequency).						
	They can describe important methods of chemical Analysis (Gas Sensors, Spectroscopy, Gas Chromatography)						
			suitable measurin devices in practi		o given p	roblems a	ind can use
Skills	The students are able to orally explain issues in the subject area of measurement technology and solution approaches as well as place the issues into the rigorometer and application area.						
Personal Competence							
Social Competence	Students can arrive at work results in groups and document them in a common report.						
Autonomy	l Students are able to familiarize themselves with new measurement technologies.						
Workload in Hours	Independ	dent Study Tir	ne 110, Study Tir	ne in Lecture	70		
Credit points	6						
Course achievement		sor <b>Bonus</b> None	Form Subject theo practical work	retical and	Descripti	ion	
Examination	Written 6	exam					
Examination duration and scale	!						

Mechanical Engineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Biomedical Engineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Energy and Environmental Engineering: Compulsory Digital Mechanical Engineering: Core qualification: Compulsory Energy and Environmental Engineering: Core qualification: Compulsory Engineering Science: Specialisation Mechatronics: Compulsory Engineering Science: Specialisation Mechanical Engineering: Compulsory Engineering Science: Specialisation Biomedical Engineering: Elective Compulsory Assignment for General Engineering Science (English program, 7 semester): Specialisation Energy the Following and Environmental Engineering: Compulsory Curricula General Engineering Science (English program, 7 semester): Specialisation Mechanical Engineering: Compulsory General Engineering Science (English program, 7 semester): Specialisation Biomedical Engineering: Compulsory General Engineering Science (English program, 7 semester): Specialisation Mechatronics: Compulsory General Engineering Science (English program, 7 semester): Specialisation Mechanical Engineering: Compulsory General Engineering Science (English program, 7 semester): Specialisation Biomedical Engineering: Elective Compulsory Mechanical Engineering: Core qualification: Compulsory Mechatronics: Core qualification: Compulsory Process Engineering: Core qualification: Compulsory

Typ Pra Hrs/wk 2	ractical Course
Hrs/wk 2	detical course
<del></del>	
<b>CP</b> 2	
	dependent Study Time 32, Study Time in Lecture 28
	rof. Thorsten Kern
Language DE	
Cycle Wi	xperiment 1: Emission and immission measurement of gaseous pollutants:
Content Ex ph op:	ifferent technologies to determine different gaseous pollutants in automotive shaust are used.  Experiment 2: Simulation and measurement of asynchrone engine and rotary pump: ne dynamic behaviour of e pump engine will be investigated. The starting will be mulated on a PC and compared with measurement.  Experiment 3: Michelson interferometer and fiber optic: fundamental optical henonema will be understood and applications with Michelson interferometer and optical fibers demonstrated.  Experiment 4:Identification of the parameters of a control system and optimal parameters
	<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>
	<ul> <li>Grundlagen über elektrische Maschinen, speziell: Asynchronmotoren</li> <li>Simulationsmethoden, speziell: Verwendung von Blockschaltbildern</li> <li>Betriebsverhalten von Kreispumpen, speziell: Kennlinien, Ähnlichkeitsgesetze</li> <li>Unger, HG.: Optische Nachrichtentechnik, Teil 1: Optische Wellenleiter. Hüthing Verlag, Heidelberg, 1984</li> <li>Dakin, J., Cushaw, B.: Optical Fibre Sensors: Principles and Components. Artech House Boston, 1988</li> <li>Culshaw, B., Dakin, J.: Optical Fibre Sensors: Systems and Application. Artech House Boston, 1989</li> <li>Leonhard: Einführung in die Regelungstechnik. Vieweg Verlag, Braunschweig-Wiesbaden</li> <li>Jan Lunze: Systemtheoretische Grundlagen, Analyse und Entwurf einschleifiger Regelungen</li> </ul>

Course L1116: Mea	surement Technology for Mechanical Engineering			
Тур	Lecture			
Hrs/wk				
СР				
	Independent Study Time 62, Study Time in Lecture 28			
	Prof. Thorsten Kern, Dennis Kähler			
Language Cycle				
Сусте	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			
Content	2.4 Oscilloscope			
	2.5 Analog-to-Digital Conversion			
	2.6 Data Transmission			
	3 Measurement of Nonelectric Quantities			
	3.1 Temperature			
	3.2 Length, Displacement, Angle			
	3.3 Strain, Force, Pressure			
	3.4 Flow			
	3.5 Time, Frequency			
Literature	Lerch, R.: "Elektrische Messtechnik; Analoge, digitale und computergestützte Verfahren", Springer, 2006, ISBN: 978-3-540-34055-3.			
	Profos, P. Pfeifer, T.: "Handbuch der industriellen Messtechnik", Oldenbourg, 2002, ISBN: 978-3486217940.			

Course L1118: Measurement Technology for Mechanical Engineering		
Тур	Recitation Section (large)	
Hrs/wk	1	
СР	1	
<b>Workload in Hours</b>	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 M0865	5: Fundamentals of Pro	duction and Qu	ality Mana	gement
Courses				
<b>Title</b> Production Process Org Quality Management (I		<b>Typ</b> Lecture Lecture	Hrs/wk 2 2	<b>CP</b> 3 3
Module Responsible	Prof. Hermann Lödding			
Admission Requirements	None			
Recommended Previous Knowledge	None			
Educational Objectives	After taking part successfully, stu	idents have reached the	following learn	ning results
Professional Competence <i>Knowledge</i> <i>Skills</i>	Students are able to explain the of Students are able to apply the problems.			to industrial
Personal Competence Social Competence				
Autonomy	-			
	Independent Study Time 124, Stu	udy Time in Lecture 56		-
Credit points	6			
Course achievement	None			
Examination	Written exam			
Examination duration and scale	180 Minuten			
the Following	General Engineering Science Mechanical Engineering: Elective General Engineering Science Mechanical Engineering, Focus Ai General Engineering Science Mechanical Engineering, Focus Pr Engineering Science: Core qualific General Engineering Science Mechanical Engineering: Elective General Engineering Science (E Compulsory Logistics and Mobility: Specialisat Mechanical Engineering: Core qualifications	Compulsory (German program, 7 ircraft Systems Enginee (German program, 7 roduct Development and cation: Compulsory (English program, 7 Compulsory English program, 7 ser tion Engineering Science	semester): S ring: Compulsor semester): S d Production: Co semester): S mester): Core of	pecialisation ry pecialisation ompulsory pecialisation qualification:

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

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

Courses				
Title		Тур	Hrs/wk	СР
	naracterization (L1087)	Lecture	2	2
Advanced Materials De	-	Lecture Recitation	2 Section <sub>2</sub>	2
Advanced Materials De	esign (L1092)	(large)	2	2
Module Responsible	Prof. Patrick Huber			
Admission Requirements	LNIANA			
Recommended		- (I I II)		
Previous Knowledge	Fundamentals of Materials Science	e (I and II)		
	After taking part successfully, stud	lents have reached t	he following learn	ing results
Professional Competence				
Knowledge	The students will be able to explain the properties of advanced materials along with			
Skills	The students will be able to select material configurations according to the technical needs and, if necessary, to design new materials considering architectural principle from the micro- to the macroscale. The students will also gain an overview of modern materials science, which enables them to select optimum materials combinations depending on the technical applications.			
Personal Competence		nt solutions to spec	ialists and to de	evelop idea
<i>,</i>	The students are able to			
Autonomy	assess their own strengths and weaknesses.			
Workload in Hours	Independent Study Time 96, Study	/ Time in Lecture 84		
Credit points				
Course achievement	INONE			
Examination	Written exam			
Examination duration and scale	90 min			
the Following	General Engineering Science ( Mechanical Engineering: Elective ( General Engineering Science ( Mechanical Engineering, Focus Bio General Engineering Science ( Mechanical Engineering, Focus Ma Data Science: Specialisation Mater	Compulsory German program, omechanics: Compuls German program, terials in Engineering	7 semester): S sory 7 semester): S g Sciences: Comp	pecialisatio

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

Mechanical Engineering: Core qualification: Elective Compulsory

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

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

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

Module M0610	0: Electrical Machines and A	ctuators		
Courses				
Title Electrical Machines an	d Actuators (L0293)	<b>Typ</b> Lecture	Hrs/wk	<b>CP</b> 4
Electrical Machines an	d Actuators (L0294)	Recitation (large)	Section 2	2
Module Responsible				
Admission Requirements	None			
Recommended	Basics of mathematics, in particular com	plexe numbe	rs, integrals, differ	entials
Previous Knowledge	Rasics of electrical engineering and mos			
Educational Objectives		nave reached	the following learr	ing results
Professional				
Competence	Students can to draw and explain the fields.	e basic princi	ples of electric ar	nd magnetio
Knowledge	They can describe the function of the standard types of electric machines an present the corresponding equations and characteristic curves. For typically use drives they can explain the major parameters of the energy efficiency of the whole system from the power grid to the driven engine.			
Skills	Students arw able to calculate two-dimensional electric and magnetic fields in particular ferromagnetic circuits with air gap. For this they apply the usual method of the design auf electric machines.  They can calulate the operational performance of electric machines from their given characteristic data and selected quantities and characteristic curves. They apply the usual equivalent circuits and graphical methods.			
Personal Competence Social Competence		calculate elec	ctric and magnat	ic fields fo
Autonomy	applications. They are able to analyse independently the operational performance of electric machines from the characteristic data and theycan calculate thereof selected quantities and characteristic curves.			
Workload in Hours	Independent Study Time 110, Study Tim	e in Lecture 7	70	
Credit points	<u> </u>			
Course achievement				
Examination	Subject theoretical and practical work			
Examination duration and scale	Design of four machines and actuators, i	review of desi	gn files	
	General Engineering Science (German p and Enviromental Engineering: Compulsi General Engineering Science (Germa Electrical Engineering: Elective Compulsi	ory in program,	·	

Assignment for the Following Curricula	Digital Mechanical Engineering: Core qualification: Compulsory Electrical Engineering: Core qualification: Elective Compulsory Energy and Environmental Engineering: Core qualification: Compulsory General Engineering Science (English program, 7 semester): Specialisation Electrical Engineering: Elective Compulsory General Engineering Science (English program, 7 semester): Specialisation Energy and Environmental Engineering: Compulsory General Engineering Science (English program, 7 semester): Specialisation Mechanical Engineering: Elective Compulsory Computational Science and Engineering: Specialisation Engineering Sciences: Elective Compulsory Logistics and Mobility: Specialisation Engineering Science: Elective Compulsory Mechanical Engineering: Core qualification: Elective Compulsory

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

Course L0294: Electrical Machines and Actuators		
Тур	Recitation Section (large)	
Hrs/wk	2	
СР	2	
<b>Workload in Hours</b>	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	

## **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.

Courses				
Title		Тур	Hrs/wk	СР
	Engineering Design II (L0264)	Lecture	2	2
Advanced Mechanical	Engineering Design II (L0265)	Recitation (large)	Section 2	1
Advanced Mechanical	Engineering Design I (L0262)	Lecture	2	2
Advanced Mechanical	Engineering Design I (L0263)	Recitation (large)	Section 2	1
Module Responsible	Prof. Dieter Krause			
Admission Requirements	None			
Recommended Previous Knowledge	<ul> <li>Fundamentals of Mechanical Engineering Design</li> <li>Mechanics</li> <li>Fundamentals of Materials Science</li> <li>Production Engineering</li> </ul>			
Educational Objectives	After taking part successfully, stude	nts have reached	the following learn	ing results
Professional Competence				
Knowledge	<ul> <li>After passing the module, students are able to:</li> <li>explain complex working principles and functions of machine elements and obasic elements of fluidics,</li> <li>explain requirements, selection criteria, application scenarios and practical examples of complex machine elements,</li> <li>indicate the background of dimensioning calculations.</li> </ul>			
Skills	<ul> <li>After passing the module, students are able to:</li> <li>accomplish dimensioning calculations of covered machine elements,</li> <li>transfer knowledge learned in the module to new requirements and tasks (problem solving skills),</li> <li>recognize the content of technical drawings and schematic sketches,</li> <li>evaluate complex designs, technically.</li> </ul>			
Personal Competence				
Social Competence	Students are able to discuss activating methods.	technical informat	ion in the lecture s	upported b
Autonomy	<ul> <li>Students are able to independently deepen their acquired knowledge exercises.</li> <li>Students are able to acquire additional knowledge and to recapitulate poor understood content e.g. by using the video recordings of the lectures.</li> </ul>			

<b>Workload in Hours</b>	Independent Study Time 68, Study Time in Lecture 112
Credit points	6
Course achievement	None
Examination	Written exam
Examination duration and scale	
Assignment for the Following Curricula	General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering; Compulsory General Engineering, Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Biomechanics: Compulsory General Engineering, Focus Biomechanics: Compulsory General Engineering, Focus Energy Systems: Compulsory General Engineering, Focus Aircraft Systems: Compulsory General Engineering, Focus Aircraft Systems Engineering: Compulsory General Engineering, Focus Aircraft Systems Engineering: Compulsory General Engineering, Focus Aircraft Systems Engineering: Compulsory General Engineering, Focus Materials in Engineering Sciences: Compulsory General Engineering, Focus Materials in Engineering Sciences: Compulsory General Engineering, Focus Mechatronics: Compulsory General Engineering, Focus Mechatronics: Compulsory General Engineering, Focus Product Development and Production: Compulsory General Engineering, Focus Product Development and Production: Specialisation Mechanical Engineering, Focus Theoretical Mechanical Engineering: Compulsory Energy Systems: Technical Complementary Course Core Studies: Elective Compulsory Engineering Science: Specialisation Mechanical Engineering: Compulsory General Engineering Science (English program, 7 semester): Specialisation Mechanical Engineering Science (English program, 7 semester): Specialisation Mechanical Engineering, Focus Biomechanics: Compulsory General Engineering Science (English program, 7 semester): Specialisation Mechanical Engineering, Focus Biomechanics: Compulsory General Engineering Science (English program, 7 semester): Specialisation Mechanical Engineering, Focus Aircraft Systems Engineering: Compulsory General Engineering Science (English program, 7 semester): Specialisation Mechanical Engineering, Focus Materials in Engineering Sciences: Compulsory General Engineering Science (English program, 7 semester): Specialisation Mechanical Engineering, Focus Materials in Engineering Sciences: Compulsory General Engineering Science (Eng

Course L0264: Adv	anced Mechanical Engineering Design II		
Тур	Lecture		
Hrs/wk	2		
СР	2		
<b>Workload in Hours</b>	Independent Study Time 32, Study Time in Lecture 28		
Lecturer	Prof. Dieter Krause, Prof. Otto von Estorff		
Language	DE		
Cycle	SoSe		
	Advanced Mechanical Engineering Design I & II		
Content	• Fundamentals of the following machine elements:  • Linear rolling bearings  • Axes & shafts  • Seals  • Clutches & brakes  • Belt & chain drives  • Gear drives  • Epicyclic gears  • Crank drives  • Sliding bearings  • Elements of fluidics   Exercise  • Calculation methods of the following machine elements:  • Linear rolling bearings  • Axes & shafts  • Clutches & brakes  • Belt & chain drives  • Belt & chain drives  • Gear drives  • Gear drives  • Gear drives  • 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> <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>		

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	

anced Mechanical Engineering Design I		
Lecture		
2		
2		
Independent Study Time 32, Study Time in Lecture 28		
Prof. Dieter Krause, Prof. Otto von Estorff		
DE		
WiSe		
Advanced Mechanical Engineering Design I & II		
Fundamentals of the following machine elements:		
<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>		

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 M1277	7: MED I: Introduction to Anatomy		
Courses			
<b>Title</b> Introduction to Anatom	Typ Hrs/wk CP ny (L0384) Lecture 2 3		
Module Responsible	Prof. Udo Schumacher		
Admission Requirements	LNONA		
Recommended Previous Knowledge	None		
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. The students can describe the basic macroscopy and microscopy of those systems.		
Skills	The students can recognize the relationship between given anatomical facts and the development of some common diseases; they can 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 level.		
Autonomy	The students are able to access anatomical knowledge by themselves, can participate in conversations on the topic and acquire the relevant knowledge themselves.		
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28		
Credit points			
Course achievement	None		
Examination	Written exam		
Examination duration and scale	90 minutes		
	General Engineering Science (German program, 7 semester): Specialisation Biomedical Engineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Biomechanics: Compulsory Data Science: Specialisation Medicine: Compulsory		
the Following	Electrical Engineering: Specialisation Medical Technology: Elective Compulsory Engineering Science: Specialisation Biomedical Engineering: Compulsory General Engineering Science (English program, 7 semester): Specialisation Mechanical Engineering, Focus Biomechanics: Compulsory General Engineering Science (English program, 7 semester): Specialisation Biomedical Engineering: Compulsory General Engineering Science (English program, 7 semester): Specialisation Biomedical Engineering: Compulsory 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 to Anatomy			
Тур	Lecture		
Hrs/wk	2		
СР	3		
		Time 62, Study Time in Lecture 28	
-	Prof. Tobias Lange		
Language			
Cycle		_	
	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	
Contont	7 <sup>th</sup> week:	Genito-urinary System	
Content	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 M127 Therapy	8: MED I: Introduction to Radiology and Radiation
Courses	
<b>Title</b> Introduction to Radiolo	Typ Hrs/wk CP gy and Radiation Therapy (L0383) Lecture 2 3
Admission Requirements	None
Recommended Previous	None
Knowledge Educational Objectives	After taking part successfully, students have reached the following learning results
Professional Competence	
	Therapy The students can distinguish different types of currently 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' passage from their initial admittance through to follow-up care.
Knowledge	<b>Diagnostics</b> The students can illustrate the technical base concepts of projection radiography including angiography and mammography, as well as sectional imaging technique (CT, MRT, US).
	The students can explain the diagnostic as well as therapeutic use of imagin techniques, as well as the technical basis for those techniques.  The students can choose the right treatment method depending on the patient' 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' diagnosti findings or the error protocol.
	<b>Therapy</b> The students can distinguish curative and palliative situations and motivate wh 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 on depending on the situation (location of the tumor) and choose the energy needed in that situation (irradiation planning).
Skills	The student can assess what an individual psychosocial service should look like (e.g. follow-up treatment, sports, social help groups, self-help groups, social services, psycho-oncology).
	Diagnostics
	[380]

	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 of 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 therapeutic measures and can meet them appropriately.
	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.
Autonomy	The students are able to access anatomical knowledge by themselves, can participate competently in conversations on the topic and acquire the relevant knowledge themselves.
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Credit points	
Course achievement	None
Examination	Written exam
Examination duration and scale	90 minutes
the Following	General Engineering Science (German program, 7 semester): Specialisation Biomedical Engineering: Compulsory 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 Mechanical Engineering, Focus Biomechanics: Compulsory General Engineering Science (English program, 7 semester): Specialisation Biomedical Engineering: Compulsory General Engineering: Compulsory General Engineering: Specialisation Biomechanics: 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 L0383: Introduction to Radiology and Radiation Therapy		
Тур	Lecture	
Hrs/wk	2	
СР	3	
<b>Workload in Hours</b>	Independent Study Time 62, Study Time in Lecture 28	
Lecturer	Prof. Ulrich Carl, Prof. Thomas Vestring	
Language	DE	

Cycle Content	The students will be given an understanding of the technological possibilities in the field of medical imaging, interventional radiology and radiation therapy/radiation oncology. It is assumed, that students in the beginning of the course have heard the word "X-ray" at best. It will be distinguished between the two arms of diagnostic (Prof. Dr. med. Thomas Vestring) and therapeutic (Prof. Dr. med. Ulrich Carl) use of X-rays. Both arms depend on special big units, which determine a predefined sequence in their respective departments
	Technik der medizinischen Radiologie" von T. + J. Laubenberg –
	<ul> <li>7. Auflage – Deutscher Ärzteverlag – erschienen 1999</li> <li>"Klinische Strahlenbiologie" von Th. Herrmann, M. Baumann und W. Dörr –</li> </ul>
	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
Literature	<ul> <li>"Taschenatlas der Physiologie" von S. Silbernagel und A. Despopoulus-</li> </ul>
	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 M0672	2: Signals and Systems				
Courses					
<b>Title</b> Signals and Systems (I		<b>Typ</b> Lecture Recitation	Hrs/ 3 Section 2	/wk CP 4	
Signals and Systems (	L0433)	(small)	2		
Module Responsible	Prof. Gerhard Bauch				
Admission Requirements	LNIANA				
	Mathematics 1-3				
Previous	The modul is an introduction to the theory of signals and systems. Good knowledge in maths as covered by the moduls Mathematik 1-3 is expected. Further experience with spectral transformations (Fourier series, Fourier transform, Laplace transform) is useful but not required.				
Educational Objectives	After taking part successfully, students h	nave reached	the following	learning resu	ılts
Professional Competence					
	The students are able to classify and describe signals and linear time-invariant (LTI) systems using methods of signal and system theory. They are able to apply the fundamental transformations of continuous-time and discrete-time signals and systems. They can describe and analyse deterministic signals and systems mathematically in both time and image domain. In particular, they understand the effects in time domain and image domain which are caused by the transition of a continuous-time signal to a discrete-time signal.				
Skills	The students are able to describe and analyse deterministic signals and linear time-invariant systems using methods of signal and system theory. They can analyse and design basic systems regarding important properties such as magnitude and phase response, stability, linearity etc They can assess the impact of LTI systems on the signal properties in time and frequency domain.				
Personal Competence					
•	l The students can jointly solve specific pr	oblems			
	The students are able to acquire relevant sources. They can control their level control tutorial problems, software tools,	ant information of knowledge	during the le		
<b>Workload in Hours</b>	Independent Study Time 110, Study Tim	e in Lecture 7	0		
Credit points					
Course achievement	INONA				
	Written exam				
Examination duration and scale	90 min				
	General Engineering Science (German Compulsory Computer Science: Core qualification: Core Data Science: Core qualification: Compule Electrical Engineering: Core qualification General Engineering Science (English pro Engineering: Compulsory General Engineering Science (English Bioprocess Engineering: Compulsory	ompulsory Isory : Compulsory ogram, 7 sem	ester): Specia	ilisation Elect	trical

		Engineering er Science: Cor		(English	program,	7	semester):	Specialisation
	General	Engineering	Science					Specialisation
		cal Engineerin	•		•		•	
Assignment for					. •			Specialisation
the Following								
Curricula	General	Engineering	Science	(English	program,	7	semester):	Specialisation
	Mechanic	cal Engineerin	g, Focus A	ircraft Sys	stems Engir	ieei	ing: Compuls	sory
	General	Engineering	Science	(English	program,	7	semester):	Specialisation
		cal Engineerin			. •			
	General	Engineering	Science	(English	program,	7	semester):	Specialisation
		cal Engineerin			. •			•
	General	Engineering	Science	(English	program,	7	semester):	Specialisation
		cal Engineerin						
		-	-					sation Process
		ing: Compulso			,		,	
			•	(English	nrogram	7	semester).	Specialisation
		cal Engineering			program,	•	semester).	Specialisation
		itional Science		-	oro qualific	atio	n: Compulso	rv.
			•	•	•	atic	ni. Compuiso	ı y
		onics: Core qua		•	•	. :	Flashiva (	
	recnnom	nathematics: S	pecialisati	ion III. Eng	ineering Sc	ien	ce: Elective (	Lompuisory

Tvp	Lecture
Hrs/wk	
СР	
	Independent Study Time 78, Study Time in Lecture 42
	Prof. Gerhard Bauch
Language	
Cycle	
	Introduction to signal and system theory  Signals  Classification of signals  Analog and digital signals  Deterministic and random signals  Description of LTI systems by differential equations or difference equations, respectively  Basic properties of signals and operations on signals  Elementary signals  Distributions (Generalized Functions)  Power and energy of signals  Correlation functions of deterministic signals  Autocorrelation function  Crosscorrelation function  Orthogonal signals  Applications of correlation  Linear time-invariant (LTI) systems  Linearity  Time-invariance  Description of LTI systems by impulse response and frequency response  Convolution  Convolution  Convolution  Convolution and correlation  Properties of LTI-systems  Causal systems  Stable systems  Memoryless systems  Memoryless systems  Fourier Series and Fourier Transform  Fourier transform of continuous-time signals, discrete-time signals

periodic signals, non-periodic signals • Properties of the Fourier transform Fourier transform of some basic signals Parseval's theorem Analysis of LTI-systems and signals in the frequency domain Frequency response, magnitude response and phase response Transmission factor, attenuation, gain Frequency-flat and frequency-selective LTI-systems Bandwidth definitions o Basic types of systems (filters), lowpass, highpass, bandpass, bandstop systems Phase delay and group delay Linear-phase systems Distortion-free systems Content • Spectrum analysis with limited observation window: Leakage effect Laplace Transform Relation of Fourier transform and Laplace transform Properties of the Laplace transform Laplace transform of some basic signals Analysis of LTI-systems in the s-domain Transfer function of LTI-systems • Relation of Laplace transform, magnitude response and phase response Analysis of LTI-systems using pole-zero plots Allpass filters Minimum-phase, maximum-phase and mixed phase filters Stable systems Sampling Sampling theorem · Reconstruction of continuous-time signals in frequency domain and time domain Oversampling Aliasing Sampling with pulses of finite duration, sample and hold Decimation and interpolation Discrete-Time Fourier Transform (DTFT) Relation of Fourier transform and DTFT Properties of the DTFT Discrete Fourier Transform (DFT) Relation of DTFT and DFT Cyclic properties of the DFT DFT matrix Zero padding Cyclic convolution Fast Fourier Transform (FFT) o Application of the DFT: Orthogonal Frequency Division Multiplex (OFDM) Z-Transform Relation of Laplace transform, DTFT, and z-transform Properties of the z-transform Z-transform of some basic discrete-time signals Discrete-time systems, digital filters FIR and IIR filters Z-transform of digital filters • Analysis of discrete-time systems using pole-zero plots in the z-domain Stability Allpass filters • Minimum-phase, maximum-phase and mixed-phase filters Linear phase filters T. Frey , M. Bossert , Signal- und Systemtheorie, B.G. Teubner Verlag 2004 K. Kammeyer, K. Kroschel, Digitale Signalverarbeitung, Teubner Verlag.

## Literature

- B. Girod ,R. Rabensteiner , A. Stenger , Einführung in die Systemtheorie, B.G. Teubner, Stuttgart, 1997
- J.R. Ohm, H.D. Lüke , Signalübertragung, Springer-Verlag 8. Auflage, 2002
- S. Haykin, B. van Veen: Signals and systems. Wiley.
- Oppenheim, A.S. Willsky: Signals and Systems. Pearson.
- Oppenheim, R. W. Schafer: Discrete-time signal processing. Pearson.

Course L0433: Signals and Systems			
Тур	Recitation Section (small)		
Hrs/wk	2		
СР	2		
<b>Workload in Hours</b>	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 M1333	3: BIO I: Implants and	Fracture Healing		
Courses				
Title Implants and Fracture	Healing (L0376)	<b>Typ</b> Lecture	Hrs/wk 2	<b>CP</b> 3
Module Responsible	Prof. Michael Morlock			
Admission Requirements	None			
	It is recommended to participa "Implants and Fracture Healing"		anatomie" befo	re attending
Educational Objectives	After taking part successfully, st	tudents have reached the	following learn	ning results
Professional Competence				
Knowledge	The students can describe the d for their existence. The students can name differer given fracture morphologies.	•		•
Skills	The students can determine the static situations under specific a		human body	under quasi-
Personal Competence				
Social Competence	The students can, in groups calculation of internal forces.	, solve basic numerica	l modeling ta	isks for the
Autonomy	The students can, in groups calculation of internal forces.	, solve basic numerica	l modeling ta	isks for the
<b>Workload in Hours</b>	Independent Study Time 62, Stu	udy Time in Lecture 28		
Credit points	3			
Course achievement	None			
Examination				
Examination duration and scale				
Assignment for the Following Curricula	General Engineering Science Mechanical Engineering, Focus I General Engineering Science Biomedical Engineering: Compu Engineering Science: Specialisat General Engineering Science Biomedical Engineering: Compu General Engineering: Compu General Engineering Science Mechanical Engineering, Focus I Mechanical Engineering: Specia Biomedical Engineering: Specia Elective Compulsory Biomedical Engineering: Special Engineering: Special Elective Compulsory Biomedical Engineering: Special Elective Compulsory Biomedical Engineering: Special Elective Compulsory Biomedical Engineering: Special Elective Compulsory	Biomechanics: Compulsor (German program, 7 Isory tion Biomedical Engineeri (English program, 7 Isory (English program, 7 Biomechanics: Compulsor Iisation Biomechanics: Colisation Artificial Organs a ialisation Implants and alisation Medical Techno	semester): S ng: Compulsor semester): S semester): S y mpulsory and Regenerati Endoprosthes	pecialisation pecialisation pecialisation pecialisation we Medicine: ses: Elective trol Theory:

Orientierungsstudium: Core qualification: Elective Compulsory Technomathematics: Specialisation III. Engineering Science: Elective Compulsory

Course L0376: Imp	lants and Fracture Healing
Тур	Lecture
Hrs/wk	2
СР	
	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Prof. Michael Morlock
Cycle	
	Topics to be covered include:
	Introduction (history, definitions, background importance)
	2. Bone (anatomy, properties, biology, adaptations in femur, tibia, humerus, radius)
	3. Spine (anatomy, biomechanics, function, vertebral bodies, intervertebral disc, ligaments)
	3.1 The spine in its entirety
	3.2 Cervical spine
	3.3 Thoracic spine
	3.4 Lumbar spine
	3.5 Injuries and diseases
Content	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
	Cochran V.B.: Orthopädische Biomechanik
	Mow V.C., Hayes W.C.: Basic Orthopaedic Biomechanics
Literature	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 M127 Biology	9: MED II: Introduction to Biochemistry and Molecular			
Courses				
Title Introduction to Biocher	Typ Hrs/wk CP mistry and Molecular Biology (L0386) Lecture 2 3			
Module Responsible	Prof. Hans-Jürgen Kreienkamp			
Admission Requirements	INONE			
Recommended Previous Knowledge	None			
Educational Objectives				
Professional Competence				
Knowledge	<ul> <li>The students can</li> <li>describe basic biomolecules;</li> <li>explain how genetic information is coded in the DNA;</li> <li>explain the connection between DNA and proteins;</li> </ul>			
Skills	<ul> <li>The students can</li> <li>recognize the importance of molecular parameters for the course of a disease;</li> <li>describe selected molecular-diagnostic procedures;</li> <li>explain the relevance of these procedures for some diseases</li> </ul>			
Personal Competence Social Competence	The students can participate in discussions in research and medicine on a technica			
Autonomy	The students can develop understanding of topics from the course, using technica literature, by themselves.			
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28			
Credit points				
Course achievement				
	Written exam			
Examination duration and scale	60 minutes			
Assignment for the Following Curricula				

Biomedical Engineering: Specialisation Management and Business Administration: Elective Compulsory
Biomedical Engineering: Specialisation Artificial Organs and Regenerative Medicine: Elective Compulsory
Biomedical Engineering: Specialisation Medical Technology and Control Theory: Elective Compulsory
Biomedical Engineering: Specialisation Implants and Endoprostheses: Elective Compulsory
Technomathematics: Specialisation III. Engineering Science: Elective Compulsory

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

Courses						
Title Introduction to Control		<b>Typ</b> Lecture Recitation	Hrs/wk 2 Section 2	4		
Introduction to Control	i Systems (Lu655)	(small)		2		
Responsible	1	Prof. Herbert Werner				
Admission Requirements	None					
Recommended Previous Knowledge						
Educational Objectives	After taking part successfully, stude	ents have reached t	the following lear	ning results		
Professional Competence						
Knowledge	<ul> <li>Students can represent dynamic system behavior in time and frequency domain, and can in particular explain properties of first and second order systems</li> <li>They can explain the dynamics of simple control loops and interpret dynamic properties in terms of frequency response and root locus</li> <li>They can explain the Nyquist stability criterion and the stability margins derived from it.</li> <li>They can explain the role of the phase margin in analysis and synthesis of control loops</li> <li>They can explain the way a PID controller affects a control loop in terms of its frequency response</li> <li>They can explain issues arising when controllers designed in continuous time domain are implemented digitally</li> </ul>					
Skills	<ul> <li>Students can transform models of linear dynamic systems from time to frequency domain and vice versa</li> <li>They can simulate and assess the behavior of systems and control loops</li> <li>They can design PID controllers with the help of heuristic (Ziegler-Nichols tuning rules</li> <li>They can analyze and synthesize simple control loops with the help of roo locus and frequency response techniques</li> <li>They can calculate discrete-time approximations of controllers designed in continuous-time and use it for digital implementation</li> <li>They can use standard software tools (Matlab Control Toolbox, Simulink) fo carrying out these tasks</li> </ul>					
Personal Competence	:					
Social Competence	Students can work in small groups to jointly solve technical problems, and experimentally validate their controller designs  Students can obtain information from provided sources (lecture notes, software)					
	documentation, experiment guides) and use it when solving given problems.  They can assess their knowledge in weekly on-line tests and thereby control their learning progress.					

	<u> </u>			
<b>Workload in Hours</b>	Independent Study Time 124, Study Time in Lecture 56			
Credit points	6			
Course achievement	NAMA			
Examination	Written exam			
Examination duration and scale	120 min			
the Following	General Engineering Science (German program, 7 semester): Core qualification: Compulsory Bioprocess Engineering: Core qualification: Compulsory Computer Science: Specialisation Computational Mathematics: Elective Compulsory Data Science: Core qualification: Elective Compulsory Electrical Engineering: Core qualification: Compulsory Energy and Environmental Engineering: Core qualification: Compulsory Engineering Science (English program, 7 semester): Specialisation Electrical Engineering: Compulsory General Engineering Science (English program, 7 semester): Specialisation Civil Engineering: Compulsory General Engineering Science (English program, 7 semester): Specialisation Bioprocess Engineering: Compulsory General Engineering Science (English program, 7 semester): Specialisation Energy and Environmental Engineering: Compulsory General Engineering Science (English program, 7 semester): Specialisation Engineerial Engineering Science (English program, 7 semester): Specialisation Computer Science: Compulsory General Engineering Science (English program, 7 semester): Specialisation Mechanical Engineering, Focus Biomechanics: Compulsory General Engineering Science (English program, 7 semester): Specialisation Mechanical Engineering, Focus Energy Systems: Compulsory General Engineering Science (English program, 7 semester): Specialisation Mechanical Engineering, Focus Materials in 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 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): Spec			

Course L0654: Introduction to Control Systems				
Тур	Lecture			
Hrs/wk				
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			
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	
<b>Workload in Hours</b>	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 M0662	2: Numerical Mathematics I				
Courses					
Title Numerical Mathematics I (L0417) Numerical Mathematics I (L0418)		<b>Typ</b> Lecture Recitation (small)	Hrs/wk 2 Section 2	<b>CP</b> 3	
Module	Prof. Sabine Le Borne	(Siliali)			
Responsible Admission					
Requirements				-	
Recommended Previous Knowledge	<ul> <li>Mathematik I + II for Engineering Students (german or english) or Analysis &amp; Linear Algebra I + II for Technomathematicians</li> <li>basic MATLAB knowledge</li> </ul>				
Educational Objectives	After taking part successfully, students	have reached	the following learr	ning results	
Professional Competence					
Knowledge	<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	<ul> <li>Students are able to</li> <li>implement, apply and compare numerical methods using MATLAB,</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	• work together in heterogeneously composed teams (i.e., teams from different study programs and background knowledge), explain theoretical foundations and support each other with practical aspects regarding the implementation of algorithms.				
Autonomy	<ul> <li>Students are capable</li> <li>to assess whether the supporting theoretical and practical excercises are better solved individually or in a team,</li> <li>to assess their individual progess and, if necessary, to ask questions and seek help.</li> </ul>				
<b>Workload in Hours</b>	Independent Study Time 124, Study Tin	ne in Lecture 5	6		
Credit points	6				
Course achievement	None				
Examination					
Examination					

duration and scale	
	General Engineering Science (German program, 7 semester): Specialisation
	Computer Science: Compulsory
	General Engineering Science (German program, 7 semester): Specialisation
	Mechanical Engineering, Focus Materials in Engineering Sciences: Compulsory
	General Engineering Science (German program, 7 semester): Specialisation
	Biomedical Engineering: Compulsory
	General Engineering Science (German program, 7 semester): Specialisation
	Mechanical Engineering, Focus Biomechanics: Compulsory
	General Engineering Science (German program, 7 semester): Specialisation
	Mechanical Engineering, Focus Theoretical Mechanical Engineering: Compulsory
	Bioprocess Engineering: Specialisation A - General Bioprocess Engineering: Elective
	Compulsory
	Computer Science: Specialisation Computational Mathematics: Elective Compulsory
	Computer Science: Specialisation II. Mathematics and Engineering Science: Elective
	Compulsory
	Data Science: Core qualification: Compulsory
	Electrical Engineering: Core qualification: Elective Compulsory
	Engineering Science: Core qualification: Compulsory
	General Engineering Science (English program, 7 semester): Specialisation
Assignment for	Mechanical Engineering, Focus Theoretical Mechanical Engineering: Elective
the Following	Compulsory
Curricula	General Engineering Science (English program, / semester): Core qualification
	Compulsory
	General Engineering Science (English program, 7 semester): Specialisation
	Computer Science: Compulsory
	General Engineering Science (English program, 7 semester): Specialisation
	Mechanical Engineering, Focus Biomechanics: Compulsory
	General Engineering Science (English program, 7 semester): Specialisation
	Mechanical Engineering, Focus Materials in Engineering Sciences: Compulsory
	General Engineering Science (English program, 7 semester): Specialisation
	Mechanical Engineering, Focus Theoretical Mechanical Engineering: Compulsory
	General Engineering Science (English program, 7 semester): Specialisation
	Biomedical Engineering: Compulsory
	Computational Science and Engineering: Core qualification: Compulsory
	Mechanical Engineering: Specialisation Theoretical Mechanical Engineering: Elective
	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: Nun	nerical 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>Error analysis: Number representation, error types, conditioning and stability</li> <li>Interpolation: polynomial and spline interpolation</li> <li>Numerical integration and differentiation: order, Newton-Cotes formula, error estimates, Gaussian quadrature, adaptive quadrature, difference formulas</li> <li>Linear systems: LU and Cholesky factorization, matrix norms, conditioning</li> <li>Linear least squares problems: normal equations, Gram.Schmidt and Householder orthogonalization, singular value decomposition, regularization</li> <li>Eigenvalue problems: power iteration, inverse iteration, QR algorithm</li> <li>Nonlinear systems of equations: Fixed point iteration, root-finding algorithms for real-valued functions, Newton and Quasi-Newton methods for systems</li> </ol>
Literature	<ul> <li>Stoer/Bulirsch: Numerische Mathematik 1, Springer</li> <li>Dahmen, Reusken: Numerik für Ingenieure und Naturwissenschaftler, Springer</li> </ul>

Course L0418: Numerical Mathematics I		
Тур	Recitation Section (small)	
Hrs/wk	2	
СР	3	
<b>Workload in Hours</b>	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 M0730	0: Computer Engineering			
Courses				
<b>Title</b> Computer Engineering Computer Engineering		Typ Lecture Recitation (small)	Hrs/wk 3 Section 1	<b>CP</b> 4 2
Module Responsible	Prof. Heiko Falk	(Siliuli)		
Admission Requirements	None			
Recommended Previous Knowledge	Basic knowledge in electrical engineerin	g		
Educational Objectives	After taking part successfully, students l	have reached th	ne following lear	ning results
Professional Competence				
Knowledge	This module deals with the foundations covers the layers from the assembly-levincludes the following topics:  • Introduction • Combinational logic: Gates, Boo synthesis, combinational network • Sequential logic: Flip-flops, autom • Technological foundations • Computer arithmetic: Integer division • Basics of computer architecture architecture, pipelining • Memories: Memory hierarchies, S • Input/output: I/O from the perspension-to-point connections, busse	lean algebra, Is addition, subte: Programming RAM, DRAM, cascitive of the CP	g down to gates  Boolean function  hardware designaction, multip  models, MIPS  ches	The module ns, hardware gn lication and single-cycle
Skills	The students perceive computer system identify the internal structure and the The students can analyze, how highly sybased on a collection of few and simpl between and to explain the different systems - from gates and circuits up to a After successful completion of the mainterdependencies between a physical con it. In particular, they shall understa software has on the hardware-centr language down to gates. This way, they these low abstraction levels have on propose feasible options.	physical components. components. components. complete procest odule, the study computer system of the consequic abstraction of will be enabled.	osition of computers ridual computers They are able tayers of today's ssors.  Ients are able m and the softw uences that the layers from the d to evaluate the	ter systems of can be built to distinguish somputing to judge the are executed execution of the assembly entire impact that
Personal Competence				
Social Competence	Students are able to solve similar probl results accordingly.	ems alone or ir	n a group and to	present the
Autonomy	Students are able to acquire new k associate this knowledge with other clas		n specific litera	ture and to
	Independent Study Time 124, Study Time	ne in Lecture 56		
Credit points	lρ			

Course	Compulsor <b>B</b> onus	Form	Description	
achievement		Excercises	Description	
Examination	Written exam			
Examination				
duration and scale	90 minutes, contents of	f course and labs		
	General Engineering Computer Science: Com		program, 7 semeste	er): Specialisation
	General Engineering	Science (German	program, 7 semeste	er): Specialisation
	Bioprocess Engineering General Engineering So	cience (German pro	gram, 7 semester): S <sub>l</sub>	pecialisation Naval
	Architecture: Compulso General Engineering Electrical Engineering: (	Science (German	program, 7 semeste	er): Specialisation
	General Engineering Biomedical Engineering	Science (German	program, 7 semeste	er): Specialisation
	General Engineering Sc and Enviromental Engin	cience (German prog		ecialisation Energy
	General Engineering Sc Engineering: Compulsor	ience (German prog		cialisation Process
	General Engineering Mechanical Engineering	Science (German		er): Specialisation
	General Engineering Mechanical Engineering	Science (German	program, 7 semeste	er): Specialisation
	General Engineering Mechanical Engineering	Science (German	program, 7 semeste	
	General Engineering Mechanical Engineering	Science (German	program, 7 semeste	er): Specialisation
	General Engineering Mechanical Engineering	Science (German	program, 7 semeste	er): Specialisation
	General Engineering	Science (German	program, 7 semeste	er): Specialisation
	Mechanical Engineering General Engineering	Science (German	program, 7 semeste	
	Mechanical Engineering General Engineering	Science (German	program, 7 semeste	er): Specialisation
	Mechanical Engineering General Engineering So	cience (German pr		Specialisation Civil
	Engineering: Compulsor Computer Science: Core		pulsorv	
	Data Science: Core qua	lification: Elective C	ompulsory	
	Electrical Engineering: ( General Engineering Sc			ialication Flectrical
Carricala	Engineering: Compulsor	ry	·	
	General Engineering S Engineering: Compulsor		ogram, 7 semester): S	Specialisation Civil
	General Engineering Bioprocess Engineering	: Compulsory		
	General Engineering So and Enviromental Engin			ecialisation Energy
	General Engineering Computer Science: Com	npulsory		·
	General Engineering Mechanical Engineering	, Focus Biomechani	cs: Compulsory	·
	General Engineering Mechanical Engineering	, Focus Energy Syst	ems: Compulsory	
	General Engineering Mechanical Engineering	, Focus Aircraft Syst	tems Engineering: Com	pulsory
	General Engineering Mechanical Engineering	, Focus Materials in	<b>Engineering Sciences:</b>	Compulsory
	General Engineering Mechanical Engineering	, Focus Mechatronic	s: Compulsory	
	General Engineering Mechanical Engineering			

General Engineering Science (English program, 7 semester): Specialisation Mechanical Engineering, Focus Theoretical Mechanical Engineering: Compulsory General Engineering Science (English program, 7 semester): Specialisation Naval Architecture: Compulsory
General Engineering Science (English program, 7 semester): Specialisation Process Engineering: Compulsory
General Engineering Science (English program, 7 semester): Specialisation Biomedical Engineering: Compulsory
Computational Science and Engineering: Core qualification: Compulsory
Mechatronics: Core qualification: Compulsory
Technomathematics: Specialisation II. Informatics: Elective Compulsory

Course L0321: Com	puter Engineering
Тур	Lecture
Hrs/wk	3
СР	4
<b>Workload in Hours</b>	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	
<b>Workload in Hours</b>	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 M1332	2: BIO I: Experimental M	ethods in Biomo	echanics	
Courses				
<b>Title</b> Experimental Methods	in Biomechanics (L0377)	<b>Typ</b> Lecture	Hrs/wk	<b>CP</b> 3
Module Responsible	Prof. Michael Morlock			
Admission Requirements	None			
	It is recommended to participa attending "Experimentelle Methode		d Frakturheilu	ung" before
Educational Objectives	After taking part successfully, stud	ents have reached the	following learr	ing results
Professional Competence				
Knowledge	The students can describe the difference for their existence.  The students can name different to given fracture morphologies.  The students can describe difference for the students can describe difference for the students.	reatments for the spin	e and hollow lechniques for	bones under
Skills	The students can describe the baused in biomechanics.			l techniques
Personal Competence				
Social Competence	The students can, in groups, solve	·		
Autonomy	The students can, in groups, solve	· 	KS.	
Credit points	Independent Study Time 62, Study	Time in Lecture 28		
Course achievement				
Examination	Written exam			
Examination duration and scale				
Assignment for the Following Curricula	General Engineering Science (Comechanical Engineering, Focus Biomedical Engineering Science (Comedical Engineering) Science (Comedical Engineering) Science (Engineering Science) Specialisation General Engineering Science (Engineering Engineering Science (Engineering Engineering) Science (Engineering Engineering) Science (Engineering Engineering) Science (Engineering) Science (Engineering) Specialisation Engineering) Specialisation Engineering: Sp	mechanics: Compulsory German program, 7 ry n Biomedical Engineerin English program, 7 mechanics: Compulsory English program, 7 ry English program, 7 ompulsory Ition Biomechanics: Contion Artificial Organs and	semester): S  ng: Elective Co semester): S  semester): S  semester): S  mpulsory nd Regenerativ  Endoprosthes	pecialisation mpulsory pecialisation pecialisation pecialisation ve Medicine: es: Elective

Elective Compulsory
Biomedical Engineering: Specialisation Management and Business Administration:
Elective Compulsory
Technomathematics: Specialisation III. Engineering Science: Elective Compulsory

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

Module M1280	0: MED II: Introduction to Physiology
Courses	
Title	Typ Hrs/wk CP
Introduction to Physiol	
Admission Requirements	None
Recommended Previous Knowledge	None
	After taking part successfully, students have reached the following learning results
Professional Competence	
Knowledge	<ul> <li>The students can</li> <li>describe the basics of the energy metabolism;</li> <li>describe physiological relations in selected fields of muscle, heart/circulation, neuro- and sensory physiology.</li> </ul>
Skills	The students can describe the effects of basic bodily functions (sensory, transmission and processing of information, development of forces and vital functions) and relate them to similar technical systems.
Personal Competence	
Social Competence	The students can conduct discussions in research and medicine on a technical level. The students can find solutions to problems in the field of physiology, both analytical and metrological.
Autonomy	The students can derive answers to questions arising in the course and other physiological areas, using technical literature, by themselves.
<b>Workload in Hours</b>	Independent Study Time 62, Study Time in Lecture 28
Credit points	
Course achievement	None
Examination	Written exam
Examination duration and scale	60 minutes
the Following	General Engineering Science (German program, 7 semester): Specialisation Biomedical Engineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Biomechanics: Compulsory Data Science: Specialisation Medicine: Compulsory Electrical Engineering: Specialisation Medical Technology: Elective Compulsory Engineering Science: Specialisation Biomedical Engineering: Elective Compulsory General Engineering Science (English program, 7 semester): Specialisation Mechanical Engineering, Focus Biomechanics: Compulsory General Engineering Science (English program, 7 semester): Specialisation Biomedical Engineering: Compulsory General Engineering Science (English program, 7 semester): Specialisation Biomedical Engineering: Elective Compulsory Mechanical Engineering: Specialisation Biomechanics: Compulsory Biomedical Engineering: Specialisation Biomechanics: Compulsory 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: Intr	oduction 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, 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			Тур	Hrs/wk	СР
Management Tutorial (	L0882)		Recitation (small)	Section 2	3
ntroduction to Manage	ement (L0880)		Lecture	3	3
Module Responsible	Prof. Christoph Ihl				
Admission Requirements	None				
Recommended Previous Knowledge	Basic Knowledge of	Mathematics and E	Business		
Educational Objectives	After taking part suc	ccessfully, students	s have reached t	he following lear	rning result
Professional Competence					
Knowledge	disciplines in of Manageme  explain the number of the most imp  describe and and sourcing management marketing  explain the runsituations und methods from	differences betwee Management and ent most important aspects of explain basic bus, supply chain mare, information moder multiple object mathematical Finform accounting an	rom Planning a nt and Controlling and to name importances of and goantreprneurial presiness functions angement, organangement, in angement ance discosting and seed to sting a	nd Organisation ng. In particular ad Management tant definitions f als in Manageme ojects as production, nization and hum novation mana n making in Bus ainty, and expla	and the sign and t
Skills	<ul> <li>analyse organ</li> <li>apply methor</li> <li>uncertainty a</li> <li>analyse products</li> <li>systems</li> <li>analyse and a</li> <li>select and a</li> <li>problems</li> </ul>	ctives, strategies o	etc.) and to care able to structure them structures of commaking under under system is of marketing its from mather	rry out an Enti appropriately impanies multiple object is and Business natical finance	repreneurs ctives, und s informat to predefin
Personal Competence	Students are able to	)			
		<del>.</del>			

Social Competence	write a coherent report on the project  to communicate appropriately and  to cooperate respectfully with their fellow students.
Autonomy	Students are able to  • work in a team and to organize the team themselves  • to write a report on their project.
<b>Workload in Hours</b>	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	several written exams during the semester
the Following	General Engineering Science (German program, 7 semester): Core qualification: Compulsory Civil- and Environmental Engineering: Core qualification: Compulsory Civil- and Environmental Engineering: Specialisation Civil Engineering: Elective Compulsory Civil- and Environmental Engineering: Specialisation Water and Environment: Elective Compulsory Civil- and Environmental Engineering: Specialisation Water and Environment: Elective Compulsory Civil- and Environmental Engineering: Specialisation Traffic and Mobility: Elective Compulsory Bioprocess Engineering: Core qualification: Compulsory Computer Science: Core qualification: Compulsory Data Science: Core qualification: Compulsory Electrical Engineering: Core qualification: Compulsory Energy and Environmental Engineering: Core qualification: Compulsory General Engineering Science (English program, 7 semester): Specialisation Electrical Engineering: Compulsory General Engineering Science (English program, 7 semester): Specialisation Civil Engineering: Compulsory General Engineering Science (English program, 7 semester): Specialisation Energy and Environmental Engineering: Compulsory General Engineering Science (English program, 7 semester): Specialisation Energy and Environmental Engineering: Compulsory General Engineering Science (English program, 7 semester): Specialisation Computer Science: Compulsory General Engineering Science (English program, 7 semester): Specialisation Mechanical Engineering, Focus Biomechanics: Compulsory General Engineering Science (English program, 7 semester): Specialisation Mechanical Engineering, Science (English program, 7 semester): Specialisation Mechanical 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

Mechatronics: Core qualification: Compulsory

Orientierungsstudium: Core qualification: Elective Compulsory

Naval Architecture: Core qualification: Compulsory Technomathematics: Core qualification: Compulsory Process Engineering: Core qualification: Compulsory

Course L0882: Man	agement Tutorial
Тур	Recitation Section (small)
Hrs/wk	2
СР	3
<b>Workload in Hours</b>	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Prof. Christoph Ihl, Katharina Roedelius, Tobias Vlcek
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 self-selected projects that focus on the elaboration of an innovative business idea from the point of view of an established company or a startup. Again, the business knowledge from the lecture should come to practical use. The group projects are guided by a mentor.
Literature	Relevante Literatur aus der korrespondierenden Vorlesung.

Course L0880: Intr	oduction to Management
Тур	Lecture
Hrs/wk	3
СР	3
Workload in Hours	Independent Study Time 48, Study Time in Lecture 42
Lecturer	Prof. Christoph Ihl, Prof. Thorsten Blecker, Prof. Christian Lüthje, Prof. Christian Ringle, Prof. Kathrin Fischer, Prof. Cornelius Herstatt, Prof. Wolfgang Kersten, Prof. Matthias Meyer, Prof. Thomas Wrona
Language	DE
Cycle	WiSe/SoSe
Content	<ul> <li>Introduction to Business and Management, Business versus Economics, relevant areas in Business and Management</li> <li>Important definitions from Management,</li> <li>Developing Objectives for Business, and their relation to important Business functions</li> <li>Business Functions: Functions of the Value Chain, e.g. Production and Procurement, Supply Chain Management, Innovation Management, Marketing and Sales 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.

## **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				
Title	(10221)	Тур	Hrs/wk	CP
Computer Engineering		Lecture Recitation	Section <sub>1</sub>	4
Computer Engineering	(L0324)	(small)	1	2
Module Responsible	Prof. Heiko Falk			
Admission Requirements	None			
Recommended Previous Knowledge	Basic knowledge in electrical engin	eering		
Educational Objectives		ents have reached	the following lear	ning results
Professional Competence				
Knowledge	This module deals with the foundar covers the layers from the assemblincludes the following topics:  Introduction Combinational logic: Gates synthesis, combinational neimodel synthesis architecture arithmetic: International neimodel synthesis syn	Boolean algebra tworks automata, systema eger addition, su ecture: Programm ies, SRAM, DRAM, erspective of the O	ing down to gates  , Boolean function  itic hardware design  ibtraction, multip  ing models, MIPS  caches	The moduns, hardwar Ign Iication ar single-cyc
	The students perceive computer sylidentify the internal structure and The students can analyze, how hig based on a collection of few and between and to explain the different systems - from gates and circuits upon the students.	the physical com hly specific and in- simple component ferent abstraction	position of compudividual computers. s. They are able to layers of today!	iter system s can be bu to distinguis
Skille	After successful completion of th	a madula the st	udonts are able t	to judgo t

	interdependencies between a physical computer system and the software executed on it. In particular, they shall understand the consequences that the execution of software has on the hardware-centric abstraction layers from the assembly language down to gates. This way, they will be enabled to evaluate the impact that these low abstraction levels have on an entire system's performance and to propose feasible options.
Personal Competence	
	Students are able to solve similar problems alone or in a group and to present the results accordingly.
Autonomy	Students are able to acquire new knowledge from specific literature and to associate this knowledge with other classes.
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56
Credit points	6
Course achievement	CompulsorBonus Form Description Yes 10 % Excercises
Examination	Written exam
Examination duration and scale	90 minutes, contents of course and labs
	Computer Science: Compulsory General Engineering Science (German program, 7 semester): Specialisation Bioprocess Engineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Naval Architecture: Compulsory General Engineering Science (German program, 7 semester): Specialisation Electrical Engineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Biomedical Engineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Energy and Enviromental Engineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Process Engineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Mechatronics: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Biomechanics: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Aircraft Systems Engineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Materials in Engineering Sciences: Compulsory General Engineering, Focus Theoretical Mechanical Engineering: Compulsory General Engineering, Focus Theoretical Mechanical Engineering: Compulsory General Engineering, Focus Product Development and Production: Compulsory General Engineering, Focus Product Development and Production: Compulsory General Engineering, Focus Product Development and Production: Specialisation
Assignment for the Following Curricula	Mechanical Engineering, Focus Energy Systems: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Energy Systems: Compulsory General Engineering Science (German program, 7 semester): Specialisation Civil Engineering: Compulsory Computer Science: Core qualification: Compulsory Data Science: Core qualification: Elective Compulsory

Bioprocess Engineering: Compulsory General Engineering Science (English program, 7 semester): Specialisation Energy and Environmental Engineering: Compulsory General Engineering Science (English program, 7 semester): Specialisation Computer Science: Compulsory General Engineering Science (English program, 7 semester): Specialisation Mechanical Engineering, Focus Biomechanics: Compulsory General Engineering Science (English program, 7 semester): Specialisation Mechanical Engineering, Focus Energy Systems: Compulsory General Engineering Science (English program, 7 semester): Specialisation Mechanical Engineering, Focus Aircraft Systems Engineering: Compulsory General Engineering Science (English program, 7 semester): Specialisation Mechanical Engineering, Focus Materials in Engineering Sciences: Compulsory General Engineering Science (English program, 7 semester): Specialisation Mechanical Engineering, Focus Mechatronics: Compulsory General Engineering Science (English program, 7 semester): Specialisation Mechanical Engineering, Focus Product Development and Production: Compulsory General Engineering Science (English program, 7 semester): Specialisation Mechanical Engineering, Focus Theoretical Mechanical Engineering: Compulsory General Engineering Science (English program, 7 semester): Specialisation Naval Architecture: Compulsory General Engineering Science (English program, 7 semester): Specialisation Process Engineering: Compulsory General Engineering Science (English program, 7 semester): Specialisation Biomedical Engineering: Compulsory Computational Science and Engineering: Core qualification: Compulsory Mechatronics: Core qualification: Compulsory Technomathematics: Specialisation II. Informatics: Elective Compulsory

Course L0321: Com	puter 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: Com	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 M0672	2: Signals and Systems				
Courses					
<b>Title</b> Signals and Systems (I		<b>Typ</b> Lecture Recitation	Section	Hrs/wk 3	<b>CP</b> 4
Signals and Systems (I		(small)			
Кезропзівіс	Prof. Gerhard Bauch				
Admission Requirements	None				
	Mathematics 1-3				
Previous	The modul is an introduction to the theo in maths as covered by the moduls Math with spectral transformations (Fourier se is useful but not required.	ematik 1-3 is	expecte	ed. Further	experience
Educational Objectives	After taking part successfully, students h	ave reached	the follo	wing learn	ing results
Professional Competence					
Knowledge	The students are able to classify and describe signals and linear time-invariant (LTI) systems using methods of signal and system theory. They are able to apply the fundamental transformations of continuous-time and discrete-time signals and systems. They can describe and analyse deterministic signals and systems mathematically in both time and image domain. In particular, they understand the effects in time domain and image domain which are caused by the transition of a continuous-time signal to a discrete-time signal.				
Skills	The students are able to describe and ar invariant systems using methods of signal design basic systems regarding importar response, stability, linearity etc They can signal properties in time and frequency described	al and system nt properties an assess the	n theory. such as	They can magnitude	analyse and e and phase
Personal Competence					
-	The students can jointly solve specific pro	oblems.			
	The students are able to acquire releva sources. They can control their level o solving tutorial problems, software tools,	ant informati f knowledge	during		
<b>Workload in Hours</b>	Independent Study Time 110, Study Time	e in Lecture 7	70		
Credit points	6				
Course achievement	None				
Examination	Written exam				
Examination duration and scale	90 min				
	General Engineering Science (German Compulsory Computer Science: Core qualification: Co Data Science: Core qualification: Compul Electrical Engineering: Core qualification: General Engineering Science (English pro Engineering: Compulsory General Engineering Science (English Bioprocess Engineering: Compulsory	mpulsory sory : Compulsory ogram, 7 sem	ester): S	pecialisati	on Electrical

		Engineering er Science: Cor		(English	program,	7	semester):	Specialisation
	General	Engineering	Science					Specialisation
		cal Engineerin						
Assignment for				_				Specialisation
the Following	Mechanic	cal Engineerin	g, Focus E	nergy Sys	tems: Com	puls	sory	
Curricula					. •			Specialisation
	Mechanic	cal Engineerin	g, Focus A	ircraft Sys	items Engir	neei	ring: Compul:	sory
	General	Engineering	Science	(English	program,	7	semester):	Specialisation
	Mechanic	cal Engineerin	g, Focus N	laterials ir	n Engineerir	ng S	Sciences: Cor	npulsory
	General	Engineering	Science	(English	program,	7	semester):	Specialisation
	Mechanic	cal Engineerin	g, Focus N	1echatroni	cs: Compul	sor	y	
	General	Engineering	Science	(English	program,	7	semester):	Specialisation
	Mechanic	cal Engineerin	g, Focus T	heoretical	Mechanica	ıl Er	ngineering: C	ompulsory
	General	Engineering S	cience (Er	nglish prod	gram, 7 ser	nes	ter): Special	isation Process
	Engineer	ing: Compulso	ry					
	General	Engineering	Science	(English	program,	7	semester):	Specialisation
		cal Engineering						-
	Computa	itional Science	and Engi	neering: C	ore qualific	atio	n: Compulso	ory
	Mechatro	onics: Core qu	alification	Compulse	ory			
	Technom	nathematics: S	pecialisat	ion III. Eng	ineering So	ien	ce: Elective (	Compulsory

Typ	Lecture
Hrs/wk	
CP	
	Independent Study Time 78, Study Time in Lecture 42
	Prof. Gerhard Bauch
Language	
Cycle	
	Introduction to signal and system theory  Signals  Classification of signals  Continuous-time and discrete-time signals  Analog and digital signals  Deterministic and random signals  Description of LTI systems by differential equations or difference equations, respectively  Basic properties of signals and operations on signals  Elementary signals  Distributions (Generalized Functions)  Power and energy of signals  Correlation functions of deterministic signals  Crosscorrelation function  Crosscorrelation function  Crosscorrelation function  Crosscorrelations of correlation  Linear time-invariant (LTI) systems  Linear time-invariance  Description of LTI systems by impulse response and frequency response  Convolution  Convolution and correlation  Properties of LTI-systems  Causal systems  Stable systems  Memoryless systems

periodic signals, non-periodic signals • Properties of the Fourier transform • Fourier transform of some basic signals Parseval's theorem Analysis of LTI-systems and signals in the frequency domain Frequency response, magnitude response and phase response Transmission factor, attenuation, gain Frequency-flat and frequency-selective LTI-systems Bandwidth definitions o Basic types of systems (filters), lowpass, highpass, bandpass, bandstop systems Phase delay and group delay Linear-phase systems Distortion-free systems Content • Spectrum analysis with limited observation window: Leakage effect Laplace Transform Relation of Fourier transform and Laplace transform Properties of the Laplace transform Laplace transform of some basic signals Analysis of LTI-systems in the s-domain Transfer function of LTI-systems • Relation of Laplace transform, magnitude response and phase response Analysis of LTI-systems using pole-zero plots Allpass filters Minimum-phase, maximum-phase and mixed phase filters Stable systems Sampling Sampling theorem · Reconstruction of continuous-time signals in frequency domain and time domain Oversampling Aliasing Sampling with pulses of finite duration, sample and hold Decimation and interpolation Discrete-Time Fourier Transform (DTFT) Relation of Fourier transform and DTFT Properties of the DTFT Discrete Fourier Transform (DFT) Relation of DTFT and DFT Cyclic properties of the DFT DFT matrix Zero padding Cyclic convolution Fast Fourier Transform (FFT) o Application of the DFT: Orthogonal Frequency Division Multiplex (OFDM) Z-Transform Relation of Laplace transform, DTFT, and z-transform Properties of the z-transform Z-transform of some basic discrete-time signals Discrete-time systems, digital filters FIR and IIR filters Z-transform of digital filters • Analysis of discrete-time systems using pole-zero plots in the z-domain Stability Allpass filters • Minimum-phase, maximum-phase and mixed-phase filters Linear phase filters T. Frey , M. Bossert , Signal- und Systemtheorie, B.G. Teubner Verlag 2004 K. Kammeyer, K. Kroschel, Digitale Signalverarbeitung, Teubner Verlag.

## Literature

- 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: Sign	nals and Systems
Тур	Recitation Section (small)
Hrs/wk	2
СР	2
<b>Workload in Hours</b>	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 M065!	5: Computational Fluid Dyn	amics I		
Courses				
<b>Title</b> Computational Fluid D	vnamics I (L0235)	<b>Typ</b> Lecture	Hrs/wk	<b>CP</b> 3
Computational Fluid D		Recitation (large)	Section 2	3
Module Responsible	Prof. Thomas Rung	<u> </u>		
Admission Requirements	LNONE			
Recommended Previous Knowledge	Mathematical Methods for Engine     Fundamentals of Differential/into		nd series expansio	ons
Educational Objectives		have reached	the following learr	ning results
Professional Competence				
Knowledge	The students are able to list the basic n	umerics of par	tial differential equ	uations.
Skills	The students are able develop appropr for the governing partial differential algorithms in a structured way.			
Personal Competence	The students can arrive at work results	in groups and	document them.	
	The students can independently analyse	e approaches t	co solving specific	problems.
Autonomy				
Workload in Hours	Independent Study Time 124, Study Tin	ne in Lecture 5	56	
Credit points	6			
Course achievement	INONE			
Examination	Written exam			
Examination duration and scale	2h			
	General Engineering Science (German and Enviromental Engineering: Compuls General Engineering Science (German Architecture: Compulsory General Engineering Science (Germ Mechanical Engineering, Focus Energy General Engineering Science (Germ Mechanical Engineering, Focus Energy Science (Germ Mechanical Engineering, Focus Energy Science)	ory program, 7 so an program, Systems: Elect an program,	emester): Specialis 7 semester): S ive Compulsory 7 semester): S	sation Nava

•	General Engineering Science (German program, 7 semester): Specialisation Energ and Enviromental Engineering: Elective Compulsory General Engineering Science (German program, 7 semester): Specialisatio r Mechanical Engineering, Focus Theoretical Mechanical Engineering: Elective				
the Following					
Curricula	Energy Systems: Technical Complementary Course Core Studies: Elective				
General Engineering Science (English program, 7 semester): Specialisa and Enviromental Engineering: Elective Compulsory General Engineering Science (English program, 7 semester): Specialisa and Enviromental Engineering: Compulsory General Engineering Science (English program, 7 semester): Specialisa Mechanical Engineering, Focus Energy Systems: Elective Compulsory General Engineering Science (English program, 7 semester): Specialis Architecture: Compulsory Mechanical Engineering: Specialisation Energy Systems: Elective Compul	General Engineering Science (English program, 7 semester): Specialisation Energy and Enviromental Engineering: Compulsory General Engineering Science (English program, 7 semester): Specialisation Mechanical Engineering, Focus Energy Systems: Elective Compulsory General Engineering Science (English program, 7 semester): Specialisation Naval				
	Technomathematics: Specialisation III. Engineering Science: Elective Compulsory				

Course L0235: Com	putational Fluid Dynamics I
Тур	Lecture
Hrs/wk	2
СР	3
<b>Workload in Hours</b>	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	
<b>Workload in Hours</b>	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 M0597	7: Advanced Mechanical	Engineering	Design	
Courses				
<b>Title</b> Advanced Mechanical	Engineering Design II (L0264)	<b>Typ</b> Lecture Recitation	Hrs/wk 2 Section	<b>CP</b> 2
	Engineering Design II (L0265)	(large)	2	1
	Engineering Design I (L0262)	Lecture Recitation	2 Section <sub>2</sub>	2
Advanced Mechanical	Engineering Design I (L0263)	(large)	2	1
Module Responsible	Prof. Dieter Krause			
Admission Requirements	None			
Recommended Previous Knowledge	<ul> <li>Mechanics</li> <li>Fundamentals of Materials So</li> </ul>		ŋn	
Educational Objectives	After taking part successfully, stude	ents have reached	the following learn	ing results
Professional Competence				
Knowledge	<ul> <li>explain requirements, select examples of complex machin</li> <li>indicate the background of d</li> </ul> After passing the module, students <ul> <li>accomplish dimensioning cal</li> </ul>	nciples and function criteria, applice elements, imensioning calcuare able to:	cation scenarios a lations. ed machine elemer	nd practica
Skills Personal	<ul> <li>transfer knowledge learned in the module to new requirements and tasks (problem solving skills),</li> <li>recognize the content of technical drawings and schematic sketches,</li> <li>evaluate complex designs, technically.</li> </ul>			
Competence				
Social Competence	<ul> <li>Students are able to discuss technical information in the lecture supported by activating methods.</li> </ul>			
Autonomy	<ul> <li>Students are able to independently deepen their acquired knowledge in exercises.</li> <li>Students are able to acquire additional knowledge and to recapitulate poorly understood content e.g. by using the video recordings of the lectures.</li> </ul>			
	Independent Study Time 68, Study	Time in Lecture 1	12	
Credit points	6			
Course achievement	None			
Examination	Written exam			
Examination duration and	120			

Mechanical Engineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Biomechanics: Compulsory General Engineering, Focus Energy Systems: Compulsory General Engineering, Focus Energy Systems: Compulsory General Engineering, Focus Energy Systems: Compulsory General Engineering, Focus Aircraft Systems Engineering: Compulsory General Engineering, Focus Aircraft Systems Engineering: Compulsory General Engineering, Focus Materials in Engineering Compulsory General Engineering, Focus Materials in Engineering Sciences: Compulsory General Engineering, Focus Mechatronics: Compulsory General Engineering, Focus Mechatronics: Compulsory General Engineering, Focus Product Development and Production: Compulsory General Engineering, Focus Theoretical Mechanical Engineering: Compulsory Energy Systems: Technical Complementary Course Core Studies: Electiv Compulsory Engineering Science: Specialisation Mechanical Engineering: Compulsory General Engineering Science (English program, 7 semester): Specialisatic Mechanical Engineering: Compulsory General Engineering Science (English program, 7 semester): Specialisatic Mechanical Engineering, Focus Biomechanics: Compulsory General Engineering Science (English program, 7 semester): Specialisatic Mechanical Engineering Science (English program, 7 semester): Specialisatic Mechanical Engineering Science (English program, 7 semester): Specialisatic Mechanical Engineering, Focus Biomechanics: Compulsory General Engineering Science (English program, 7 semester): Specialisatic Mechanical Engineering, Focus Energy Systems: Compulsory General Engineering, Focus Energy Systems Engineering: Compulsory General Engineering, Focus Aircraft Systems Engineering: Compulsory General Engineering, Focus Materials in Engineering Sciences: Compulsory	scale								
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Assignment for the Following Curricula  Mechanical Engineering Science (English program, 7 semester): Specialisation									
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Curricula General Engineering Science (English program, 7 semester): Specialisation Mechanical Engineering: Compulsory General Engineering Science (English program, 7 semester): Specialisation Mechanical Engineering, Focus Biomechanics: Compulsory General Engineering Science (English program, 7 semester): Specialisation Mechanical Engineering, Focus Energy Systems: Compulsory General Engineering Science (English program, 7 semester): Specialisation Mechanical Engineering, Focus Aircraft Systems Engineering: Compulsory General Engineering Science (English program, 7 semester): Specialisation Mechanical Engineering, Focus Materials in Engineering Sciences: Compulsory	Assignment for								
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Mechanical Engineering, Focus Biomechanics: Compulsory General Engineering Science (English program, 7 semester): Specialisation Mechanical Engineering, Focus Energy Systems: Compulsory General Engineering Science (English program, 7 semester): Specialisation Mechanical Engineering, Focus Aircraft Systems Engineering: Compulsory General Engineering Science (English program, 7 semester): Specialisation Mechanical Engineering, Focus Materials in Engineering Sciences: Compulsory									
General Engineering Science (English program, 7 semester): Specialisation Mechanical Engineering, Focus Energy Systems: Compulsory General Engineering Science (English program, 7 semester): Specialisation Mechanical Engineering, Focus Aircraft Systems Engineering: Compulsory General Engineering Science (English program, 7 semester): Specialisation Mechanical Engineering, Focus Materials in Engineering Sciences: Compulsory									
Mechanical Engineering, Focus Energy Systems: Compulsory General Engineering Science (English program, 7 semester): Specialisation Mechanical Engineering, Focus Aircraft Systems Engineering: Compulsory General Engineering Science (English program, 7 semester): Specialisation Mechanical Engineering, Focus Materials in Engineering Sciences: Compulsory									
General Engineering Science (English program, 7 semester): Specialisation Mechanical Engineering, Focus Aircraft Systems Engineering: Compulsory General Engineering Science (English program, 7 semester): Specialisation Mechanical Engineering, Focus Materials in Engineering Sciences: Compulsory									
Mechanical Engineering, Focus Aircraft Systems Engineering: Compulsory General Engineering Science (English program, 7 semester): Specialisation Mechanical Engineering, Focus Materials in Engineering Sciences: Compulsory									
General Engineering Science (English program, 7 semester): Specialisation Mechanical Engineering, Focus Materials in Engineering Sciences: Compulsory									
Mechanical Engineering, Focus Materials in Engineering Sciences: Compulsory									
General Engineering Science (English program 7 semester): Specialisation		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									
Mechanical Engineering: Core qualification: Compulsory		Mechanical Engineering: Core qualification: Compulsory							
Naval Architecture: Core qualification: Compulsory		Naval Architecture: Core qualification: Compulsory							

Course L0264: Adv	anced Mechanical Engineering Design II
Тур	Lecture
Hrs/wk	2
СР	2
<b>Workload in Hours</b>	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Prof. Dieter Krause, Prof. Otto von Estorff
Language	DE
Cycle	SoSe
Content	Advanced Mechanical Engineering Design I & II  Lecture  • Fundamentals of the following machine elements:  • Linear rolling bearings  • Axes & shafts  • Seals  • Clutches & brakes  • Belt & chain drives  • Gear drives  • Epicyclic gears  • Crank drives  • Sliding bearings  • Elements of fluidics  Exercise  • Calculation methods of the following machine elements:  • Linear rolling bearings  • Axes & shafts  • Clutches & brakes  • Belt & chain drives  • Gear drives  • Gear drives  • Epicyclic gears  • Crank gears  • Sliding bearings
Literature	<ul> <li>Calculations of hydrostatic systems (fluidics)</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>

Course L0265: Adv	Course L0265: Advanced Mechanical Engineering Design II		
Тур	Recitation Section (large)		
Hrs/wk	2		
СР	1		
<b>Workload in Hours</b>	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 L0263: Advanced Mechanical Engineering Design I		
Тур	Recitation Section (large)	
Hrs/wk	2	
СР	1	
<b>Workload in Hours</b>	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	

Courses				
Title		Тур	Hrs/wk	СР
Introduction to Control	l Systems (L0654)	Lecture	2 Castian	4
Introduction to Control	l Systems (L0655)	Recitation (small)	Section 2	2
Module Responsible				
Admission Requirements	LNIANA			
Recommended Previous Knowledge	Representation of signals and stransform	systems in time and	frequency doma	ain, Lapla
Educational Objectives	I ATTOR TAKING NAME CHANGCHILLY CHI	dents have reached t	he following learn	ing result
Professional Competence				
Knowledge	<ul> <li>Students can represent of domain, and can in particle systems</li> <li>They can explain the dyna properties in terms of frequency from it.</li> <li>They can explain the Ny derived from it.</li> <li>They can explain the role control loops</li> <li>They can explain the way a frequency response</li> <li>They can explain issues and domain are implemented of</li> </ul>	cular explain propertion mics of simple control uency response and re quist stability criterion of the phase margin a PID controller affect ising when controllers	es of first and s I loops and interpoot locus on and the stabi in analysis and s a control loop in	econd orderet dynamicallity marginal synthesis terms of
Skills	<ul> <li>Students can transform in frequency domain and vice.</li> <li>They can simulate and ass.</li> <li>They can design PID cont tuning rules.</li> <li>They can analyze and syn locus and frequency response.</li> <li>They can calculate discrete continuous-time and use it.</li> <li>They can use standard so carrying out these tasks.</li> </ul>	e versa ess the behavior of sy rollers with the help thesize simple contro use techniques te-time approximatio for digital implement	rstems and controllers ation	ol loops gler-Nicho help of ro designed
Personal Competence Social Competence	Students can work in small g		ve technical pro	oblems, a
Autonomy	Students can obtain information documentation, experiment guide.  They can assess their knowledge	from provided sources) and use it when so	olving given probl	ems.

	<u> </u>			
<b>Workload in Hours</b>	Independent Study Time 124, Study Time in Lecture 56			
Credit points	6			
Course achievement				
Examination	Written exam			
Examination duration and scale	120 min			
the Following	General Engineering Science (German program, 7 semester): Core qualification: Compulsory Bioprocess Engineering: Core qualification: Compulsory Computer Science: Specialisation Computational Mathematics: Elective Compulsory Data Science: Core qualification: Elective Compulsory Electrical Engineering: Core qualification: Compulsory Energy and Environmental Engineering: Core qualification: Compulsory General Engineering Science (English program, 7 semester): Specialisation Electrical Engineering: Compulsory General Engineering Science (English program, 7 semester): Specialisation Civil Engineering: Compulsory General Engineering Science (English program, 7 semester): Specialisation Bioprocess Engineering: Compulsory General Engineering Science (English program, 7 semester): Specialisation Bioprocess Engineering: Compulsory General Engineering Science (English program, 7 semester): Specialisation Engineerial Engineering Science (English program, 7 semester): Specialisation Computer Science: Compulsory General Engineering Science (English program, 7 semester): Specialisation Mechanical Engineering, Focus Biomechanics: Compulsory General Engineering Science (English program, 7 semester): Specialisation Mechanical Engineering, Focus Energy Systems: Compulsory General Engineering Science (English program, 7 semester): Specialisation Mechanical Engineering, Focus Materials in 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 Mecharionics: Compulsory General Engineering Science (English program, 7 semester): Specialisation Mechanical Engineering, Focus Mecharionics: Compulsory General Engineering Science (English program, 7 semester): Specialisation Mechanical Engineering, Focus Product Development and Production: Compulsory General Engineering Science (English program, 7 semester): Specialisat			

Course L0654: Intr	oduction to Control Systems			
Тур	Lecture			
Hrs/wk				
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 plots Root locus design of PID controllers  Frequency response techniques Bode diagram Minimum and non-minimum phase systems Nyquist plot, Nyquist stability criterion, phase and gain margin Loop shaping, lead lag compensation Frequency response interpretation of PID control  Time delay systems Root locus and frequency response of time delay systems Smith predictor  Digital control Sampled-data systems, difference equations Tustin approximation, digital implementation of PID controllers  Software tools Introduction to Matlab, Simulink, Control toolbox Computer-based exercises throughout the course			
Literature	<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	
<b>Workload in Hours</b>	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 M0684	4: Heat Transfer					
Courses						
Title		Тур	Н	Irs/wk	СР	
Heat Transfer (L0458)		Lecture	3		4	
Heat Transfer (L0459)		Recitation (large)	Section 2		2	
Module Responsible	Dr. Andreas Moschallski					
Admission Requirements	None					
Recommended Previous Knowledge	Technical Thermodynamics I, II and Fluid	Dynamics				
Educational Objectives	After taking part successfully, students have reached the following learning results					
Professional						
Competence	The students are able to					
		<u>-</u>	_			
Knowledge	- describe the different physical mechani	sm of Heat Tr	anster,			
Knowledge	- explain the technical terms,					
	- to analyse comlex heat transfer processes in a critical way.					
	The students are able to					
	- understand the physics of Heat Transfer,					
Skills	- calculate and evaluate complex Heat Tr	ansfer proces	ses,			
	- solve excersises self-consistent and in small groups.					
Personal Competence	1					
Social Competence	The students are able to discuss in small	groups and d	evelop an	approac	cn.	
Autonomy	The students are able to develop a complex problem self-consistent and analyse the results in a critical way. A qualified exchange with other students is given.					
<b>Workload in Hours</b>	Independent Study Time 110, Study Time	e in Lecture 7	0			
Credit points						
Course achievement	None					
Examination	Written exam					
Examination duration and scale	120 min					
Assignment for	General Engineering Science (German Mechanical Engineering, Focus Energy Sy General Engineering Science (German Biomedical Engineering: Compulsory General Engineering Science (German Mechanical Engineering, Focus Theor Compulsory General Engineering Science (German Mechanical Engineering, Focus Theoretical Energy Systems: Technical Compleme	ystems: Comp n program, n program, retical Mecha n program, al Mechanical	ulsory 7 semes 7 semes anical En 7 semes Engineeri	ster): Spater): Spagneerin ster): Spagneerin ster): Spang: Com	pecialisation pecialisation g: Elective pecialisation pulsory	

the Following	Compulsory				
Curricula	General Engineering Science (English program, 7 semester): Specialisation				
	Mechanical Engineering, Focus Theoretical Mechanical Engineering: Elective				
	Compulsory				
	General Engineering Science (English program, 7 semester): Specialisation				
	Mechanical Engineering, Focus Energy Systems: Compulsory				
	General Engineering Science (English program, 7 semester): Specialisation				
	Biomedical Engineering: 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	
<b>Workload in Hours</b>	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	
<b>Workload in Hours</b>	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	2: Reciprocating Machinery				
Courses					
Title		Тур		Hrs/wk	СР
Fundamentals of Recip	Lecture		1	1	
Reciprocating Engines Fundamentals of Recip	Recitation	Section	1	1	
Reciprocating Engines (L0634) (large)			1 2		
Internal Combustion E		Lecture Recitation	Section	2	2
	-	(large)			2
-	Prof. Christopher Friedrich Wirz				
Admission Requirements	None				
Recommended Previous Knowledge	Thermodynamics, Mechanics, Machine E	lements			
Educational Objectives	After taking part successfully, students h	ave reached	the follow	ing learn	ing results
Professional Competence					
Knowledge	students are able to reflect fundamentals regarding power and working machinery and describe the qualitative and quantitative correlations of operating methods and efficiencies of multiple types of engines, compressors and pumps. They are able to utilize technical terms and parameters as well as aspects regarding the development of power density and efficiency, furthermore to give an overview of charging systems, fuels and emissions. The students are able to select specific types of machinery and assess design related and operational problems.  As a result of the part module "Internal Combustion Engines I", the students are able reflect and utilize the state-of-the-art regarding efficiency limits. In addition, they are able to utilize their knowledge of design, mechanical and thermodynamic characteristics and the approach of similarity. They are able to explain, assess and develop engines as well as charging systems. Detailed knowledge is present regarding computer-aided process design.				
Skills	The students are skilled to employ basic and detail knowledge regarding reciprocating machinery, their selection and operation. They are further able to assess, analyse and solve technical and operational problems and to perform mechanical and thermodynamic design.				
Personal Competence					
Competence	The students are able to communicate a	nd cooperate	in a prof	essional e	environment
Social Competence	in the field of machinery design and application.				
Autonomy	The widespread scope of gained kno situations in their future profession indep				to handle
	Independent Study Time 110, Study Tim	e in Lecture 7	0		
Credit points					
Course					

achievement	None
Examination	Written exam
Examination duration and scale	120 min
Assignment for the Following Curricula	

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

Course L0634: F Reciprocating Engi	•
Тур	Recitation Section (large)
Hrs/wk	1
СР	1
<b>Workload in Hours</b>	Independent Study Time 16, Study Time in Lecture 14
Lecturer	Prof. Christopher Friedrich Wirz
Language	DE
Cycle	WiSe
Content	See interlocking course
Literature	See interlocking course

Course L0059: Internal Combustion Engines I		
Тур	Lecture	
Hrs/wk	2	
СР	2	
<b>Workload in Hours</b>	Independent Study Time 32, Study Time in Lecture 28	
Lecturer	Prof. Wolfgang Thiemann	
Language	DE	
Cycle	SoSe	
Content	<ul> <li>The beginnings of engine development</li> <li>Design of of motors</li> <li>Real process calculation</li> <li>Charging methods</li> <li>Kinematics of the crank mechanism</li> <li>Forces in the engine</li> </ul>	
Literature	<ul> <li>Vorlesungsskript</li> <li>Übungsaufgaben mit Lösungsweg</li> <li>Literaturliste</li> </ul>	

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

Courses				
<b>Title</b> Gas and Steam Power	Plants (L0206)	<b>Typ</b> Lecture	Hrs/wk 3	<b>CP</b> 5
Gas and Steam Power	Plants (L0210)	Recitation (large)	Section 1	1
Module Responsible	NN			
Admission Requirements	None			
Recommended Previous Knowledge	"Heat Transfer"			
Educational Objectives	After taking part successfully, stud	ents have reached	the following learr	ning results
Professional Competence				
Knowledge	The students can evaluate the development of the electricity demand and the energy conversion routes in the thermal power plant, describe the various types of power plant and the layout of the steam generator block. They are also able to determine the operation characteristics of the power plant. Additionally they can describe the exhaust gas cleaning apparatus and the combination possibilities of conventional fossil-fuelled power plants with solar thermal and geothermal power plants or plants equipped with Carbon Capture and Storage.			
	The students have basic knowledge about the principles, operation and design of turbomachinery  The students will be able, using theories and methods of the energy technolog from fossil fuels and based on well-founded knowledge on the function an			
Skills	construction of gas and steam por production of heat and electricity, analysis of the problem and expospower generation the students are develop realistic optimal concept production of heat. From the tech follow better the deliberations on the political triangle (economy, secure	so as to develop sure to the inhere endowed with the ots for the gene nnical basics the s the electricity mix	conceptual solution tinterplay between capability and me ration of electric tudents become tomposition within	ons. Throughen heat are thodology fity and the ability of the the energen
	Within the framework of the exerc software suite EBSILON Professio solved with the PC, to highlight as plant cycles.	nal <sup>TM</sup> . With this	tool small practic	al tasks a
	The students are able to do simplif of a plant, as single component or a		turbomachinery e	ither as pa
Personal Competence				
Social Competence	An excursion within the framework of the lecture is planned for students that interested. The students get in this manner direct contact with a modern popular in this region. The students will obtain first-hand experience with a popular in operation and gain insights into the conflicts between technical and policissues.		odern power orith a power and politic	
	The students assisted by the tutor models and run with these scena practical knowledge from the lectu	rio analyses. In th	is manner the the	eoretical an

Autonomy	different process combinations and boundary conditions highlighted. The students are able independently to analyse the operational performance of steam power plants and calculate selected quantities and characteristic curves.		
<b>Workload in Hours</b>	Independent Stu	dy Time 124, Study Tin	ne in Lecture 56
Credit points	6		
Course achievement	No 5 %	Attestation	<b>Description</b> 15-minütiges, unbenotetes Testat über EBSILON Professional; nur bestanden/nicht bestanden (keine anteiligen Punkte)
	No 5 %	Excercises	10 Übungsaufgaben im Laufe der Vorlesungen à 5 Minuten; bis zu 5 % Bonus je nach Anteil richtiger Abgaben
Examination	Written exam		
Examination duration and scale	Written examina	cion of 120 min	
Assignment for the Following Curricula	General Engineering Science (German program, 7 semester): Specialisation Energy and Environmental Engineering: Elective Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Energy Systems: Elective Compulsory Energy and Environmental Engineering: Core qualification: Elective Compulsory Energy Systems: Technical Complementary Course Core Studies: Elective Compulsory General Engineering Science (English program, 7 semester): Specialisation Energy and Environmental Engineering: Elective Compulsory General Engineering Science (English program, 7 semester): Specialisation Mechanical Engineering, Focus Energy Systems: Elective Compulsory Mechanical Engineering: Specialisation Energy Systems: Elective Compulsory		

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

Course L0210: Gas and Steam Power Plants			
Тур	Typ Recitation Section (large)		
Hrs/wk	1		
СР	1		
<b>Workload in Hours</b>	Independent Study Time 16, Study Time in Lecture 14		
Lecturer	Prof. Alfons Kather		
Language DE			

## Cycle WiSe

In the  $1^{st}$  part of the lecture a general introduction into fluid-flow machines and steam power plants is offered, including:

- Energy balance of a fluid-flow machine
- Theory of turbine and compressor stage
- Equal and positive pressure blading
- Flow losses
- Characteristic numbers
- Axial and radial design
- Design features
- · Hydraulic fluid-flow machines
- Pump and water turbine designs
- Design examples of reciprocating engines and turbomachinery
- Steam power plants
- Gas turbine systems
- Diesel engine systems
- Waste heat utilisation

followed by the more specialised issues:

- Electricity Demand and Forecasting
- Thermodynamic fundamentals
- Energy Conversion in Thermal Power Plants
- Types of Power Plant
- Layout of the power plant block
- Individual elements of the power plant
- Cooling systems
- Flue gas cleaning
- Operation characteristics of the power plant
- Construction materials
- Location of power plants

The environmental impact of acidification, fine particulate or CO<sub>2</sub> emissions and the resulting climatic effects are a special focus of the lecture and the lecture hall exercise. The challenges in plant operation from interconnecting conventional power plants and renewable energy sources are discussed and the technical options for providing security of supply and network stability are presented, also under consideration of cost effectiveness. In this critical review, focus is especially placed on the compatibility of the different solutions with the environment and climate. With this, the awareness for the responsibility of an engineer's own actions are emphasized and the potential extent of the different solutions presented clearly.

Within the framework of the exercise the students learn the use of the specialised software suite EBSILON Professional<sup>TM</sup>. With this tool small tasks are solved on the PC, to highlight aspects of the design and development of power plant cycles. The students present their results orally and can afterwards ask questions and get feedback. The course work has a positive effect on the students final grade.

Literature

- Skripte
- Kalide: Kraft- und Arbeitsmaschinen
- Thomas, H.J.: Thermische Kraftanlagen. Springer-Verlag, 1985
- Strauß, K.: Kraftwerkstechnik. Springer-Verlag, 2006
- Kugeler und Phlippen: Energietechnik. Springer-Verlag, 1990
- T. Bohn (Hrsg.): Handbuchreihe Energie, Band 7: Gasturbinenkraftwerke, Kombikraftwerke, Heizkraftwerke und Industriekraftwerke, Technischer Verlag Resch / Verlag TÜV Rheinland

### Content

Module M0829	9: Foundations of Managen	nent		
Courses				
<b>Title</b> Management Tutorial (		<b>Typ</b> Recitation (small)	Hrs/wk Section 2	<b>CP</b> 3
Introduction to Manage		Lecture	3	3
посренени				
Admission Requirements				
Recommended Previous Knowledge	Basic Knowledge of Mathematics and B	usiness		
Educational Objectives		have reached	the following learn	ing results
Professional Competence				
Knowledge	<ul> <li>After taking this module, students know the important basics of many different areas in Business and Management, from Planning and Organisation to Marketing and Innovation, and also to Investment and Controlling. In particular they are able to</li> <li>explain the differences between Economics and Management and the subdisciplines in Management and to name important definitions from the field of Management</li> <li>explain the most important aspects of and goals in Management and name the most important aspects of entreprneurial projects</li> <li>describe and explain basic business functions as production, procurement and sourcing, supply chain management, organization and human ressource management, information management, innovation management and marketing</li> <li>explain the relevance of planning and decision making in Business, esp. in situations under multiple objectives and uncertainty, and explain some basic methods from mathematical Finance</li> <li>state basics from accounting and costing and selected controlling methods.</li> </ul>			
Skills	Students are able to analyse business units with respect to different criter (organization, objectives, strategies etc.) and to carry out an Entrepreneursh project in a team. In particular, they are able to  • analyse Management goals and structure them appropriately • analyse organisational and staff structures of companies • apply methods for decision making under multiple objectives, under uncertainty and under risk • analyse production and procurement systems and Business information systems • analyse and apply basic methods of marketing • select and apply basic methods from mathematical finance to predefine problems • apply basic methods from accounting, costing and controlling to predefine problems			epreneurship lives, unde information predefined
Personal Competence	Students are able to  work successfully in a team of st			nuois st s
	to apply their knowledge from th  [439]	ne lecture to ar	n entrepreneurship	project and

Social Competence	write a coherent report on the project
	to communicate appropriately and
	to cooperate respectfully with their fellow students.
	Students are able to
	Students are able to
Autonomy	<ul> <li>work in a team and to organize the team themselves</li> </ul>
	to write a report on their project.
M/	Landard and Charle Time 110. Charle Times in Landard 70.
	Independent Study Time 110, Study Time in Lecture 70
Credit points	
Course	None
acmevement	
	Subject theoretical and practical work
Examination	
duration and scale	several written exams during the semester
Searc	General Engineering Science (German program, 7 semester): Core qualification:
	Compulsory
	Civil- and Environmental Engineering: Core qualification: Compulsory
	Civil- and Environmental Engineering: Specialisation Civil Engineering: Elective
	Compulsory
	Civil- and Environmental Engineering: Specialisation Water and Environment: Elective Compulsory
	Civil- and Environmental Engineering: Specialisation Traffic and Mobility: Elective
	Compulsory
	Bioprocess Engineering: Core qualification: Compulsory
	Computer Science: Core qualification: Compulsory Data Science: Core qualification: Compulsory
	Electrical Engineering: Core qualification: Compulsory
	Energy and Environmental Engineering: Core qualification: Compulsory
	General Engineering Science (English program, 7 semester): Specialisation Electrical
	Engineering: Compulsory
	General Engineering Science (English program, 7 semester): Specialisation Civil Engineering: Compulsory
	General Engineering Science (English program, 7 semester): Specialisation
	Bioprocess Engineering: Compulsory
	General Engineering Science (English program, 7 semester): Specialisation Energy
	and Enviromental Engineering: Compulsory General Engineering Science (English program, 7 semester): Specialisation
	Computer Science: Compulsory
	General Engineering Science (English program, 7 semester): Specialisation
Assignment for	Mechanical Engineering, Focus Biomechanics: Compulsory
tne Following	General Engineering Science (English program, 7 semester): Specialisation Mechanical Engineering, Focus Energy Systems: Compulsory
Carricula	General Engineering, Focus Energy Systems: Compulsory  General Engineering Science (English program, 7 semester): Specialisation
	Mechanical Engineering, Focus Aircraft Systems Engineering: Compulsory
	General Engineering Science (English program, 7 semester): Specialisation
	Mechanical Engineering, Focus Materials in Engineering Sciences: Compulsory
	General Engineering Science (English program, 7 semester): Specialisation Mechanical Engineering, Focus Mechatronics: Compulsory
	General Engineering Science (English program, 7 semester): Specialisation
	Mechanical Engineering, Focus Product Development and Production: Compulsory
	General Engineering Science (English program, 7 semester): Specialisation
	Mechanical Engineering, Focus Theoretical Mechanical Engineering: Compulsory General Engineering Science (English program, 7 semester): Specialisation Naval
	Architecture: Compulsory
	General Engineering Science (English program, 7 semester): Specialisation Process
	Engineering: Compulsory
	General Engineering Science (English program, 7 semester): Specialisation
	Biomedical Engineering: Compulsory  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 Compulsory

Naval Architecture: Core qualification: Compulsory Technomathematics: Core qualification: Compulsory Process Engineering: Core qualification: Compulsory

Course L0882: Management Tutorial		
Тур	Recitation Section (small)	
Hrs/wk	2	
СР	3	
<b>Workload in Hours</b>	Independent Study Time 62, Study Time in Lecture 28	
Lecturer	Prof. Christoph Ihl, Katharina Roedelius, Tobias Vlcek	
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 self-selected projects that focus on the elaboration of an innovative business idea from the point of view of an established company or a startup. Again, the business knowledge from the lecture should come to practical use. The group projects are guided by a mentor.	
Literature	Relevante Literatur aus der korrespondierenden Vorlesung.	

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

Module M0618	3: Renewables and Energy S	Systems		
Courses				
Title Power Industry (L0316 Energy Systems and E Renewable Energy (L0 Renewable Energy (L1	nergy Industry (L0315) 313)	Typ Lecture Lecture Lecture Recitation (small)	Hrs/wk 1 2 2 Section 1	CP 1 2 2
Module Responsible	Prof. Martin Kaltschmitt			
Admission Requirements	None			
Recommended Previous Knowledge				
Educational Objectives	After taking part successfully, students	have reached t	he following learn	ing results
Professional Competence				
Knowledge	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.			
Skills	Students are able to apply methodological demand or energy production for variethey can evaluate energy systems tectand design them under certain given necessary subject-specific calculation reproblem.  The students are able to explain of processing from the field of renewable the right context.	ous types of e chnically, environ conditions. The ules, also for no questions and	nergy systems. Formentally and exercises, they can ot standardized so possible approa	urthermore, conomically choose the plutions of a ches to its
Personal Competence				
Social Competence	The students are able to analyze suitab with technical, economical and ecologic allows them to make an effective contri	cal criteria und	er sustainability a	spects. This
Autonomy	Students can independently exploit s about the subject area and transform it			r knowledge
Workload in Hours	Independent Study Time 96, Study Time	e in Lecture 84		
Credit points				
Course achievement	None			
Examination	Written exam			

Examination duration and scale	3 hours written exam
Assignment for the Following Curricula	Compulsory

Course L0316: Pow	er Industry
Тур	Lecture
Hrs/wk	1
СР	1
<b>Workload in Hours</b>	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> <li>Cost and efficiency calculation</li> </ul> </li> </ul>
Literature	Folien der Vorlesung

Course L0315: Energy Systems and Energy Industry		
Тур	Lecture	
Hrs/wk	2	
СР	2	
<b>Workload in Hours</b>	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	
<b>Workload in Hours</b>	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: Ren	ewable Energy
Тур	Recitation Section (small)
Hrs/wk	1
СР	1
<b>Workload in Hours</b>	Independent Study Time 16, Study Time in Lecture 14
Lecturer	Prof. Martin Kaltschmitt
Language	DE/EN
Cycle	SoSe
Content	Students work on different tasks in the field of renewable energies. They present their solutions in the exercise lesson and discuss it with other students and the lecturer.  Possible tasks in the field of renewable energies are:  Solar thermal heat Concentrating solare power Photovoltaic Windenergie Hydropower Heat pump Deep geothermal energy
Literature	<ul> <li>Kaltschmitt, M.; Streicher, W.; Wiese, A. (Hrsg.): Erneuerbare Energien - Systemtechnik, Wirtschaftlichkeit, Umweltaspekte; Springer, Berlin, Heidelberg, 2006, 4. Auflage</li> <li>Kaltschmitt, M.; Streicher, W.; Wiese, A. (Hrsg.): Renewable Energy - Technology, Economics and Environment; Springer, Berlin, Heidelberg, 2007</li> </ul>

# **Focus Aircraft Systems Engineering**

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

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

Courses				
Title		Тур	Hrs/wk	CP
	Engineering Design II (L0264)	Lecture Recitation	2 Section <sub>2</sub>	2
	Engineering Design II (L0265)	(large)	2	1
	Engineering Design I (L0262)	Lecture Recitation	2 Section <sub>2</sub>	2
Advanced Mechanical	Engineering Design I (L0263)	(large)	2	1
Module Responsible	Prof. Dieter Krause			
Admission Requirements	INODE			
Recommended Previous Knowledge	<ul> <li>Fundamentals of Mechanical Engineering Design</li> <li>Mechanics</li> <li>Fundamentals of Materials Science</li> <li>Production Engineering</li> </ul>			
Educational Objectives	After taking part successfully, stu	udents have reached	the following learn	ing results
Professional Competence				
	After passing the module, studer	its are able to:		
Knowledge	<ul> <li>explain complex working principles and functions of machine elements and o basic elements of fluidics,</li> <li>explain requirements, selection criteria, application scenarios and practica examples of complex machine elements,</li> <li>indicate the background of dimensioning calculations.</li> </ul>			
	I After passing the module, studer	its are able to:		
Skills	<ul> <li>accomplish dimensioning calculations of covered machine elements,</li> <li>transfer knowledge learned in the module to new requirements and tasks (problem solving skills),</li> <li>recognize the content of technical drawings and schematic sketches,</li> <li>evaluate complex designs, technically.</li> </ul>			
Personal Competence				

# Students are able to independently deepen their acquired knowledge in Autonomy Students are able to acquire additional knowledge and to recapitulate poorly understood content e.g. by using the video recordings of the lectures. Workload in Hours Independent Study Time 68, Study Time in Lecture 112 Credit points 6 Course None achievement **Examination** Written exam **Examination** duration and 120 scale General Engineering Science (German program, 7 semester): Specialisation Mechanical 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 Energy Systems: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Aircraft Systems Engineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Materials in Engineering Sciences: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Mechatronics: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Product Development and Production: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Theoretical Mechanical Engineering: Compulsory Energy Systems: Technical Complementary Course Core Studies: Elective **Assignment for** Compulsory the Following Engineering Science: Specialisation Mechanical Engineering: Compulsory Curricula General Engineering Science (English program, 7 semester): Specialisation Mechanical Engineering: Compulsory General Engineering Science (English program, 7 semester): Specialisation Mechanical Engineering, Focus Biomechanics: Compulsory General Engineering Science (English program, 7 semester): Specialisation Mechanical Engineering, Focus Energy Systems: Compulsory General Engineering Science (English program, 7 semester): Specialisation Mechanical Engineering, Focus Aircraft Systems Engineering: Compulsory General Engineering Science (English program, 7 semester): Specialisation Mechanical Engineering, Focus Materials in Engineering Sciences: Compulsory General Engineering Science (English program, 7 semester): Specialisation Mechanical Engineering, Focus Mechatronics: Compulsory General Engineering Science (English program, 7 semester): Specialisation Mechanical Engineering, Focus Product Development and Production: Compulsory General Engineering Science (English program, 7 semester): Specialisation Mechanical Engineering, Focus Theoretical Mechanical Engineering: Compulsory Mechanical Engineering: Core qualification: Compulsory Naval Architecture: Core qualification: Compulsory

Тур	Locturo
	Lecture
Hrs/wk	2
СР	2
<b>Workload in Hours</b>	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Prof. Dieter Krause, Prof. Otto von Estorff
Language	DE
Cycle	SoSe
	Advanced Mechanical Engineering Design I & II
Content	• Fundamentals of the following machine elements:  • Linear rolling bearings • Axes & shafts • Seals • Clutches & brakes • Belt & chain drives • Gear drives • Epicyclic gears • Crank drives • Sliding bearings • Elements of fluidics   Exercise  • Calculation methods of the following machine elements: • Linear rolling bearings • Axes & shafts • Clutches & brakes • Belt & chain drives • Gear drives • Sliding bearings • Crank gears • Sliding bearings
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>

Course L0265: Advanced Mechanical Engineering Design II		
Тур	Recitation Section (large)	
Hrs/wk	2	
СР	1	
<b>Workload in Hours</b>	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: Adv	anced Mechanical Engineering Design I
Тур	Lecture
Hrs/wk	2
СР	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Prof. Dieter Krause, Prof. Otto von Estorff
Language	DE
Cycle	WiSe
	Advanced Mechanical Engineering Design I & II
Content	• 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  • Axes & shafts  • Clutches & brakes  • Belt & chain drives  • Gear drives  • Gear drives  • Gear drives  • Crank 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> <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>

Course L0263: Advanced Mechanical Engineering Design I		
Тур	Recitation Section (large)	
Hrs/wk	2	
СР	1	
<b>Workload in Hours</b>	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 M0672	2: Signals and Systems					
Courses						
<b>Title</b> Signals and Systems (L0432) Signals and Systems (L0433)		<b>Typ</b> Lecture Recitation	Section	Hrs/wk 3	<b>CP</b> 4	
		(small)			_	
Кезропзівіс	Prof. Gerhard Bauch					
Admission Requirements	None					
	Mathematics 1-3					
Previous	The modul is an introduction to the theo in maths as covered by the moduls Math with spectral transformations (Fourier se is useful but not required.	ematik 1-3 is	s expecte	ed. Further	experience	
Educational Objectives	After taking part successfully, students h	ave reached	the follo	wing learn	ing results	
Professional Competence						
Knowledge	The students are able to classify and describe signals and linear time-invariant (LTI) systems using methods of signal and system theory. They are able to apply the fundamental transformations of continuous-time and discrete-time signals and systems. They can describe and analyse deterministic signals and systems mathematically in both time and image domain. In particular, they understand the effects in time domain and image domain which are caused by the transition of a continuous-time signal to a discrete-time signal.					
Skills	The students are able to describe and analyse deterministic signals and linear time-invariant systems using methods of signal and system theory. They can analyse and design basic systems regarding important properties such as magnitude and phase response, stability, linearity etc They can assess the impact of LTI systems on the signal properties in time and frequency domain.					
Personal Competence						
-	I The students can jointly solve specific pro	oblems.				
	The students are able to acquire releva sources. They can control their level o solving tutorial problems, software tools,	ant informati of knowledge	during			
Workload in Hours	Independent Study Time 110, Study Time	e in Lecture 7	70			
Credit points	6					
Course achievement	None					
Examination	Written exam					
Examination duration and scale	90 min					
	General Engineering Science (German Compulsory Computer Science: Core qualification: Co Data Science: Core qualification: Compul Electrical Engineering: Core qualification: General Engineering Science (English pro Engineering: Compulsory General Engineering Science (English Bioprocess Engineering: Compulsory	empulsory sory : Compulsory ogram, 7 sem	ester): S	pecialisati	on Electrica	

		Engineering er Science: Cor		(English	program,	7	semester):	Specialisation
	•			(English	program,	7	semester):	Specialisation
	Mechanic	cal Engineerin	g, Focus E	iomechan	ics: Compu	lsor	У	
Assignment for	General	Engineering	Science	(English	program,	7	semester):	Specialisation
the Following	Mechanic	cal Engineerin	g, Focus E	nergy Sys	tems: Com	puls	sory	-
Curricula	General	Engineering	Science	(English	program,	7	semester):	Specialisation
	Mechanic	cal Engineerin	g, Focus A	ircraft Sys	stems Engir	neei	ring: Compuls	sory
	General	Engineering	Science	(English	program,	7	semester):	Specialisation
	Mechanic	cal Engineerin	g, Focus N	laterials ir	n Engineerir	ng S	Sciences: Con	npulsory
	General	Engineering	Science	(English	program,	7	semester):	Specialisation
	Mechanic	Mechanical Engineering, Focus Mechatronics: Compulsory						
	General	Engineering	Science	(English	program,	7	semester):	Specialisation
	Mechanic	Mechanical Engineering, Focus Theoretical Mechanical Engineering: Compulsory						
		General Engineering Science (English program, 7 semester): Specialisation Process						
		ingineering: Compulsory						
					program,	7	semester):	Specialisation
		cal Engineering	•	-				
	•	itional Science	•	_	•	atio	n: Compulso	ry
		onics: Core qu		•	,			
	Technom	nathematics: S	pecialisat	ion III. Eng	ineering So	ien	ce: Elective (	Compulsory

Course L0432: Sign	•
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
	Introduction to signal and system theory  Signals  Classification of signals  Analog and digital signals  Deterministic and random signals  Description of LTI systems by differential equations or difference equations, respectively  Basic properties of signals and operations on signals  Elementary signals  Distributions (Generalized Functions)  Power and energy of signals  Correlation functions of deterministic signals  Autocorrelation function  Crosscorrelation function  Orthogonal signals  Applications of correlation  Linear time-invariant (LTI) systems  Linearity  Time-invariance  Description of LTI systems by impulse response and frequency response  Convolution  Convolution  Convolution  Properties of LTI-systems  Causal systems  Memoryless systems  Memoryless systems  Fourier Series and Fourier Transform  Fourier transform of continuous-time signals, discrete-time signals

periodic signals, non-periodic signals • Properties of the Fourier transform • Fourier transform of some basic signals Parseval's theorem Analysis of LTI-systems and signals in the frequency domain Frequency response, magnitude response and phase response Transmission factor, attenuation, gain Frequency-flat and frequency-selective LTI-systems Bandwidth definitions o Basic types of systems (filters), lowpass, highpass, bandpass, bandstop systems Phase delay and group delay Linear-phase systems Distortion-free systems Content • Spectrum analysis with limited observation window: Leakage effect Laplace Transform Relation of Fourier transform and Laplace transform Properties of the Laplace transform Laplace transform of some basic signals Analysis of LTI-systems in the s-domain Transfer function of LTI-systems Relation of Laplace transform, magnitude response and phase response Analysis of LTI-systems using pole-zero plots Allpass filters Minimum-phase, maximum-phase and mixed phase filters Stable systems Sampling Sampling theorem · Reconstruction of continuous-time signals in frequency domain and time domain Oversampling Aliasing Sampling with pulses of finite duration, sample and hold Decimation and interpolation Discrete-Time Fourier Transform (DTFT) Relation of Fourier transform and DTFT Properties of the DTFT Discrete Fourier Transform (DFT) Relation of DTFT and DFT Cyclic properties of the DFT DFT matrix Zero padding Cyclic convolution Fast Fourier Transform (FFT) o Application of the DFT: Orthogonal Frequency Division Multiplex (OFDM) Z-Transform Relation of Laplace transform, DTFT, and z-transform Properties of the z-transform Z-transform of some basic discrete-time signals Discrete-time systems, digital filters FIR and IIR filters Z-transform of digital filters • Analysis of discrete-time systems using pole-zero plots in the z-domain Stability Allpass filters • Minimum-phase, maximum-phase and mixed-phase filters Linear phase filters T. Frey , M. Bossert , Signal- und Systemtheorie, B.G. Teubner Verlag 2004 K. Kammeyer, K. Kroschel, Digitale Signalverarbeitung, Teubner Verlag.

# Literature

- B. Girod ,R. Rabensteiner , A. Stenger , Einführung in die Systemtheorie, B.G. Teubner, Stuttgart, 1997
- J.R. Ohm, H.D. Lüke , Signalübertragung, Springer-Verlag 8. Auflage, 2002
- S. Haykin, B. van Veen: Signals and systems. Wiley.
- Oppenheim, A.S. Willsky: Signals and Systems. Pearson.
- Oppenheim, R. W. Schafer: Discrete-time signal processing. Pearson.

Course L0433: Signals and Systems				
Тур	Recitation Section (small)			
Hrs/wk	2			
СР	2			
<b>Workload in Hours</b>	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 M1320	0: Simulation and Desig	n of Mechatron	ic Systems	5
Courses				
Title		Тур	Hrs/wk	СР
	of Mechatronic Systems (L1822)	Lecture	2	2
Simulation and Design	of Mechatronic Systems (L1823)	Recitation S	ection 1	2
Simulation and Design	of Mechatronic Systems (L1824)	(large) Practical Course	1	2
Module Responsible	Prof. Uwe Weltin			
Admission Requirements	None			
Recommended				
Previous Knowledge	Fundatmentals of mechanics, conti	rol theory and electrica	al engineering	
Educational Objectives	After taking part successfully, stud	ents have reached the	following learr	ing results
Professional Competence				
-	Students are able to describe n simulation and optimization of med		ons for desigr	n, modeling
Skills	Students are able to apply modern They can identify, simulate and laboratory conditions.			
Personal Competence				
Social Competence	Students are able to work goal-ori to target groups.	ented in small mixed	groups and pre	esent results
	Students are able to recognize and	improve knowledge d	eficits indepen	dently.
Autonomy	With instructor assistance, student and define a further course of stud	s are able to evaluate y.	their own kno	wledge leve
Workload in Hours	Independent Study Time 124, Stud	y Time in Lecture 56		
Credit points	6	-		
Course achievement	None			
	Written exam			
Examination duration and scale	90 min			
the Following	General Engineering Science (Comechanical Engineering, Focus Medical Engineering, Focus Airon Digital Mechanical Engineering, Focus Airon Digital Mechanical Engineering Science (Emechanical Engineering, Focus Airon General Engineering, Focus Airon General Engineering, Focus Mechanical Engineering, Focus Mechanical Engineering, Focus Compulsory  Mechanical Engineering: Specialisa Mechanical Engineer	chatronics: Compulsor German program, 7 craft Systems Engineer re qualification: Comp English program, 7 craft Systems Engineer English program, 7 chatronics: Compulsor English program, 7 Theoretical Mechani	y semester): S ring: Compulsor ulsory semester): S ring: Compulsor semester): S y semester): S cal Engineering: Compulsory	pecialisation y pecialisation y pecialisation pecialisation pecialisation g: Elective

Compulsory Mechanical Engineering: Specialisation Theoretical Mechanical Engineering: Elective	,
Compulsory Mechatronics: Core qualification: Compulsory	

Course L1822: Simulation and Design of Mechatronic Systems				
Тур	Lecture			
Hrs/wk	2			
СР	2			
<b>Workload in Hours</b>	Independent Study Time 32, Study Time in Lecture 28			
Lecturer	Prof. Uwe Weltin			
Language	DE			
Cycle	WiSe			
	Mechatronic Design			
	Modeling			
Content	Model Identifikation			
	Numerical Methods in simulation			
	Applications and examples in Matlab $^{ ext{ ext{ ext{ ext{ ext{ ext{ ext{ ext$			
	Skript zur Veranstaltung			
Literature	Weitere Literatur in der Veranstaltung			

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

Courses							
<b>Title</b> Advanced Mechanical	Design	Project (L0266)			ject-/problem-	Hrs/wk	<b>CP</b> 6
				bas	sed Learning	<del>-</del>	0
Module Responsible	Dr. Je	ns Schmidt					
Admission Requirements	None						
Recommended Previous Knowledge	•	Mechanical E Advanced Me			sign		
Educational Objectives	After	taking part suc	ccessfully, stu	idents have	reached the foll	lowing learn	ing results
Professional Competence							
	After	passing the mo	odule, studen	ts are able	to:		
Knowledge	<ul> <li>express the procedure for systematically handling of</li> <li>complex design tasks ,</li> <li>describe working principles, their use and combination possibilities,</li> <li>explain guidelines for designing for function and manufacturing,</li> <li>explain advanced use-oriented knowledge of machine elements.</li> </ul>						
		passing the mo				s usina sketi	ches.
Skills	<ul> <li>analyze complex tasks and develop principle solutions using sketches,</li> <li>convert principle solutions into a detailed design,</li> <li>use methods to design and solve engineering design tasks systematically an solution-oriented,</li> <li>create a technical documentation including all necessary technical drawing to understand the functions of the system,</li> <li>document calculations of selected machine elements clearly and in detail.</li> </ul>						
Personal							
Competence							
	After	passing the mo	odule, studen	ts are able	to:		
Social Competence	<ul> <li>present and discuss solutions and technical drawings within groups,</li> <li>reflect the own results in the work groups of the course</li> </ul>						
	After	passing the mo	odule, studen	ts are able	to:		
Autonomy			essary knowl	edge and se	projects, while electing appropr	•	
Workload in Hours	Indep	endent Study	Time 124, Stu	ıdy Time in	Lecture 56		
Credit points							
Course achievement		<b>pulsor₿onus</b> None	<b>Form</b> Attestation	on	Descrip	otion	
Examination	Writte	en exam					
Examination duration and scale							

# the Following

General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Product Development and Production: Compulsory General Engineering Science (German program, 7 semester): Specialisation Assignment for Mechanical Engineering, Focus Theoretical Mechanical Engineering: Elective Compulsory

Curricula General Engineering Science (English program, 7 semester): Specialisation Mechanical Engineering, Focus Aircraft Systems Engineering: 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 Mechanical Engineering: Core qualification: Compulsory

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

Courses				
<b>Title</b> Introduction to Control	l Systems (L0654)	<b>Typ</b> Lecture	Hrs/wk	<b>CP</b> 4
Introduction to Control	l Systems (L0655)	Recitation (small)	Section 2	2
Module Responsible	Prof. Herbert Werner			
Admission Requirements	INODE			
Recommended Previous Knowledge	Representation of signals and stransform	systems in time an	d frequency dom	nain, Laplac
Educational Objectives		idents have reached	the following lear	ning results
Professional Competence				
Knowledge	<ul> <li>Students can represent of domain, and can in partice systems</li> <li>They can explain the dynal properties in terms of frequency from it.</li> <li>They can explain the Nyderived from it.</li> <li>They can explain the role control loops</li> <li>They can explain the way a frequency response</li> <li>They can explain issues and domain are implemented of</li> </ul>	cular explain proper mics of simple contruency response and quist stability criter of the phase marginal PID controller affectising when controller	ties of first and solloops and inter root locus ion and the stab n in analysis and ts a control loop i	second order pret dynam pility margin synthesis of items of items
Skills	<ul> <li>Students can transform refrequency domain and vice</li> <li>They can simulate and ass</li> <li>They can design PID cont tuning rules</li> <li>They can analyze and syn locus and frequency responsions</li> <li>They can calculate discression continuous-time and use it</li> <li>They can use standard so carrying out these tasks</li> </ul>	e versa ess the behavior of strollers with the help athesize simple continues techniques te-time approximations for digital implemen	systems and control of heuristic (Zie rol loops with the ons of controllers station	rol loops egler-Nichols help of roo designed i
Personal Competence		groups to jointly so	alvo tochnical pr	abloms an
Social Competence	Students can work in small gexperimentally validate their constitutions. Students can obtain information documentation, experiment guide	troller designs n from provided sou	urces (lecture no	tes, softwai
	They can assess their knowledge learning progress.	e in weekly on-line t	ests and thereby	control the

<b>Workload in Hours</b>	Independent Study Time 124, Study Time in Lecture 56			
Credit points				
Course achievement	None			
Examination	Written exam			
Examination duration and scale				
the Following	General Engineering Science (German program, 7 semester): Core qualification: Compulsory Bioprocess Engineering: Core qualification: Compulsory Computer Science: Specialisation Computational Mathematics: Elective Compulsory Data Science: Core qualification: Elective Compulsory Electrical Engineering: Core qualification: Compulsory Electrical Engineering: Core qualification: Compulsory Energy and Environmental Engineering: Core qualification: Compulsory General Engineering Science (English program, 7 semester): Specialisation Electrical Engineering: Compulsory General Engineering Science (English program, 7 semester): Specialisation Civil Engineering: Compulsory General Engineering Science (English program, 7 semester): Specialisation Energy and Environmental Engineering: Compulsory General Engineering Science (English program, 7 semester): Specialisation Energy and Environmental Engineering: Compulsory General Engineering Science (English program, 7 semester): Specialisation Computer Science: Compulsory General Engineering Science (English program, 7 semester): Specialisation Mechanical Engineering, Focus Biomechanics: Compulsory General Engineering Science (English program, 7 semester): Specialisation Mechanical Engineering, Focus Energy Systems: Compulsory General Engineering Science (English program, 7 semester): Specialisation Mechanical Engineering, Focus Materials in 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 Mechartonics: Compulsory General Engineering Science (English program, 7 semester): Specialisation Mechanical Engineering, Focus Mecharionics: Compulsory General Engineering, Science (English program, 7 semester): Specialisation Mechanical Engineering, Focus Mecharionics: Compulsory General Engineering Science (English program, 7 semester): Specialisation Naval Archit			

Course L0654: Intro	oduction to Control Systems			
Тур	Lecture			
Hrs/wk				
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		
<b>Workload in Hours</b>	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 M0730	D: Computer Engineeri	ng		
Courses				
<b>Title</b> Computer Engineering Computer Engineering		<b>Typ</b> Lecture Recitation	Hrs/wk 3 Section 1	<b>CP</b> 4
		(small)	1	
пезропзівіє	Prof. Heiko Falk			
Admission Requirements	None			
Recommended Previous Knowledge	Basic knowledge in electrical en	gineering		
Educational Objectives	After taking part successfully, st	udents have reached t	he following learn	ing 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 functions, hardware synthesis, combinational networks • Sequential logic: Flip-flops, automata, systematic hardware design			
Skills	The students perceive computer systems from the architect's perspective, i.e., the identify the internal structure and the physical composition of computer systems. The students can analyze, how highly specific and individual computers can be bui based on a collection of few and simple components. They are able to distinguis between and to explain the different abstraction layers of today's computin 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 execute on it. In particular, they shall understand the consequences that the execution confits on the hardware-centric abstraction layers from the assemble language down to gates. This way, they will be enabled to evaluate the impact that these low abstraction levels have on an entire system's performance and the propose feasible options.			
Personal Competence Social Competence		ar problems alone or i	n a group and to	present the
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, St	udy Time in Lecture 56	5	
Credit points	6			

Examination Wri	es 10 %	<b>Form</b> Excercises	Description	
Examination duration and 90	ritton ovem			
duration and 90	iilleii exdiii			
	minutes, contents of	course and labs		
Correst Bio Ger Arc Ger Elect Ger Bio Ger Bio Ger and Ger Eng Ger Med Ger Med Ger Med Ger Eng Corricula  Assignment for the Following Curricula  Curricula  Curricula  Ger Eng Ger Med	eneral Engineering Special	Science (German pulsory Science (German progry Science (German progry Science (German progry Science (German progression progr	program, 7 semester): s: Compulsory program, 7 semester): ems Engineering: Compulsory program, 7 semester): engineering Sciences: Conpuration of the conformant of the conform	Specialisation alisation Naval Specialisation Specialisation isation Energy sation Process Specialisation Specialisation Specialisation ory Specialisation ompulsory Specialisation ompulsory Specialisation ompulsory Specialisation compulsory Specialisation isalisation Civil ation Electrical ialisation Civil Specialisation isation Energy Specialisation isation Energy Specialisation

General Engineering Science (English program, 7 semester): Specialisation Mechanical Engineering, Focus Theoretical Mechanical Engineering: Compulsory General Engineering Science (English program, 7 semester): Specialisation Naval Architecture: Compulsory
General Engineering Science (English program, 7 semester): Specialisation Process Engineering: Compulsory
General Engineering Science (English program, 7 semester): Specialisation Biomedical Engineering: Compulsory
Computational Science and Engineering: Core qualification: Compulsory
Mechatronics: Core qualification: Compulsory
Technomathematics: Specialisation II. Informatics: Elective Compulsory

Course L0321: Com	puter Engineering
Тур	Lecture
Hrs/wk	3
СР	4
<b>Workload in Hours</b>	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		
<b>Workload in Hours</b>	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 M059 Design	9: Integrated Proc	luct Dev	velopment a	nd Ligh	ntweight
Courses					
<b>Title</b> CAE-Team Project (L02  Development of Lightw  Integrated Product Dev	veight Design Products (L0270)		Typ Project-/problem- based Learning Lecture Lecture	Hrs/wk 2 2 2 2	<b>CP</b> 2 2 2 2
Module Responsible	Prof. Dieter Krause				
Admission Requirements	None				
	Advanced Knowledge about engineering design: Fundamentals of Mechanical Engineering Design Mechanical Engineering: Design Advanced Mechanical Engineering Design				
Educational Objectives	After taking part successfully	, students ha	ive reached the fo	llowing learn	ing results
Professional Competence Knowledge	After completing the module, students are capable of:  • explaining the functional principle of 3D-CAD-Systems, PDM- and FEM				
Skills	After completing the module, students are able to:  • evaluate different CAD- and PDM-Systems with regards to the desire requirements such as classification schemes and product structuring • design an exemplary product using CAD-,PDM- and/or FEM-Systems with shared workload				
Personal Competence	After completing the module,	students are	e able to:		
Social Competence	To develop a project plan and allocate work appropriate work packages.				
Autonomy	Students are capable of:  • independently adapt to a CAE-Tool and complete a given practical task with				
	Independent Study Time 96,	Study Time i	n Lecture 84		
Credit points					
Course	Compulsor <b>B</b> onus Forn	1	Descri	ption	

achievement	Yes	20 %	Subject practical			CAE-Teamprojekt und Ausarbeitung		Vortrag
Examination	Written ex	am						
Examination duration and scale								
Assignment for the Following Curricula	Mechanica General E Mechanica Engineerin General E Mechanica General E Mechanica Mechanica Mechanica Compulsor Mechanica Product De	I Engineering Ingineering I Engineering g Science: Sp Engineering I Engineering	g, Focus Ai Science g, Focus Proceialisation Science g, Focus Ai Science g, Focus Proceialis g: Elective ag: Specialis Materials	rcraft Sys (German roduct Devon Mechan (English rcraft Sys (English roduct Dev (English Compulso alisation	tems Engir program, velopment nical Engin program, tems Engir program, velopment program, ory Product E	7 semester): neering: Compul: 7 semester): and Production: eering: Elective 7 semester): neering: Compul: 7 semester): and Production: 7 semester): Development are ms Engineering: chnical Complement	Sory Spec Comp Spec Sory Spec Comp Spec Comp	cialisation oulsory ulsory cialisation culsory cialisation oduction:

Course L0271: CAE	-Team Project
Тур	Project-/problem-based Learning
Hrs/wk	2
СР	2
<b>Workload in Hours</b>	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			
<b>Workload in Hours</b>	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: Inte	grated Product Development I
Тур	Lecture
Hrs/wk	
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>Introduction to Integrated Product Development</li> <li>3D CAD -Systems and CAD interfaces</li> <li>Administration of part lists / PDM systems</li> <li>PDM in different industries</li> <li>Selection of CAD-/PDM Systems</li> <li>Simulation</li> <li>Construction methods</li> <li>Design for X</li> </ul>
Literature	<ul> <li>Ehrlenspiel, K.: Integrierte Produktentwicklung, München, Carl Hanser Verlag</li> <li>Lee, K.: Principles of CAD / CAM / CAE Systems, Addison Wesles</li> <li>Schichtel, M.: Produktdatenmodellierung in der Praxis, München, Carl Hanser Verlag</li> <li>Anderl, R.: CAD Schnittstellen, München, Carl Hanser Verlag</li> <li>Spur, G., Krause, F.: Das virtuelle Produkt, München, Carl Hanser Verlag</li> </ul>

Module M0767	7: Aeronautical Systems			
Courses				
Title		Тур	Hrs/wk	СР
Fundamentals of Aircra		Lecture Recitation	2 Section <sub>1</sub>	2
Fundamentals of Aircra	aft Systems (L0742)	(small)	1	1
Air Transportation Syst	tems (L0591)	Lecture	2 Continu	2
Air Transportation Syst	tems (L0816)	Recitation (large)	Section 1	1
Module Responsible	Prof. Frank Thielecke			
Admission Requirements	None			
Recommended Previous Knowledge	Basics of mathematics, mechanics a	and thermodynami	cs	
Educational Objectives	After taking part successfully, stude	nts have reached	the following lear	ning results
Professional Competence				
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 relationchips, the key parameters, roles and ways 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 overall 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.			
<b>Workload in Hours</b>	Independent Study Time 96, Study 1	Time in Lecture 84		
Credit points				
Course achievement	None			
	Written exam			
Examination duration and scale				
Assignment for the Following Curricula	General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Aircraft Systems Engineering: Compulsory General Engineering Science (English program, 7 semester): Specialisation Mechanical Engineering, Focus Aircraft Systems Engineering: Compulsory Logistics and Mobility: Specialisation Logistics and Mobility: Elective Compulsory Mechanical Engineering: Specialisation Aircraft Systems Engineering: Compulsory			

Course L0741: Fundamentals of Aircraft Systems				
Тур	Lecture			
Hrs/wk	2			
СР	2			
<b>Workload in Hours</b>	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: Fun	Course L0742: Fundamentals of Aircraft Systems		
Тур	Recitation Section (small)		
Hrs/wk	1		
СР	1		
<b>Workload in Hours</b>	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			
<b>Workload in Hours</b>	Independent Study Time 32, Study Time in Lecture 28			
Lecturer	Prof. Volker Gollnick			
Language	DE			
Cycle	SoSe			
Content	<ol> <li>Air transport as part of the global transportation system</li> <li>Legal basis of air transportation</li> <li>Safety and security aspects</li> <li>Aircraft basics</li> <li>The role of the aircraft amnufacturer</li> <li>The role of the aircraft operator</li> <li>Airport operation</li> <li>The principles of air traffic management</li> <li>Environmental aspects of air transportation</li> <li>Future perspectives of air transport</li> </ol>			
Literature	<ol> <li>V. Gollnick, D. Schmitt: "Air Transport System", Springer-Verlag, ISBN 978-3-7091-1879-5</li> <li>H. Mensen: "Handbuch der Luftfahrt", Springer-Verlag, 2003</li> <li>K. Hünecke: "Die Technik des modernen Verkehrsflugzeugs", Motorbuch-Verlag, 2000, ISBN 3-613-01895-0</li> <li>I. Moir, A. Seabridge: "Aircraft Systems", AIAA Education Series, 2001, ISBN 1-56347-506-5</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, ISBN0-07-003077-4</li> <li>P. Maurer: "Luftverkehrsmanagement", Oldenbourg-Verlag, ISBN 3-486-27422-8</li> <li>H. Mensen: "Moderne Flugsicherung", Springer-Verlag, 2004, ISBN 3-540-20581-0</li> </ol>			

Course L0816: Air	Transportation Systems
Тур	Recitation Section (large)
Hrs/wk	1
СР	1
<b>Workload in Hours</b>	Independent Study Time 16, Study Time in Lecture 14
Lecturer	Prof. Volker Gollnick
Language	DE
Cycle	SoSe
Content	Practical exercises to understand  • aircraft movement in wind conditions  • aircraft performance analyses  • radio navigation prinicples  Objective: Understanding and application of principle methods to practical aviation problems
Literature	Hünnecke: Das moderne Verkehrsflugzeug von heute Flühr: Avionik und Flugsicherungstechnik

Courses					
Title		<b>Typ</b> Recitation	Section	Hrs/wk	СР
Management Tutorial (		(small)	Section	_	3
Introduction to Manage		Lecture		3	3
1100 0011011010					
Admission Requirements					
Recommended Previous Knowledge	Basic Knowledge of Mathematics and	Business			
Educational Objectives	LATTER TAKING NART CHCCECCTIIIIV CTHGEN	s have reached t	he follo	wing learn	ing results
Professional Competence					
Knowledge	<ul> <li>After taking this module, students know the important basics of many different areas in Business and Management, from Planning and Organisation to Marketing and Innovation, and also to Investment and Controlling. In particular they are able to</li> <li>explain the differences between Economics and Management and the sub-disciplines in Management and to name important definitions from the field of Management</li> <li>explain the most important aspects of and goals in Management and name the most important aspects of entreprneurial projects</li> <li>describe and explain basic business functions as production, procurement and sourcing, supply chain management, organization and human ressource management, information management, innovation management and marketing</li> <li>explain the relevance of planning and decision making in Business, esp. in situations under multiple objectives and uncertainty, and explain some basic methods from mathematical Finance</li> <li>state basics from accounting and costing and selected controlling methods.</li> </ul>				
Skills	Students are able to analyse busi (organization, objectives, strategies project in a team. In particular, they are analyse Management goals and analyse organisational and state apply methods for decision uncertainty and under risk analyse production and procesystems  analyse and apply basic method select and apply basic method problems  apply basic methods from accomproblems	etc.) and to caure able to distructure them f structures of commaking under urement system ds of marketing ods from mather	approprompanies multip	an Entre iately s le objecti Business finance to	preneurship ves, unde information predefined
Personal Competence	Students are able to				

Social Competence	write a coherent report on the project  to communicate appropriately and  to cooperate respectfully with their fellow students.
Autonomy	<ul> <li>Students are able to</li> <li>work in a team and to organize the team themselves</li> <li>to write a report on their project.</li> </ul>
<b>Workload in Hours</b>	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	several written exams during the semester
the Following	General Engineering Science (German program, 7 semester): Core qualification: Compulsory Civil- and Environmental Engineering: Core qualification: Compulsory Civil- and Environmental Engineering: Specialisation Civil Engineering: Elective Compulsory Civil- and Environmental Engineering: Specialisation Water and Environment: Elective Compulsory Civil- and Environmental Engineering: Specialisation Water and Environment: Elective Compulsory Civil- and Environmental Engineering: Specialisation Traffic and Mobility: Elective Compulsory Bioprocess Engineering: Core qualification: Compulsory Bioprocess Engineering: Core qualification: Compulsory Computer Science: Core qualification: Compulsory Data Science: Core qualification: Compulsory Electrical Engineering: Core qualification: Compulsory Energy and Environmental Engineering: Core qualification: Compulsory General Engineering Science (English program, 7 semester): Specialisation Electrical Engineering: Compulsory General Engineering Science (English program, 7 semester): Specialisation Eloprocess Engineering: Compulsory General Engineering: Compulsory General Engineering: Compulsory General Engineering Science (English program, 7 semester): Specialisation Energy and Environmental Engineering: Compulsory General Engineering Science (English program, 7 semester): Specialisation Computer Science: Compulsory General Engineering Science (English program, 7 semester): Specialisation Mechanical Engineering, Focus Biomechanics: Compulsory General Engineering Science (English program, 7 semester): Specialisation Mechanical Engineering, Focus Aircraft Systems: Compulsory General Engineering Science (English program, 7 semester): Specialisation Mechanical Engineering, Focus Aircraft Systems Engineering: 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 Science (English p

Mechatronics: Core qualification: Compulsory

Orientierungsstudium: Core qualification: Elective Compulsory

Naval Architecture: Core qualification: Compulsory Technomathematics: Core qualification: Compulsory Process Engineering: Core qualification: Compulsory

Course L0882: Management Tutorial				
Тур	Recitation Section (small)			
Hrs/wk	2			
СР	3			
<b>Workload in Hours</b>	Independent Study Time 62, Study Time in Lecture 28			
Lecturer	Prof. Christoph Ihl, Katharina Roedelius, Tobias Vlcek			
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 self-selected projects that focus on the elaboration of an innovative business idea from the point of view of an established company or a startup. Again, the business knowledge from the lecture should come to practical use. The group projects are guided by a mentor.			
Literature	Relevante Literatur aus der korrespondierenden Vorlesung.			

Course L0880: Intr	oduction to Management					
Тур	Lecture					
Hrs/wk	3					
СР	3					
<b>Workload in Hours</b>	Independent Study Time 48, Study Time in Lecture 42					
Lecturer	Prof. Christoph Ihl, Prof. Thorsten Blecker, Prof. Christian Lüthje, Prof. Christian Ringle, Prof. Kathrin Fischer, Prof. Cornelius Herstatt, Prof. Wolfgang Kersten, Prof. Matthias Meyer, Prof. Thomas Wrona					
Language	DE					
Cycle	WiSe/SoSe					
Content	<ul> <li>Introduction to Business and Management, Business versus Economics, relevant areas in Business and Management</li> <li>Important definitions from Management,</li> <li>Developing Objectives for Business, and their relation to important Business functions</li> <li>Business Functions: Functions of the Value Chain, e.g. Production and Procurement, Supply Chain Management, Innovation Management, Marketing and Sales         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.					

## **Focus Materials in Engineering Sciences**

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

Module M0597	7: Advanced Mechanical	Engineering	Design			
Courses						
Title Advanced Mechanical   Advanced Mechanical   Advanced Mechanical   Advanced Mechanical	Typ Lecture Recitation (large) Lecture Recitation (large)	Hrs/wk 2 Section 2 2 Section 2	CP 2 1 2			
Module Responsible	Prof. Dieter Krause					
Admission Requirements	None					
Recommended Previous Knowledge	<ul> <li>Fundamentals of Mechanical</li> <li>Mechanics</li> <li>Fundamentals of Materials So</li> <li>Production Engineering</li> </ul>		ın			
Educational Objectives	After taking part successfully, stude	ents have reached	the following learn	ing results		
Professional Competence						
Knowledge	After passing the module, students are able to:  • explain complex working principles and functions of machine elements and of basic elements of fluidics,  • explain requirements, selection criteria, application scenarios and practical examples of complex machine elements,  • indicate the background of dimensioning calculations.					
Skills	<ul> <li>After passing the module, students</li> <li>accomplish dimensioning cal</li> <li>transfer knowledge learned (problem solving skills),</li> <li>recognize the content of tech</li> <li>evaluate complex designs, te</li> </ul>	culations of covere in the module to nnical drawings and	new requirement	s and tasks		
Personal Competence						
Social Competence	<ul> <li>Students are able to discuss activating methods.</li> </ul>	technical informat	ion in the lecture s	upported by		
	<ul> <li>Students are able to independent exercises.</li> </ul>	endently deepen	their acquired ki	nowledge in		

Autonomy	<ul> <li>Students are able to acquire additional knowledge and to recapitulate poorly understood content e.g. by using the video recordings of the lectures.</li> </ul>
Workload in Hours	Independent Study Time 68, Study Time in Lecture 112
Credit points	
Course achievement	None
Examination	Written exam
Examination duration and scale	120
Assignment for the Following Curricula	General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Biomechanics: Compulsory General Engineering, Focus Energy Systems: Compulsory General Engineering, Focus Energy Systems: Compulsory General Engineering, Focus Energy Systems: Compulsory General Engineering, Focus Aircraft Systems Engineering: Compulsory General Engineering, Focus Aircraft Systems Engineering: Compulsory General Engineering, Focus Aircraft Systems Engineering: Compulsory General Engineering, Focus Materials in Engineering Sciences: Compulsory General Engineering, Focus Materials in Engineering Sciences: Compulsory General Engineering, Focus Mechatronics: Compulsory General Engineering, Focus Mechatronics: Compulsory General Engineering, Focus Product Development and Production: Compulsory General Engineering, Focus Product Development and Production: Compulsory General Engineering, Focus Theoretical Mechanical Engineering: Compulsory Energy Systems: Technical Complementary Course Core Studies: Elective Compulsory Energy Systems: Technical Complementary Course Core Studies: Elective Compulsory Engineering Science: Specialisation Mechanical Engineering: Compulsory General Engineering Science (English program, 7 semester): Specialisation Mechanical Engineering, Focus Biomechanics: Compulsory General Engineering Science (English program, 7 semester): Specialisation Mechanical Engineering, Focus Energy Systems: Compulsory General Engineering, Focus Energy Systems: Compulsory General Engineering, Focus Aircraft Systems Engineering: Compulsory General Engineering, Focus Materials in Engineering Sciences: Specialisation Mechanical Engineering, Focus Materials in Engineering Scienc

Course L0264: Adv	anced Mechanical Engineering Design II
Тур	Lecture
Hrs/wk	2
СР	2
<b>Workload in Hours</b>	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Prof. Dieter Krause, Prof. Otto von Estorff
Language	DE
Cycle	SoSe
	Advanced Mechanical Engineering Design I & II
Content	• Fundamentals of the following machine elements:  • Linear rolling bearings  • Axes & shafts  • Seals  • Clutches & brakes  • Belt & chain drives  • Gear drives  • Epicyclic gears  • Crank drives  • Sliding bearings  • Elements of fluidics   Exercise  • Calculation methods of the following machine elements:  • Linear rolling bearings  • Axes & shafts  • Clutches & brakes  • Belt & chain drives  • Gear drives  • Gear drives  • Calculations of hydrostatic systems (fluidics)
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>

Course L0265: Advanced Mechanical Engineering Design II					
Тур	Typ 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: Adv	anced Mechanical Engineering Design I
Тур	Lecture
Hrs/wk	2
СР	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Prof. Dieter Krause, Prof. Otto von Estorff
Language	DE
Cycle	WiSe
	Advanced Mechanical Engineering Design I & II  Lecture  • Fundamentals of the following machine elements:  • Linear rolling bearings  • Axes & shafts  • Seals  • Clutches & brakes  • Belt & chain drives
Content	<ul> <li>Gear drives</li> <li>Epicyclic gears</li> <li>Crank drives</li> <li>Sliding bearings</li> <li>Elements of fluidics</li> </ul>
	Calculation methods of the following machine elements:         Linear rolling bearings         Axes & shafts         Clutches & brakes         Belt & chain drives         Gear drives         Epicyclic gears         Crank gears         Sliding bearings          Calculations of hydrostatic systems (fluidics)
Literature	<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>
	Sowie weitere Bücher zu speziellen Themen

Course L0263: Advanced Mechanical Engineering Design I				
Тур	Recitation Section (large)			
Hrs/wk	Hrs/wk 2			
СР	1			
<b>Workload in Hours</b>	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			

Courses					
<b>Title</b> Signals and Systems (l	L0432)	<b>Typ</b> Lecture	Hrs/wk	<b>CP</b>	
Signals and Systems (I	L0433)	Recitation (small)	Section 2	2	
Module Responsible	Prof. Gerhard Bauch				
Admission Requirements	None				
•	Mathematics 1-3				
Previous	The modul is an introduction to the thecin maths as covered by the moduls Math with spectral transformations (Fourier so is useful but not required.	nematik 1-3 is	s expected. Furthe	er experienc	
Educational Objectives	IAHAMAKING NAM SHOORSSHIIIV SHIGANIS M	nave reached	the following lear	ning results	
Professional Competence					
	The students are able to classify and describe signals and linear time-invariant (LTI) systems using methods of signal and system theory. They are able to apply the fundamental transformations of continuous-time and discrete-time signals and systems. They can describe and analyse deterministic signals and systems mathematically in both time and image domain. In particular, they understand the effects in time domain and image domain which are caused by the transition of a continuous-time signal to a discrete-time signal.				
Skills	The students are able to describe and analyse deterministic signals and linear time invariant systems using methods of signal and system theory. They can analyse and design basic systems regarding important properties such as magnitude and phase response, stability, linearity etc They can assess the impact of LTI systems on the signal properties in time and frequency domain.				
Personal Competence					
	The students can jointly solve specific pr	oblems.			
Autonomy	The students are able to acquire releven sources. They can control their level control tutorial problems, software tools.	of knowledge	during the lectu		
Workload in Hours	Independent Study Time 110, Study Tim	e in Lecture 7	70		
Credit points	6				
Course achievement					
Examination	Written exam				
Examination duration and scale	90 min				
	General Engineering Science (German Compulsory Computer Science: Core qualification: Co Data Science: Core qualification: Compu	ompulsory	semester): Core	qualification	

		Engineering er Science: Cor		(English	program,	7	semester):	Specialisation
	General	Engineering	Science		. •			Specialisation
		cal Engineerin						
Assignment for	General	Engineering	Science	(English	program,	7	semester):	Specialisation
the Following		_	_				•	
Curricula	General	Engineering	Science	(English	program,	7	semester):	Specialisation
	Mechanic	cal Engineering	g, Focus A	ircraft Sys	tems Engin	neer	ing: Compuls	sory
	General	Engineering	Science	(English	program,	7	semester):	Specialisation
	Mechanic	cal Engineerin	g, Focus M	laterials in	Engineerir	ng S	ciences: Con	npulsory
	General	Engineering	Science	(English	program,	7	semester):	Specialisation
	Mechanic	cal Engineerin	g, Focus M	lechatroni	cs: Compul	sor	/	
	General	Engineering	Science	(English	program,	7	semester):	Specialisation
	Mechanic	cal Engineerin	g, Focus T	heoretical	Mechanica	l Er	igineering: C	ompulsory
	General Engineering Science (English program, 7 semester): Specialisation Process							
	Engineer	Engineering: Compulsory						
	General Engineering Science (English program, 7 semester): Specialisation							
	Biomedical Engineering: Compulsory							
	Computational Science and Engineering: Core qualification: Compulsory							
	Mechatronics: Core qualification: Compulsory							
	Technomathematics: Specialisation III. Engineering Science: Elective Compulsory							
	l		•					

avT	Lecture
Hrs/wk	
CP (	
	Independent Study Time 78, Study Time in Lecture 42
	Prof. Gerhard Bauch
Language	
Cycle	
	Introduction to signal and system theory  Signals  Classification of signals  Analog and digital signals  Deterministic and random signals  Description of LTI systems by differential equations or difference equations, respectively  Basic properties of signals and operations on signals  Elementary signals  Distributions (Generalized Functions)  Power and energy of signals  Correlation functions of deterministic signals  Autocorrelation function  Crosscorrelation function  Orthogonal signals  Applications of correlation  Linear time-invariant (LTI) systems  Linearity  Time-invariance  Description of LTI systems by impulse response and frequency response  Convolution  Convolution  Convolution  Convolution  Properties of LTI-systems  Causal systems  Stable systems  Memoryless systems  Memoryless systems  Fourier Series and Fourier Transform  Fourier transform of continuous-time signals, discrete-time signals

periodic signals, non-periodic signals • Properties of the Fourier transform • Fourier transform of some basic signals Parseval's theorem Analysis of LTI-systems and signals in the frequency domain Frequency response, magnitude response and phase response Transmission factor, attenuation, gain Frequency-flat and frequency-selective LTI-systems Bandwidth definitions o Basic types of systems (filters), lowpass, highpass, bandpass, bandstop systems Phase delay and group delay Linear-phase systems Distortion-free systems Content • Spectrum analysis with limited observation window: Leakage effect Laplace Transform Relation of Fourier transform and Laplace transform Properties of the Laplace transform Laplace transform of some basic signals Analysis of LTI-systems in the s-domain Transfer function of LTI-systems • Relation of Laplace transform, magnitude response and phase response Analysis of LTI-systems using pole-zero plots Allpass filters Minimum-phase, maximum-phase and mixed phase filters Stable systems Sampling Sampling theorem · Reconstruction of continuous-time signals in frequency domain and time domain Oversampling Aliasing Sampling with pulses of finite duration, sample and hold Decimation and interpolation Discrete-Time Fourier Transform (DTFT) Relation of Fourier transform and DTFT Properties of the DTFT Discrete Fourier Transform (DFT) Relation of DTFT and DFT Cyclic properties of the DFT DFT matrix Zero padding Cyclic convolution Fast Fourier Transform (FFT) • Application of the DFT: Orthogonal Frequency Division Multiplex (OFDM) Z-Transform Relation of Laplace transform, DTFT, and z-transform Properties of the z-transform • Z-transform of some basic discrete-time signals Discrete-time systems, digital filters FIR and IIR filters Z-transform of digital filters • Analysis of discrete-time systems using pole-zero plots in the z-domain Stability Allpass filters • Minimum-phase, maximum-phase and mixed-phase filters Linear phase filters T. Frey , M. Bossert , Signal- und Systemtheorie, B.G. Teubner Verlag 2004

K. Kammeyer, K. Kroschel, Digitale Signalverarbeitung, Teubner Verlag.

## Literature

- B. Girod ,R. Rabensteiner , A. Stenger , Einführung in die Systemtheorie, B.G. Teubner, Stuttgart, 1997
- J.R. Ohm, H.D. Lüke , Signalübertragung, Springer-Verlag 8. Auflage, 2002
- S. Haykin, B. van Veen: Signals and systems. Wiley.
- Oppenheim, A.S. Willsky: Signals and Systems. Pearson.
- Oppenheim, R. W. Schafer: Discrete-time signal processing. Pearson.

Course L0433: Signals and Systems			
Тур	Recitation Section (small)		
Hrs/wk	2		
СР	2		
<b>Workload in Hours</b>	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 M0988	3: Structural Materials					
Courses						
<b>Title</b> Fundamentals of Mech Welding Technology (L	anical Properties of Materials (L1090) 1123)	<b>Typ</b> Lecture Lecture	Hrs/wk 2 3	<b>CP</b> 3 3		
Module Responsible	Prof. Claus Emmelmann					
Admission Requirements	None					
Recommended Previous Knowledge	Fundamentals of Materials Science					
Educational Objectives	After taking part successfully, students	have reached the foll	owing learn	ing results		
Professional Competence						
	The students get to know the principles that are responsible for the mechanical behaviour of metals. They acquire basic knowlegde in modelling of the materials behaviour. Furthermore, the students learn about the behaviour of metals under static and dynamic loads. The students get to know the most important welding technologies and the corresponding systems. They learn about the influence of welding on the materials and design.					
Skills	The students know the mechanical properties of metals and the underlying principles. They are able to name the influencing factors on the welding behaviour of steel materials.  The students are able to select between alloys according to the desired mechaincal properties and welability. They can distinguish between different welding techniques and select the suitable technique and system components for a defined application. They are able to dimension weld joints within design tasks.					
Personal Competence				-		
Social Competence						
Autonomy						
-	Independent Study Time 110, Study Tir	ne in Lecture 70				
Credit points	6					
Course achievement	None					
Examination	Written exam					
Examination duration and scale						
Assignment for the Following Curricula	General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Materials in Engineering Sciences: Compulsory General Engineering Science (English program, 7 semester): Specialisation Mechanical Engineering Focus Materials in Engineering Sciences: Compulsory					

Course L1090: Fundamentals of Mechanical Properties of Materials		
Тур	Lecture	
Hrs/wk	2	
СР	3	
<b>Workload in Hours</b>	Independent Study Time 62, Study Time in Lecture 28	
Lecturer	Prof. Norbert Huber	
Language	DE	
Cycle	SoSe	
Content	<ol> <li>Introduction and overview</li> <li>Bonding and crystallography, stress, strain, linear elasticity</li> <li>Plasticity of metallic materials</li> <li>Dislocations: Structure, stress, strain, strain energy</li> <li>Dislocations: Motion and forces</li> <li>Partial dislocations, dislocation interactions, jogs and kinks</li> <li>Strengthening mechanisms</li> <li>Introduction to modelling of materials behaviour, classification of</li> <li>phenomena</li> <li>Linear and nonlinear elasticity</li> <li>Plasticity, tensile loading, cyclic loading</li> <li>Viscoelasticity, effects of loading history, creep, relaxation</li> <li>Viscoplasticity, overstress, rate sensitivity of metallic materials</li> <li>Identification of material parameters</li> </ol>	
	Hull and Bacon: Introduction to Dislocations (1984)  G. Gottstein: Physik. Grundlagen der Materialk. (2001)  N.Huber: Scriptum "Materialtheorie" Uni Karlsruhe (1998)  P. Haupt: Cont. Mechanics and Theory of Materials (2002)	

Тур	Lecture		
Hrs/wk	3		
СР	3		
Vorkload in Hours	Independent Study Time 48, Study Time in Lecture 42		
Lecturer	Prof. Claus Emmelmann, Prof. Karl-Ulrich Kainer		
Language			
Cycle			
	- phase transitions, phase diagrams and thermal activated processes		
	- fundamentals of steels, heat treatment applications for steels and tim temperature transformation diagrams		
	- properties of weldable carbon and fine grained steels		
	- properties of weldable low- and high-alloy steels, corrosion resistant steels an 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		
Content	- structure and influence parameters for the welded joint		
	- submerged arc welding/tungsten inert gas welding/inert gas metal arc weldin (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		
	Schulze, G.: Die Metallurgie des Schweißens, 4. Aufl., Berlin 2010 Strassburg, F.W		
	und Wehner H.: Schweißen nichtrostender Stähle, 4. Aufl. Düsseldorf, 2009 Dilthe U.: Schweißtechnische Fertigungsverfahren, Bd. 1: Schweiß- ur Schneidtechnologien, 3. Aufl., Berlin 2006.		
Literature	Dilthey, U.: Schweißtechnische Fertigungsverfahren, Bd. 2: Verhalten der Werkstof beim Schweißen, 3. Aufl., Berlin 2005.		
	Dilthey, U.: Schweißtechnische Fertigungsverfahren, Bd. 3: Gestaltung ur Festigkeit von Schweißkonstruktionen, 2. Aufl., Berlin 2002.		

Module M0833	3: Introduction to Cor	ntroi Systems		
Courses				
Title Introduction to Control Introduction to Control	-	<b>Typ</b> Lecture Recitation (small)	Hrs/wk 2 Section 2	<b>CP</b> 4 2
Module	Prof. Herbert Werner	(Smail)		
Responsible Admission Requirements	l None			
Recommended Previous Knowledge	Representation of signals and transform	d systems in time and	frequency doma	ain, Laplace
Educational Objectives	After taking part successfully,	students have reached t	he following learn	ing results
Professional Competence				
Knowledge	<ul><li>systems</li><li>They can explain the dy properties in terms of fr</li><li>They can explain the</li></ul>	rticular explain propertion representation of simple controlled equency response and representation of the phase marginary a PID controller affects arising when controllers	es of first and so I loops and interpoot locus on and the stabi in analysis and sa control loop in	econd orderet dynamic lity margin synthesis of terms of its
Skills	locus and frequency res  They can calculate disc	rice versa assess the behavior of sy controllers with the help synthesize simple contro ponse techniques crete-time approximation e it for digital implement software tools (Matlab (	rstems and control of heuristic (Zied of loops with the ons of controllers ation	ol loops gler-Nichols help of roo designed in
Personal Competence Social Competence	Students can work in small experimentally validate their c	ontroller designs	·	
Autonomy	Students can obtain informat documentation, experiment gu They can assess their knowled learning progress.	uides) and use it when so	olving given proble	ems.

<b>Workload in Hours</b>	Independent Study Time 124, Study Time in Lecture 56
Credit points	
Course achievement	None
Examination	Written exam
Examination duration and scale	
the Following	General Engineering Science (German program, 7 semester): Core qualification: Compulsory Bioprocess Engineering: Core qualification: Compulsory Computer Science: Specialisation Computational Mathematics: Elective Compulsory Data Science: Core qualification: Elective Compulsory Electrical Engineering: Core qualification: Compulsory Electrical Engineering: Core qualification: Compulsory Energy and Environmental Engineering: Core qualification: Compulsory General Engineering Science (English program, 7 semester): Specialisation Electrical Engineering: Compulsory General Engineering Science (English program, 7 semester): Specialisation Civil Engineering: Compulsory General Engineering Science (English program, 7 semester): Specialisation Energy and Environmental Engineering: Compulsory General Engineering Science (English program, 7 semester): Specialisation Energy and Environmental Engineering: Compulsory General Engineering Science (English program, 7 semester): Specialisation Computer Science: Compulsory General Engineering Science (English program, 7 semester): Specialisation Mechanical Engineering, Focus Biomechanics: Compulsory General Engineering Science (English program, 7 semester): Specialisation Mechanical Engineering, Focus Energy Systems: Compulsory General Engineering Science (English program, 7 semester): Specialisation Mechanical Engineering, Focus Materials in 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 Mecharionics: Compulsory General Engineering Science (English program, 7 semester): Specialisation Mechanical Engineering, Focus Mecharionics: Compulsory General Engineering, Science (English program, 7 semester): Specialisation Mechanical Engineering, Focus Mecharionics: Compulsory General Engineering Science (English program, 7 semester): Specialisation Naval Archit

Course L0654: Intro	oduction to Control Systems
Тур	Lecture
Hrs/wk	
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
<b>Workload in Hours</b>	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 M1009	9: Material Science Labora	tory		
Courses				
<b>Title</b> Companion Lecture for Material Science Labor	Materials Science Laboratory (L1088) ratory (L1235)	<b>Typ</b> Lecture Practical Course	Hrs/wk 2 4	<b>CP</b> 2 4
Module Responsible	Prof. Bodo Fiedler			
Admission Requirements	None			
Recommended Previous Knowledge	none			
Educational Objectives	After taking part successfully, students	s have reached the foll	owing learn	ing results
Professional Competence				
Knowledge	Students are able to give a summary of the technical details of experiments in the area of materials sciences and illustrate respective relationships. They are capable of describing and communicating relevant problems and questions using appropriate technical language. They can explain the typical process of solving practical problems and present related results.			
Skills	The students can transfer their fundamental knowledge on material sciences to the process of solving practical problems. They identify and overcome typical problems during the realization of experiments in the context of material sciences.			
Personal Competence				
Social Competence	Students are able to cooperate in smatche context of materials sciences. The their results alone or in groups in front	ey are able to effective	ely present	
Autonomy	Students are capable of solving proble provided literature. They are able to tusing the literature and other sources	fill gaps in as well as	extent their	
	Independent Study Time 96, Study Tim	ne in Lecture 84		
Credit points				
Course achievement	None			
Examination	Written exam			
Examination duration and scale	1,5 h written Exam (50%) covering the	elesson		
Assignment for the Following Curricula	General Engineering Science (Gern Mechanical Engineering, Focus Materia General Engineering Science (Engl Mechanical Engineering, Focus Materia Mechanical Engineering: Specialisati Compulsory Mechanical Engineering: Specialisa Compulsory Product Development, Materials and Fore Studies: Elective Compulsory	als in Engineering Scier lish program, 7 ser als in Engineering Scier ion Product Developi tion Materials in I	nces: Comp nester): S nces: Comp ment and Engineering	ulsory pecialisation ulsory Production: Sciences:

Course L1088: Companion Lecture for Materials Science Laboratory		
Тур	Lecture	
Hrs/wk	2	
СР	2	
<b>Workload in Hours</b>	Independent Study Time 32, Study Time in Lecture 28	
Lecturer	Prof. Patrick Huber	
Language	DE	
Cycle	WiSe	
Content	Physico-chemical backgrounds and fundamental experimental principles with regard to the following experiments, the topics to be addressed are indicated in brackets for each experiment:  1. Phase diagrams, heat treatment, hardness measurements (thermodynamics, elastic properties of solids)  2. notch impact test (elastic properties of solids)  3. Processes during the solidifaction of metals (thermodynamics and kinetics of solid-liquid phase transitions)  4. tensile test (elastic properties of solids)  5. Identificiation of polymers (polymer physics)  6. fiber-reinforced polymers (physical principles of composite materials)  7. Production and microstructure of ceramic materials (physico-chemical principles of ceramics)  8. Mechanical properties of ceramic materials (elastic properties of solids and composite materials)	
Literature	William D. Callister und David G. Rethwisch, Materialwissenschaften und Werkstofftechnik, Wiley&Sons, Asia (2011) William D. Callister, Materials Science and Technology, Wiley& Sons, Inc. (2007)	

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

Module M0662	2: Numerical Mathematic	cs I		
Courses				
Title Numerical Mathematics I (L0417) Numerical Mathematics I (L0418)  Typ Lecture 2 3 Recitation (small) 2 3		3		
Module Responsible	Prof. Sabine Le Borne			
Admission Requirements	None			
Recommended Previous Knowledge	Linear Algebra I + II for Tech		man or english) <b>o</b> l	<b>r</b> Analysis &
Educational Objectives	After taking part successfully, stude	ents have reached t	he following learn	ing results
Professional Competence	Students are able to			
Knowledge	<ul> <li>name numerical methods for interpolation, integration, least squares problems, eigenvalue problems, nonlinear root finding problems and to explain their core ideas,</li> </ul>			
Skills	<ul> <li>Students are able to</li> <li>implement, apply and compa</li> <li>justify the convergence behaproblem and solution algorith</li> <li>select and execute a suitable</li> </ul>	aviour of numerical nm,	methods with res	spect to the
Personal Competence	Students are able to			
Social Competence	<ul> <li>work together in heterog</li> </ul>	nd background kno ach other with pra	wledge), explain	theoretical
Autonomy	<ul> <li>to assess whether the support better solved individually or to assess their individual processes help.</li> </ul>	in a team,	·	
Workload in Hours	Independent Study Time 124, Study	/ Time in Lecture 56	j	
Credit points				
Course achievement	None			
Examination	Written exam			
Examination				

duration and scale	
	General Engineering Science (German program, 7 semester): Specialisation
	Computer Science: Compulsory
	General Engineering Science (German program, 7 semester): Specialisation
	Mechanical Engineering, Focus Materials in Engineering Sciences: Compulsory
	General Engineering Science (German program, 7 semester): Specialisation
	Biomedical Engineering: Compulsory
	General Engineering Science (German program, 7 semester): Specialisation
	Mechanical Engineering, Focus Biomechanics: Compulsory
	General Engineering Science (German program, 7 semester): Specialisati
	Mechanical Engineering, Focus Theoretical Mechanical Engineering: Compulsory
	Bioprocess Engineering: Specialisation A - General Bioprocess Engineering: Electi
	Compulsory
	Computer Science: Specialisation Computational Mathematics: Elective Compulso
	Computer Science: Specialisation II. Mathematics and Engineering Science: Election
	Compulsory
	Data Science: Core qualification: Compulsory
	Electrical Engineering: Core qualification: Elective Compulsory
	Engineering Science: Core qualification: Compulsory
	General Engineering Science (English program, 7 semester): Specialisat
	Mochanical Engineering Focus Theoretical Mochanical Engineering: Floot
nment for	Compulsory
Following	I(-onoral Engineering Ecience (English program / competer): ( ore gualificati
Curricula	Compulsory
	General Engineering Science (English program, 7 semester): Specialisati
	Computer Science: Compulsory
	General Engineering Science (English program, 7 semester): Specialisat
	Mechanical Engineering, Focus Biomechanics: Compulsory
	General Engineering Science (English program, 7 semester): Specialisat
	Mechanical Engineering, Focus Materials in Engineering Sciences: Compulsory
	General Engineering Science (English program, 7 semester): Specialisat
	Mechanical Engineering, Focus Theoretical Mechanical Engineering: Compulsory
	General Engineering Science (English program, 7 semester): Specialisat
	Biomedical Engineering: Compulsory
	Computational Science and Engineering: Core qualification: Compulsory
	Mechanical Engineering: Specialisation Theoretical Mechanical Engineering: Elect
	Compulsory
	Mechanical Engineering: Specialisation Theoretical Mechanical Engineering
	Compulsory
	Mechanical Engineering: Specialisation Energy Systems: Elective Compulsory
	Theoretical Mechanical Engineering: Technical Complementary Course Core Studi
	Elective Compulsory
	Process Engineering: Specialisation Process Engineering: Elective Compulsory

Course L0417: Num	nerical Mathematics I
Тур	Lecture
Hrs/wk	2
СР	3
<b>Workload in Hours</b>	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Prof. Sabine Le Borne
Language	EN
Cycle	WiSe
Content	<ol> <li>Error analysis: Number representation, error types, conditioning and stability</li> <li>Interpolation: polynomial and spline interpolation</li> <li>Numerical integration and differentiation: order, Newton-Cotes formula, error estimates, Gaussian quadrature, adaptive quadrature, difference formulas</li> <li>Linear systems: LU and Cholesky factorization, matrix norms, conditioning</li> <li>Linear least squares problems: normal equations, Gram.Schmidt and Householder orthogonalization, singular value decomposition, regularization</li> <li>Eigenvalue problems: power iteration, inverse iteration, QR algorithm</li> <li>Nonlinear systems of equations: Fixed point iteration, root-finding algorithms for real-valued functions, Newton and Quasi-Newton methods for systems</li> </ol>
Literature	<ul> <li>Stoer/Bulirsch: Numerische Mathematik 1, Springer</li> <li>Dahmen, Reusken: Numerik für Ingenieure und Naturwissenschaftler, Springer</li> </ul>

Course L0418: Numerical Mathematics I		
Тур	Recitation Section (small)	
Hrs/wk	2	
СР	3	
<b>Workload in Hours</b>	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 M0730	D: Computer Engineeri	ng			
Courses					
<b>Title</b> Computer Engineering Computer Engineering		<b>Typ</b> Lecture Recitation	Hrs/wk 3 Section 1	<b>CP</b> 4	
		(small)	-	_	
пезропзівіє	Prof. Heiko Falk				
Admission Requirements	None				
Recommended Previous Knowledge	Basic knowledge in electrical engineering				
Educational Objectives	After taking part successfully, students have reached the following learning results				
Professional Competence					
Knowledge	<ul> <li>This module deals with the foundations of the functionality of computing systems. It covers the layers from the assembly-level programming down to gates. The module includes the following topics: <ul> <li>Introduction</li> <li>Combinational logic: Gates, Boolean algebra, Boolean functions, hardware synthesis, combinational networks</li> <li>Sequential logic: Flip-flops, automata, systematic hardware design</li> <li>Technological foundations</li> <li>Computer arithmetic: Integer addition, subtraction, multiplication and division</li> <li>Basics of computer architecture: Programming models, MIPS single-cycle architecture, pipelining</li> <li>Memories: Memory hierarchies, SRAM, DRAM, caches</li> <li>Input/output: I/O from the perspective of the CPU, principles of passing data, point-to-point connections, busses</li> </ul> </li></ul>				
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 a 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 has on the hardware-centric abstraction layers from the assembly language down to gates. This way, they will be enabled to evaluate the impact that these low abstraction levels have on an entire system's performance and to propose feasible options.				
Personal Competence		ar problems alone or i	n a group and to	present the	
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, St	udy Time in Lecture 56	5		
Credit points					

Course	Compulsor <b>B</b> onus	Form	Description
achievement		Excercises	•
Examination	Written exam		
Examination duration and scale	90 minutes, contents of	course and labs	
Assignment for the Following	General Engineering Computer Science: Com General Engineering Bioprocess Engineering General Engineering General Engineering General Engineering Electrical Engineering Electrical Engineering Electrical Engineering General Engineering Mechanical Engineering General Engineering General Engineering Sengineering: Compulsor Computer Science: Core Data Science: Core qua Electrical Engineering Sengineering: Compulsor General Engineering General Engineering General Engineering Mechanical Engineering General Engineering General Engineering General Engineering Mechanical Engineering	Science (German pulsory Science (German prory Science (German prory Science (German prory Science (German progry Science (German progry ience (German progry ience (German progry Science (English progressione (English progressi	program, 7 semester): Specialisation Process program, 7 semester): Specialisation
•		[502]	

General Engineering Science (English program, 7 semester): Specialisation Mechanical Engineering, Focus Theoretical Mechanical Engineering: Compulsory General Engineering Science (English program, 7 semester): Specialisation Naval Architecture: Compulsory General Engineering Science (English program, 7 semester): Specialisation Process Engineering: Compulsory General Engineering Science (English program, 7 semester): Specialisation Biomedical Engineering: Compulsory Computational Science and Engineering: Core qualification: Compulsory Mechatronics: Core qualification: Compulsory Technomathematics: Specialisation II. Informatics: Elective Compulsory

Course L0321: Com	nputer 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	
<b>Workload in Hours</b>	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 M1005	5: Enhanced Fundamentals	of Materi	als Science		
Courses					
Title Enhanced Fundamentals: Ceramics and Polymers (L1233)		Typ Lecture	Hrs/wk	<b>CP</b> 2	
Enhanced Fundamentals: Ceramics and Polymers (L1234)		Recitation (large)	Section 1	1	
Enhanced Fundamenta	als: Metals (L1086)	Lecture	2	3	
Module Responsible	Prof. Gerold Schneider				
Admission Requirements	None				
	Module "Fundamentals of Materials Scien	nce"			
Recommended Previous Knowledge					
Knowledge	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	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 Tim	e in Lecture	70		
Credit points	6				
Course achievement	None				
Examination	Written exam				
Examination duration and scale					
Assignment for the Following Curricula	General Engineering Science (Germa Mechanical Engineering, Focus Materials General Engineering Science (Germa Mechanical Engineering, Focus Product Data Science: Core qualification: Elective General Engineering Science (English Mechanical Engineering, Focus Materials General Engineering, Focus Product Description	in Engineering program, Development e Compulsory hopogram, in Engineering program, hopogram,	ng Sciences: Compo 7 semester): Sp and Production: Co 7 semester): Sp ng Sciences: Compo 7 semester): Sp	ulsory pecialisation impulsory pecialisation ulsory pecialisation	

Mechanical Engineering: Specialisation Materials in Engineering Sciences: Compulsory
Technomathematics: Specialisation III. Engineering Science: Elective Compulsory

Тур	Lecture
Hrs/wk	2
СР	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Prof. Gerold Schneider, Prof. Robert Meißner
Language	DE/EN
Cycle	
	<ol> <li>Einführung</li> <li>Natürliche "Keramiken" - Steine "Künstliche" Keramik - vom Porzellan bis zur Hochleistungskeramik Anwendunge von Hochleistungskeramik</li> </ol>
	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)
Content	4. Sintern
	Triebkraft des Sinterns Effekt von gekrümmten Oberflächen und Diffusionswegen Sinterstadien des isothermen Festphasensinterns Herring scaling laws Heißisostatisches Pressen
	5. Mechanische Eigenschaften von Keramiken
	Elastisches und plastisches Materialverhalten Bruchzähigkeit - Linear-elastische Bruchmechanik Festigkeit - Festigkeitsstreuung
	6. Elektrische Eigenschaften von Keramiken
	Ferroelektische Keramiken
	Piezo-, ferroelektrische Materialeigenschaften Anwendungen
	Keramische Ionenleiter
	lonische Leitfähigkeit Dotiertes Zirkonoxid in der Brennstoffzelle und Lambdasonde

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

**Literature** 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	
<b>Workload in Hours</b>	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	

Course L1086: Enhanced Fundamentals: Metals		
Тур	Lecture	
Hrs/wk	2	
СР	3	
<b>Workload in Hours</b>	Independent Study Time 62, Study Time in Lecture 28	
Lecturer	Prof. Jörg Weißmüller, Prof. Patrick Huber	
Language	DE	
Cycle	SoSe	
Content	<ul> <li>Enhanced Fundamentals of Metals:</li> <li>Introduction to phenomenological thermodynamics</li> <li>Elasticity</li> <li>Thermal materials behavior (heat capacity, thermal expansion)</li> <li>Conductors, semiconductors, isolators: conduction mechanisms and band structure</li> <li>Superconductors</li> <li>Dry corrosion</li> <li>Electrochemistry in the material sciences</li> <li>Wet corrosion</li> <li>Alloy corrosion</li> <li>Corrosion protection</li> <li>Stainless steel</li> <li>Battery materials</li> <li>Supercapacitors</li> <li>Fuel cells</li> <li>Materials for hydrogen storage</li> <li>Magnetism: phenomenology, Magnetometers, atomistics, micromagnetism</li> <li>Magnetic materials</li> <li>Magnetic materials: applications</li> </ul> Vorlesungsskript	
Literature		

Module M0829	9: Foundations of Manage	ment		
Courses				
<b>Title</b> Management Tutorial (		<b>Typ</b> Recitation (small)	Hrs/wk Section 2	<b>CP</b> 3
Introduction to Manage		Lecture	3	3
Admission Requirements	INONE			
Recommended Previous Knowledge	Basic Knowledge of Mathematics and	Business		
Educational Objectives	LATTER TAKING NART SHECESSTILLIV STILLENT	s have reached	the following learn	ing results
Professional Competence				
Knowledge	After taking this module, students know the important basics of many different areas in Business and Management, from Planning and Organisation to Marketing and Innovation, and also to Investment and Controlling. In particular they are able to  • explain the differences between Economics and Management and the subdisciplines in Management and to name important definitions from the field of Management  • explain the most important aspects of and goals in Management and name the most important aspects of entreprneurial projects  • describe and explain basic business functions as production, procurement and sourcing, supply chain management, organization and human ressource management, information management, innovation management and marketing  • explain the relevance of planning and decision making in Business, esp. in situations under multiple objectives and uncertainty, and explain some basic methods from mathematical Finance  • state basics from accounting and costing and selected controlling methods.			
Skills	Students are able to analyse busin (organization, objectives, strategies project in a team. In particular, they a              • analyse Management goals and	etc.) and to core able to  I structure them f structures of comaking under urement system ds of marketing ds from mathe	arry out an Entre appropriately ompanies r multiple object ms and Business ematical finance to	epreneurship lives, under information predefined
Personal Competence	Students are able to  work successfully in a team of s			
	to apply their knowledge from t  [508]	the lecture to ar	າ entrepreneurship	project and

Social Competence	<ul> <li>write a coherent report on the project</li> <li>to communicate appropriately and</li> <li>to cooperate respectfully with their fellow students.</li> </ul>			
Autonomy	Students are able to  • work in a team and to organize the team themselves • to write a report on their project.			
Workload in Hours	Independent Study Time 110, Study Time in Lecture 70			
Credit points				
Course achievement	None			
Examination	Subject theoretical and practical work			
Examination duration and scale	several written exams during the semester			
the Following	General Engineering Science (German program, 7 semester): Core qualification: Compulsory Civil- and Environmental Engineering: Core qualification: Compulsory Civil- and Environmental Engineering: Specialisation Civil Engineering: Electiv Compulsory Civil- and Environmental Engineering: Specialisation Water and Environmental Elective Compulsory Civil- and Environmental Engineering: Specialisation Traffic and Mobility: Elective Compulsory Civil- and Environmental Engineering: Specialisation Traffic and Mobility: Elective Compulsory Bioprocess Engineering: Core qualification: Compulsory Bioprocess Engineering: Core qualification: Compulsory Computer Science: Core qualification: Compulsory Data Science: Core qualification: Compulsory Energy and Environmental Engineering: Compulsory General Engineering Science (English program, 7 semester): Specialisation Electrical Engineering: Compulsory General Engineering Science (English program, 7 semester): Specialisation Civengineering: Compulsory General Engineering: Compulsory General Engineering Science (English program, 7 semester): Specialisation Energing and Environmental Engineering: Compulsory General Engineering Science (English program, 7 semester): Specialisation Computer Science: Compulsory General Engineering Science (English program, 7 semester): Specialisation Mechanical Engineering, Focus Anteraft Systems Engineering: Compulsory General Engineering Science (English program, 7 semester): Specialisation Mechanical Engineering, Focus Anteraft Systems Engineering Sciences: Compulsory General Engineering Science (English program, 7 semester): Specialisation Mechanical Engineering, Focus Anteraft Systems Engineering Sciences: Compulsory General Engineering Science (English program, 7 semester): Specialisation Mechanical Engineering, Focus Mechanical Mechanical Engineering Science (English program, 7 semester): Specialisation Mechanical Eng			

Mechatronics: Core qualification: Compulsory

Orientierungsstudium: Core qualification: Elective Compulsory

Naval Architecture: Core qualification: Compulsory Technomathematics: Core qualification: Compulsory Process Engineering: Core qualification: Compulsory

Course L0882: Management Tutorial			
Тур	Recitation Section (small)		
Hrs/wk	2		
СР	3		
<b>Workload in Hours</b>	Independent Study Time 62, Study Time in Lecture 28		
Lecturer	Prof. Christoph Ihl, Katharina Roedelius, Tobias Vlcek		
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 self-selected projects that focus on the elaboration of an innovative business idea from the point of view of an established company or a startup. Again, the business knowledge from the lecture should come to practical use. The group projects are guided by a mentor.		
Literature	Relevante Literatur aus der korrespondierenden Vorlesung.		

Course L0880: Introduction to Management			
Тур	Lecture		
Hrs/wk	3		
СР	3		
<b>Workload in Hours</b>	Independent Study Time 48, Study Time in Lecture 42		
Lecturer	Prof. Christoph Ihl, Prof. Thorsten Blecker, Prof. Christian Lüthje, Prof. Christian Ringle, Prof. Kathrin Fischer, Prof. Cornelius Herstatt, Prof. Wolfgang Kersten, Prof. Matthias Meyer, Prof. Thomas Wrona		
Language	DE		
Cycle	WiSe/SoSe		
Content	<ul> <li>Introduction to Business and Management, Business versus Economics, relevant areas in Business and Management</li> <li>Important definitions from Management,</li> <li>Developing Objectives for Business, and their relation to important Business functions</li> <li>Business Functions: Functions of the Value Chain, e.g. Production and Procurement, Supply Chain Management, Innovation Management, Marketing and Sales         Cross-sectional Functions, e.g. Organisation, Human Ressource Management, Supply Chain Management, Information Management         Definitions as information, information systems, aspects of data security and strategic information systems         Definition and Relevance of innovations, e.g. innovation opporunities, risks etc.     </li> </ul>		
Literature	Bamberg, G., Coenenberg, A.: Betriebswirtschaftliche Entscheidungslehre, 14. Au 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 Rechnungslegun 7. Aufl., Stuttgart 2008.  Schweitzer, M.: Planung und Steuerung, in: Bea/Friedl/Schweitzer: Allgemein 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. Auflag Stuttgart 2006.		

## **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 M0597: Advanced Mechanical Engineering Design				
Courses				
Title	5 · · · D · · · !! (1.00.04)	Тур	Hrs/wk	СР
	Engineering Design II (L0264)	Lecture Recitation	2 Section <sub>2</sub>	2
	Engineering Design II (L0265)	(large)	-	1
	Engineering Design I (L0262) Engineering Design I (L0263)	Lecture Recitation	2 Section <sub>2</sub>	2 1
Advanced Mechanical	Engineering Design (10203)	(large)	2	1
Module Responsible	Prof. Dieter Krause			
Admission Requirements	None			
Recommended Previous Knowledge	<ul> <li>Fundamentals of Mechanical</li> <li>Mechanics</li> <li>Fundamentals of Materials So</li> <li>Production Engineering</li> </ul>		n	
Educational Objectives	After taking part successfully, stude	ents have reached	the following learn	ing results
Professional Competence				
Knowledge	After passing the module, students are able to:  • explain complex working principles and functions of machine elements and of basic elements of fluidics.			
Skills	<ul> <li>After passing the module, students are able to:</li> <li>accomplish dimensioning calculations of covered machine elements,</li> <li>transfer knowledge learned in the module to new requirements and tasks (problem solving skills),</li> <li>recognize the content of technical drawings and schematic sketches,</li> <li>evaluate complex designs, technically.</li> </ul>			
Personal Competence				
Social Competence	<ul> <li>Students are able to discuss activating methods.</li> </ul>	technical informat	ion in the lecture s	upported by
Autonomy	<ul> <li>Students are able to independently deepen their acquired knowledge in exercises.</li> <li>Students are able to acquire additional knowledge and to recapitulate poorly understood content e.g. by using the video recordings of the lectures.</li> </ul>			

<b>Workload in Hours</b>	Independent Study Time 68, Study Time in Lecture 112
Credit points	
Course achievement	None
Examination	Written exam
Examination duration and scale	120
	General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering; Compulsory General Engineering, Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Biomechanics: Compulsory General Engineering, Focus Biomechanics: Compulsory General Engineering, Focus Energy Systems: Compulsory General Engineering, Focus Aircraft Systems Engineering: Compulsory General Engineering, Focus Aircraft Systems Engineering: Compulsory General Engineering, Focus Aircraft Systems Engineering: Compulsory General Engineering, Focus Materials in Engineering Sciences: Compulsory General Engineering, Focus Materials in Engineering Sciences: Compulsory General Engineering, Focus Mechatronics: Compulsory General Engineering, Focus Mechatronics: Compulsory General Engineering, Focus Mechatronics: Compulsory General Engineering, Focus Product Development and Production: Compulsory General Engineering, Focus Product Development and Production: Compulsory General Engineering, Focus Theoretical Mechanical Engineering: Compulsory General Engineering, Focus Theoretical Mechanical Engineering: Compulsory Engineering Science: Specialisation Mechanical Engineering: Compulsory Engineering Science: Specialisation Mechanical Engineering: Compulsory General Engineering Science (English program, 7 semester): Specialisation Mechanical Engineering, Focus Biomechanics: Compulsory General Engineering Science (English program, 7 semester): Specialisation Mechanical Engineering, Focus Biomechanics: Compulsory General Engineering, Science (English program, 7 semester): Specialisation Mechanical Engineering, Focus Materials in Engineering; Compulsory General Engineering, Science (English program, 7 semester): Specialisation Mechanical Engineering, Focus Materials in Engineering; Compulsory General Engineering, Focus Mechatronics: Compulsory General Engineering, Focus Mechatronics: Compulsory General Engineering, Focus Mechatronics: Compulsory General Engineering, Focus Product Development and Production

anced Mechanical Engineering Design II
Lecture
2
2
Independent Study Time 32, Study Time in Lecture 28
Prof. Dieter Krause, Prof. Otto von Estorff
DE
SoSe
Advanced Mechanical Engineering Design I & II
• 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  • Axes & shafts  • Clutches & brakes  • Belt & chain drives  • Gear drives  • Gear drives  • Cank gears  • Crank gears  • Crank gears  • Cliding bearings
<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>

Course L0265: Advanced Mechanical Engineering Design II		
Тур	Recitation Section (large)	
Hrs/wk	2	
СР	1	
<b>Workload in Hours</b>	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: Adv	anced Mechanical Engineering Design I
Тур	Lecture
Hrs/wk	2
СР	2
<b>Workload in Hours</b>	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Prof. Dieter Krause, Prof. Otto von Estorff
Language	DE
Cycle	WiSe
Content	Advanced Mechanical Engineering Design I & II  Lecture  • Fundamentals of the following machine elements:  • Linear rolling bearings  • Axes & shafts  • Seals  • Clutches & brakes  • Belt & chain drives  • Gear drives  • Epicyclic gears  • Crank drives  • Sliding bearings  • Elements of fluidics  Exercise  • Calculation methods of the following machine elements:  • Linear rolling bearings  • Axes & shafts  • Clutches & brakes  • Belt & chain drives  • Gear drives  • Gear drives  • Gear drives  • Crank gears  • Sliding bearings
Literature	<ul> <li>Calculations of hydrostatic systems (fluidics)</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>

Course L0263: Advanced Mechanical Engineering Design I		
Тур	Recitation Section (large)	
Hrs/wk	2	
СР	1	
<b>Workload in Hours</b>	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	

2: Signals and Systems				
L0432) L0433)	Typ Lecture Recitation	Section	Hrs/wk 3	<b>CP</b> 4 2
	(small)			
<u>                                     </u>				
None				
Mathematics 1-3				
in maths as covered by the moduls Math	nematik 1-3 is	s expecte	ed. Further	experience
After taking part successfully, students h	ave reached	the follo	wing learn	ing results
The students are able to classify and describe signals and linear time-invariant (LTI) systems using methods of signal and system theory. They are able to apply the fundamental transformations of continuous-time and discrete-time signals and systems. They can describe and analyse deterministic signals and systems mathematically in both time and image domain. In particular, they understand the effects in time domain and image domain which are caused by the transition of				
invariant systems using methods of signal design basic systems regarding importal response, stability, linearity etc They ca	al and systen nt properties an assess the	n theory. such as	They can magnitude	analyse and e and phase
	oblems.			
The students are able to acquire releva sources. They can control their level o	ant informati of knowledge	during		
Independent Study Time 110, Study Time	e in Lecture 7	70		
6				
None				
Written exam				
90 min				
Compulsory Computer Science: Core qualification: Co Data Science: Core qualification: Compul Electrical Engineering: Core qualification: General Engineering Science (English pro Engineering: Compulsory	ompulsory Isory : Compulsory ogram, 7 sem	nester): S	pecialisati	on Electrical
	Prof. Gerhard Bauch  None  Mathematics 1-3  The modul is an introduction to the theo in maths as covered by the moduls Mathwith spectral transformations (Fourier set is useful but not required.  After taking part successfully, students have trained by the suspension of continuous fundamental transformations of continuous fundamental f	Lecture Recitation (small)  Prof. Gerhard Bauch  None  Mathematics 1-3  The modul is an introduction to the theory of signals in maths as covered by the moduls Mathematik 1-3 is with spectral transformations (Fourier series, Fourier is useful but not required.  After taking part successfully, students have reached  The students are able to classify and describe signals systems using methods of signal and system theor fundamental transformations of continuous-time a systems. They can describe and analyse determ mathematically in both time and image domain. In peffects in time domain and image domain which at a continuous-time signal to a discrete-time signal. The students are able to describe and analyse determ invariant systems using methods of signal and system design basic systems regarding important properties response, stability, linearity etc They can assess the signal properties in time and frequency domain.  The students are able to acquire relevant informati sources. They can control their level of knowledge solving tutorial problems, software tools, clicker system Independent Study Time 110, Study Time in Lecture 16  None  Written exam  90 min  General Engineering Science (German program, 7 compulsory Computer Science: Core qualification: Compulsory Data Science: Core qualification: Compulsory Electrical Engineering: Core qualification: Compulsory General Engineering Science (English program, 7 sem Engineering: Compulsory General Engineering Science (English program, 7 sem Engineering: Compulsory General Engineering Science (English program, 7 sem Engineering: Compulsory General Engineering Science (English program, 7 sem Engineering: Compulsory General Engineering Science (English program, 7 sem Engineering: Compulsory General Engineering Science (English program, 7 sem Engineering: Compulsory	Description of the program of the pr	Department of the program of the pro

		Engineering er Science: Cor		(English	program,	7	semester):	Specialisation
	General	Engineering	Science					Specialisation
		cal Engineerin						
Assignment for	General	Engineering	Science	(English	program,	7	semester):	Specialisation
the Following	Mechanic	cal Engineerin	g, Focus E	nergy Sys	tems: Com <sub>l</sub>	puls	sory	
Curricula	General	Engineering	Science	(English	program,	7	semester):	Specialisation
	Mechanic	cal Engineering	g, Focus A	ircraft Sys	tems Engin	neer	ing: Compuls	sory
	General	Engineering	Science	(English	program,	7	semester):	Specialisation
		cal Engineerin						
	General	Engineering	Science	(English	program,	7	semester):	Specialisation
	Mechanic	cal Engineerin	g, Focus M	1echatroni	cs: Compul	sor	/	
	General	Engineering	Science	(English	program,	7	semester):	Specialisation
	Mechanic	cal Engineerin	g, Focus T	heoretical	Mechanica	l Er	gineering: C	ompulsory
	General	Engineering S	cience (Er	nglish prod	aram, 7 ser	nes	ter): Speciali	sation Process
		ing: Compulso		J	,		, ,	
	_		•	(Enalish	program.	7	semester):	Specialisation
		al Engineering			, ,		,	
		tional Science			ore qualific	atio	n: Compulso	rv
		onics: Core qua						´
		nathematics: S		•	-	ien	ce: Elective (	Compulsory
		identernation 5	peciansac	Ling	eering 50			on parsory

Course L0432: Sign	nals and Systems
Тур	Lecture
Hrs/wk	3
СР	4
Workload in Hours	Independent Study Time 78, Study Time in Lecture 42
Lecturer	Prof. Gerhard Bauch
Language	DE/EN
Cycle	SoSe
	Introduction to signal and system theory  Signals  Classification of signals  Continuous-time and discrete-time signals  Analog and digital signals  Deterministic and random signals  Description of LTI systems by differential equations or difference equations, respectively  Basic properties of signals and operations on signals  Elementary signals  Distributions (Generalized Functions)  Power and energy of signals  Correlation functions of deterministic signals  Autocorrelation function  Crosscorrelation function  Crosscorrelation function  Crosscorrelation of correlation  Linear time-invariant (LTI) systems  Linearity  Time-invariance  Description of LTI systems by impulse response and frequency response  Convolution  Convolution  Convolution and correlation
	<ul> <li>Causal systems</li> <li>Stable systems</li> <li>Memoryless systems</li> <li>Fourier Series and Fourier Transform</li> <li>Fourier transform of continuous-time signals, discrete-time signals</li> </ul>

periodic signals, non-periodic signals • Properties of the Fourier transform • Fourier transform of some basic signals Parseval's theorem Analysis of LTI-systems and signals in the frequency domain Frequency response, magnitude response and phase response Transmission factor, attenuation, gain Frequency-flat and frequency-selective LTI-systems Bandwidth definitions o Basic types of systems (filters), lowpass, highpass, bandpass, bandstop systems Phase delay and group delay Linear-phase systems Distortion-free systems Content • Spectrum analysis with limited observation window: Leakage effect Laplace Transform Relation of Fourier transform and Laplace transform Properties of the Laplace transform Laplace transform of some basic signals Analysis of LTI-systems in the s-domain Transfer function of LTI-systems • Relation of Laplace transform, magnitude response and phase response Analysis of LTI-systems using pole-zero plots Allpass filters Minimum-phase, maximum-phase and mixed phase filters Stable systems Sampling Sampling theorem · Reconstruction of continuous-time signals in frequency domain and time domain Oversampling Aliasing Sampling with pulses of finite duration, sample and hold Decimation and interpolation Discrete-Time Fourier Transform (DTFT) Relation of Fourier transform and DTFT Properties of the DTFT Discrete Fourier Transform (DFT) Relation of DTFT and DFT Cyclic properties of the DFT DFT matrix Zero padding Cyclic convolution Fast Fourier Transform (FFT) o Application of the DFT: Orthogonal Frequency Division Multiplex (OFDM) Z-Transform • Relation of Laplace transform, DTFT, and z-transform Properties of the z-transform Z-transform of some basic discrete-time signals Discrete-time systems, digital filters FIR and IIR filters Z-transform of digital filters • Analysis of discrete-time systems using pole-zero plots in the z-domain Stability Allpass filters • Minimum-phase, maximum-phase and mixed-phase filters Linear phase filters T. Frey , M. Bossert , Signal- und Systemtheorie, B.G. Teubner Verlag 2004 K. Kammeyer, K. Kroschel, Digitale Signalverarbeitung, Teubner Verlag.

## Literature

- B. Girod ,R. Rabensteiner , A. Stenger , Einführung in die Systemtheorie, B.G. Teubner, Stuttgart, 1997
- J.R. Ohm, H.D. Lüke , Signalübertragung, Springer-Verlag 8. Auflage, 2002
- S. Haykin, B. van Veen: Signals and systems. Wiley.
- Oppenheim, A.S. Willsky: Signals and Systems. Pearson.
- Oppenheim, R. W. Schafer: Discrete-time signal processing. Pearson.

Course L0433: Signals and Systems		
Тур	Recitation Section (small)	
Hrs/wk	2	
СР	2	
<b>Workload in Hours</b>	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 M1320	0: Simulation and Desig	gn of Mechatroni	ic Systems	5
Courses				
Title	of Mechatronic Systems (L1822)	<b>Typ</b> Lecture	Hrs/wk	<b>CP</b> 2
Simulation and Design	of Mechatronic Systems (L1823)	Recitation Se (large)	ection 1	2
Simulation and Design	of Mechatronic Systems (L1824)	Practical Course	1	2
Module Responsible	Prof. Uwe Weltin			
Admission Requirements	None			
Recommended Previous Knowledge	Fundatmentals of mechanics, con	trol theory and electrica	l engineering	
Educational Objectives	After taking part successfully, stu	dents have reached the	following learn	ing results
Professional Competence <i>Knowledge</i>			ons for desigr	ı, modeling
Skills	Students are able to apply moder They can identify, simulate and laboratory conditions.			
Personal Competence				
Social Competence	Students are able to work goal-o to target groups.	riented in Small mixed (	groups and pre	esent results
Autonomy	Students are able to recognize an With instructor assistance, stude and define a further course of stu	nts are able to evaluate	•	-
Workload in Hours	Independent Study Time 124, Stu	ıdy Time in Lecture 56		
Credit points	6			
Course achievement	INIONA			
Examination	Written exam			
Examination duration and scale	90 min			
the Following	General Engineering Science Mechanical Engineering, Focus Mogeneral Engineering, Focus Ai Digital Mechanical Engineering, Focus Ai Digital Mechanical Engineering Science Mechanical Engineering, Focus Ai General Engineering, Focus Ai General Engineering, Focus Mogeneral Engineering, Focus Mogeneral Engineering, Focus Mechanical Engineering, Focus Compulsory Mechanical Engineering: Specialis Mechanical Engineering: Specialis Mechanical Engineering: Specialis	echatronics: Compulsory (German program, 7 rcraft Systems Engineer fore qualification: Compu (English program, 7 rcraft Systems Engineer (English program, 7 echatronics: Compulsory (English program, 7 a Theoretical Mechanic sation Aircraft Systems Estion Mechatronics: Cor	semester): Sing: Compulsor semester): Sing: Compulsor semester): Sing: Compulsor semester): Sing: Engineering: Compulsory	pecialisation y pecialisation y pecialisation pecialisation g: Elective

Compulsory Mechanical Engineering: Specialisation Theoretical Mechanical Engineering: Elective Compulsory Mechanical Compulsory
Mechatronics: Core qualification: Compulsory

Course L1822: Simulation and Design of Mechatronic Systems		
Тур	Lecture	
Hrs/wk	2	
СР	2	
<b>Workload in Hours</b>	Independent Study Time 32, Study Time in Lecture 28	
Lecturer	Prof. Uwe Weltin	
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: Sim	Course L1823: Simulation and Design of Mechatronic Systems		
Тур	Recitation Section (large)		
Hrs/wk	1		
СР	2		
<b>Workload in Hours</b>	Independent Study Time 46, Study Time in Lecture 14		
Lecturer	Prof. Uwe Weltin		
Language	DE		
Cycle	WiSe		
Content	See interlocking course		
Literature	See interlocking course		

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

Module M070 Transients	08: Electrical Engineering III: Circuit Theory and
Courses	
Title	Typ Hrs/wk CP
Circuit Theory (L0566)	
Circuit Theory (L0567)	Recitation Section 2 2 (small)
Module Responsible	Prof. Arne Jacob
Admission Requirements	
Recommended Previous Knowledge	
Educational Objectives	After taking part successfully, students have reached the following learning results
Professional Competence	
Knowledge	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	None
Examination	Written exam
Examination duration and scale	150 min
1	i <del></del> i

	General Engineering Science (German program, 7 semester): Specialisation
	Mechanical Engineering, Focus Mechatronics: Compulsory
	General Engineering Science (German program, 7 semester): Specialisation
	Electrical Engineering: Compulsory
	Electrical Engineering: Core qualification: Compulsory
	General Engineering Science (English program, 7 semester): Specialisation Electrical
	Engineering: Compulsory
the Following	General Engineering Science (English program, 7 semester): Specialisation
Curricula	Mechanical Engineering, Focus Mechatronics: Compulsory
	Computational Science and Engineering: Specialisation II. Mathematics &
	Engineering Science: Elective Compulsory
	Computational Science and Engineering: Specialisation Engineering Sciences:
	Elective Compulsory
	Mechatronics: Core qualification: Compulsory
	Technomathematics: Specialisation III. Engineering Science: Elective Compulsory

Course L0566: Circ	uit Theory
Тур	Lecture
Hrs/wk	3
СР	4
<b>Workload in Hours</b>	Independent Study Time 78, Study Time in Lecture 42
Lecturer	Prof. Arne Jacob
Language	DE
Cycle	WiSe
	- Circuit theorems
	- N-port circuits
	- Periodic excitation of linear circuits
Content	- Transient analysis in time domain
	- Transient analysis in frequency domain; Laplace Transform
	- Frequency behaviour of passive one-ports
	- 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)
Literature	- 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			
<b>Workload in Hours</b>	Independent Study Time 32, Study Time in Lecture 28			
Lecturer	Prof. Arne Jacob			
Language	DE			
Cycle	WiSe			
Content	see interlocking course			
	siehe korrespondierende Lehrveranstaltung			
Literature	see interlocking course			

Title Introduction to Control		<b>Typ</b> Lecture Recitation	Hrs/wk 2 Section 2	<b>CP</b> 4
Introduction to Control	i Systems (L0655)	(small)	2	2
Module Responsible	Prof. Herbert Werner			
Admission Requirements	LNODE			
Recommended Previous Knowledge		stems in time and	frequency doma	ain, Laplac
Educational Objectives	After taking part successfully, stud	lents have reached t	he following learn	ing results
Professional Competence				
Knowledge	<ul> <li>Students can represent dy domain, and can in particus systems</li> <li>They can explain the dyname properties in terms of frequerived from it.</li> <li>They can explain the Nyquerived from it.</li> <li>They can explain the role of control loops</li> <li>They can explain the way a frequency response</li> <li>They can explain issues arisedomain are implemented di</li> </ul>	ular explain propert nics of simple control ency response and r uist stability criterion of the phase marging PID controller affect sing when controllers	ies of first and soll loops and interpoot locus on and the stabin in analysis and a control loop in	econd orderet dynamility marginal synthesis terms of i
Skills	<ul> <li>Students can transform m frequency domain and vice</li> <li>They can simulate and asse</li> <li>They can design PID contratuning rules</li> <li>They can analyze and synt locus and frequency respon</li> <li>They can calculate discrete continuous-time and use it in the carrying out these tasks</li> </ul>	versa ss the behavior of sy ollers with the help hesize simple contro se techniques e-time approximatio for digital implement	ystems and controllers	ol loops gler-Nichol help of ro designed
Personal Competence	Students can work in small or	ouns to jointly sol	ve technical pro	nhlems ar
Social Competence	experimentally validate their control Students can obtain information documentation, experiment guides They can assess their knowledge	roller designs from provided sou	rces (lecture note	es, softwa

<b>Workload in Hours</b>	Independent Study Time 124, Study Time in Lecture 56
Credit points	6
Course achievement	INDDA
Examination	Written exam
Examination duration and scale	120 min
the Following	General Engineering Science (German program, 7 semester): Core qualification: Compulsory Bioprocess Engineering: Core qualification: Compulsory Computer Science: Specialisation Computational Mathematics: Elective Compulsory Data Science: Core qualification: Elective Compulsory Electrical Engineering: Core qualification: Compulsory Electrical Engineering: Core qualification: Compulsory Energy and Environmental Engineering: Core qualification: Compulsory General Engineering Science (English program, 7 semester): Specialisation Electrical Engineering: Compulsory General Engineering Science (English program, 7 semester): Specialisation Civil Engineering: Compulsory General Engineering Science (English program, 7 semester): Specialisation Bioprocess Engineering: Compulsory General Engineering Science (English program, 7 semester): Specialisation Energy and Environmental Engineering: Compulsory General Engineering Science (English program, 7 semester): Specialisation Computer Science: Compulsory General Engineering Science (English program, 7 semester): Specialisation Mechanical Engineering, Focus Biomechanics: Compulsory General Engineering Science (English program, 7 semester): Specialisation Mechanical Engineering, Focus Energy Systems: Compulsory General Engineering Science (English program, 7 semester): Specialisation Mechanical Engineering, Focus Materials in Engineering: Compulsory General 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 Mechanicals in Engineering Sciences: Compulsory General Engineering Science (English program, 7 semester): Specialisation Mechanical Engineering, Focus Mechanical Engineering: Compulsory General Engineering Science (English program, 7 semester): Specialisation Mechanical Engineering, Focus Theoretical Mechanical Engineering: Compul

Course L0654: Intr	oduction to 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 Bade 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	
<b>Workload in Hours</b>	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 M0730	D: Computer Engine	eering				
Courses						
<b>Title</b> Computer Engineering Computer Engineering			Typ Lecture Recitation (small)	Section	Hrs/wk 3	<b>CP</b> 4
Module Responsible	Prof. Heiko Falk		(Siliali)			
Admission Requirements						
Recommended Previous Knowledge	Basic knowledge in electric	al engineering	l			
Educational Objectives	After taking part successfu	lly, students h	ave reached	the follo	wing learn	ing results
Professional Competence						
Knowledge	<ul> <li>Computer arithmet division</li> <li>Basics of computer architecture, pipelini</li> <li>Memories: Memory h</li> <li>Input/output: I/O from point-to-point conne</li> </ul> The students perceive combidentify the internal struct	assembly-levers:  : Gates, Boole onal networks of-flops, automorations ic: Integer a architecture: ing interarchies, SR in the perspections, busses uputer systems ure and the perspections of the perspections.	ean algebra, ata, systema addition, su Programmi AM, DRAM, cative of the Control of the Control of the Am, bysical com	Boolear tic hardw btraction mg mode caches CPU, prince chitect's position of	function rare design, multipleds, MIPS ciples of perspection of comput	The module s, hardware n ication and single-cycle assing data, we, i.e., they ter systems.
Skills	The students can analyze, based on a collection of fe between and to explain systems - from gates and continuous completic interdependencies between on it. In particular, they sl software has on the halanguage down to gates. These low abstraction lever propose feasible options.	ew and simple the different ircuits up to come of the moon a physical conall understant dware-centrichis way, they ware.	components abstraction omplete proc dule, the sto omputer syst d the conse abstraction will be enabl	s. They a layers of cessors. Sudents a rem and to ever ever ever ever ever ever ever eve	re able to be to b	o distinguish computing o judge the are executed execution of e assembly impact that
Personal Competence		similar proble	ms alone or	in a gro	up and to	present the
Autonomy	Students are able to acc associate this knowledge w			om speci	fic literat	ure and to
Workload in Hours Credit points	Independent Study Time 12	24, Study Time	e in Lecture 5	56		

Examination   Written exam
Examination duration and scale  General Engineering Science (German program, 7 semester): Specialisa Computer Science: Compulsory General Engineering Science (German program, 7 semester): Specialisa Bioprocess Engineering: Compulsory General Engineering Science (German program, 7 semester): Specialisa Bioprocess Engineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation N Architecture: Compulsory General Engineering Science (German program, 7 semester): Specialisa Electrical Engineering Science (German program, 7 semester): Specialisa Biomedical Engineering: Compulsory General Engineering Science (German program, 7 semester): Specialisa Biomedical Engineering: Compulsory General Engineering Science (German program, 7 semester): Specialisa and Environmental Engineerings Compulsory General Engineering Science (German program, 7 semester): Specialisa Mechanical Engineering, Focus Micraft Systems Engineering: Compulsory General Engineering, Focus Aircraft Systems Engineering: Compulsory General Engineering, Focus Materials in Engineering Sciences: Compulsory General Engineering, Focus Product Development and Production: Compulsory General Engineering, Science (German program, 7 semester): Specialisa Mechanical Engineering, Focus Energy Systems: Compulsory General Engineering Science (German program, 7 semester): Specialisa Mechanical Engineering, Focus Energy Systems: Compulsory General Engineering Science (German program, 7 semester): Specialisa Mechanical Engineering Science (German program, 7 semester): Specialisa Mechanical Engineering Science (Ge
duration and scale  General Engineering Science (German program, 7 semester): Specialisat Computer Science: Compulsory General Engineering Science (German program, 7 semester): Specialisation Specialisa Speci
Computer Science: Compulsory General Engineering Science (German program, 7 semester): Specialisa Bioprocess Engineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation N Architecture: Compulsory General Engineering Science (German program, 7 semester): Specialisa Electrical Engineering Science (German program, 7 semester): Specialisa Biomedical Engineering: Compulsory General Engineering Science (German program, 7 semester): Specialisa Biomedical Engineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Endinand Environmental Engineering: Compulsory General Engineering Science (German program, 7 semester): Specialisa Mechanical Engineering Science (German program, 7 semester): Specialisa Mechanical Engineering, Focus Mechatronics: Compulsory General Engineering, Focus Biomechanics: Compulsory General Engineering, Focus Biomechanics: Compulsory General Engineering, Focus Biomechanics: Compulsory General Engineering, Focus Alterials in Engineering: Compulsory General Engineering, Focus Materials in Engineering Sciences: Compulsory General Engineering, Focus Materials in Engineering Sciences: Compulsory General Engineering, Focus Theoretical Mechanical Engineering: Compulsory General Engineering, Focus Product Development and Production: Compulsory General Engineering, Focus Product Development and Production: Compulsory General Engineering, Focus Energy Systems: Compulsory General Engineering, Science (German program, 7 semester): Specialisa Mechanical Engineering, Focus Energy Systems: Compulsory General Engineering Science (German program, 7 semester): Specialisa Mechanical Engineering, Focus Energy Systems: Compulsory General Engineering Science (German program, 7 semester): Specialisa Mechanical Engineering Science (German program, 7 semester): Specialisa Mechanical Engineer
Engineering: Compulsory General Engineering Science (English program, 7 semester): Specialisation Engineering: Compulsory General Engineering Science (English program, 7 semester): Specialisa Bioprocess Engineering: Compulsory General Engineering Science (English program, 7 semester): Specialisa Bioprocess Engineering: Compulsory General Engineering Science (English program, 7 semester): Specialisa Computer Science: Compulsory General Engineering Science (English program, 7 semester): Specialisa Mechanical Engineering, Focus Biomechanics: Compulsory General Engineering, Focus Biomechanics: Compulsory General Engineering, Focus Energy Systems: Compulsory General Engineering, Focus Energy Systems: Compulsory General Engineering, Focus Aircraft Systems Engineering: Compulsory General Engineering, Focus Materials in Engineering Sciences: Compulsory General Engineering, Focus Materials in Engineering Sciences: Compulsory General Engineering, Focus Mechatronics: Compulsory

General Engineering Science (English program, 7 semester): Specialisation Mechanical Engineering, Focus Theoretical Mechanical Engineering: Compulsory General Engineering Science (English program, 7 semester): Specialisation Naval Architecture: Compulsory
General Engineering Science (English program, 7 semester): Specialisation Process Engineering: Compulsory
General Engineering Science (English program, 7 semester): Specialisation Biomedical Engineering: Compulsory
Computational Science and Engineering: Core qualification: Compulsory
Mechatronics: Core qualification: Compulsory
Technomathematics: Specialisation II. Informatics: Elective Compulsory

Course L0321: Com	puter Engineering
Тур	Lecture
Hrs/wk	3
СР	4
<b>Workload in Hours</b>	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	
<b>Workload in Hours</b>	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	

	9: Foundations of Manage			
Courses				
Title		Тур	Hrs/wk	СР
Management Tutorial (	(L0882)	Recitation (small)	Section 2	3
Introduction to Manage		Lecture	3	3
Module Responsible	Prof. Christoph Ihl			
Admission Requirements	INODE			
Knowledge	Basic Knowledge of Mathematics and	Business		
Educational Objectives		ts have reached t	the following learn	ing results
Professional Competence				
Knowledge	<ul> <li>describe and explain basic by and sourcing, supply chain may management, information or marketing</li> <li>explain the relevance of plant situations under multiple object methods from mathematical First state basics from accounting a</li> </ul>	from Planning a ent and Controlling and to name important process of and goal entreprneurial process functions anagement, organ anagement, in the process and uncertained and costing and second costing an	nd Organisation to ng. In particular the and Management a tant definitions from als in Managemen ojects as production, particular nization and humal novation managen of making in Businal ainty, and explain	ney are able and the sub- om the field at and name an ressource ement and ness, esp. in a some basic methods.
Skills	Students are able to analyse busi (organization, objectives, strategies project in a team. In particular, they are analyse Management goals an analyse organisational and sta apply methods for decision uncertainty and under risk analyse production and procesystems analyse and apply basic method select and apply basic method problems apply basic method problems	etc.) and to cause able to  d structure them ff structures of commaking under curement system and of marketing ods from mather	appropriately ompanies multiple object and Business	epreneurship ives, unde information predefined
Personal Competence	Students are able to	ahuda sh-		
	<ul> <li>work successfully in a team of</li> <li>to apply their knowledge from</li> </ul>		entrepreneurship	project and
	. [53/1]			

Mechatronics: Core qualification: Compulsory

Orientierungsstudium: Core qualification: Elective Compulsory

Naval Architecture: Core qualification: Compulsory Technomathematics: Core qualification: Compulsory Process Engineering: Core qualification: Compulsory

Course L0882: Management Tutorial			
Тур	Recitation Section (small)		
Hrs/wk	2		
СР	3		
<b>Workload in Hours</b>	Independent Study Time 62, Study Time in Lecture 28		
Lecturer	Prof. Christoph Ihl, Katharina Roedelius, Tobias Vlcek		
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 self-selected projects that focus on the elaboration of an innovative business idea from the point of view of an established company or a startup. Again, the business knowledge from the lecture should come to practical use. The group projects are guided by a mentor.		
Literature	Relevante Literatur aus der korrespondierenden Vorlesung.		

Course L0880: Introduction to Management			
Тур	Lecture		
Hrs/wk	3		
СР	3		
<b>Workload in Hours</b>	Independent Study Time 48, Study Time in Lecture 42		
Lecturer	Prof. Christoph Ihl, Prof. Thorsten Blecker, Prof. Christian Lüthje, Prof. Christian Ringle, Prof. Kathrin Fischer, Prof. Cornelius Herstatt, Prof. Wolfgang Kersten, Prof. Matthias Meyer, Prof. Thomas Wrona		
Language	DE		
Cycle	WiSe/SoSe		
Content	<ul> <li>Introduction to Business and Management, Business versus Economics, relevant areas in Business and Management</li> <li>Important definitions from Management,</li> <li>Developing Objectives for Business, and their relation to important Business functions</li> <li>Business Functions: Functions of the Value Chain, e.g. Production and Procurement, Supply Chain Management, Innovation Management, Marketing and Sales 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. Au 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 Rechnungslegur 7. Aufl., Stuttgart 2008.  Schweitzer, M.: Planung und Steuerung, in: Bea/Friedl/Schweitzer: Allgemei 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. Auflag Stuttgart 2006.		

Module M0777: Semiconductor Circuit Design				
Courses				
<b>Title</b> Semiconductor Circuit Semiconductor Circuit	Fircuit Design (L0864)		Hrs/wk 3 Section 1	<b>CP</b> 4
		(small)		
Module Responsible	Prof. Matthias Kuhl			
Admission Requirements	None			
Recommended Previous Knowledge	Fundamentals of electrical engineering  Basics of physics, especially semiconductor physics			
Educational Objectives	After taking part successfully, students have reached the following learning results			
Professional Competence				
Knowledge	<ul> <li>Students are able to explain the functionality of different MOS devices in electronic circuits.</li> <li>Students are able to explain how analog circuits functions and where they are applied.</li> <li>Students are able to explain the functionality of fundamental operational amplifiers and their specifications.</li> <li>Students know the fundamental digital logic circuits and can discuss their advantages and disadvantages.</li> <li>Students have knowledge about memory circuits and can explain their functionality and specifications.</li> <li>Students know the appropriate fields for the use of bipolar transistors.</li> </ul>			
Skills	<ul> <li>Students can calculate the specifications of different MOS devices and can define the parameters of electronic circuits.</li> <li>Students are able to develop different logic circuits and can design different types of logic circuits.</li> <li>Students can use MOS devices, operational amplifiers and bipolar transistor for specific applications.</li> </ul>		sign different	
Personal Competence				
Social Competence	<ul> <li>Students are able work effic</li> <li>Students working together professional questions.</li> </ul>			and answer
Autonomy	Students are able to assess	their level of knowle	edge.	
Workload in Hours	Independent Study Time 124, Stud	y Time in Lecture 5	6	
Credit points				
Course	None			

achievement				
Examination	Written exam			
Examination duration and scale	120 min			
	General Engineering Science (German program, 7 semester): Specialisation Electrical Engineering: Compulsory			
	General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Mechatronics: Compulsory  Data Science: Core qualification: Elective Compulsory			
	Electrical Engineering: Core qualification: Compulsory Engineering Science: Specialisation Electrical Engineering: Compulsory Engineering Science: Specialisation Mechatronics: Compulsory			
	General Engineering Science (English program, 7 semester): Specialisation Electrical			
	Engineering: Compulsory General Engineering Science (English program, 7 semester): Specialisation			
Curricula	Mechanical Engineering, Focus Mechatronics: Compulsory			
	General Engineering Science (English program, 7 semester): Specialisation Mechatronics: Compulsory			
	Computational Science and Engineering: Specialisation II. Mathematics &			
	Engineering Science: Elective Compulsory Mechanical Engineering: Specialisation Mechatronics: Compulsory			
	Mechatronics: Core qualification: Compulsory			
	Technomathematics: Specialisation III. Engineering Science: Elective Compulsory			

Course L0763: Semiconductor Circuit Design				
Тур	Lecture			
Hrs/wk	3			
СР	4			
<b>Workload in Hours</b>	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 Verla 14. Auflage, 2012, ISBN 3540428496  R. J. Baker, CMOS - Circuit Design, Layout and Simulation, J. Wiley & Sons Inc., Auflage, 2011, ISBN: 047170055S  H. Göbel, Einführung in die Halbleiter-Schaltungstechnik, Berlin, Heidelbe Springer-Verlag Berlin Heidelberg, 2011, ISBN: 9783642208874 ISB 9783642208867			

Course L0864: Sem	iconductor Circuit Design
Тур	Recitation Section (small)
Hrs/wk	1
СР	2
	Independent Study Time 46, Study Time in Lecture 14
	Prof. Matthias Kuhl, Weitere Mitarbeiter
Language	
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>
	<ul> <li>U. Tietze und Ch. Schenk, E. Gamm, Halbleiterschaltungstechnik, Springer Verlag, 14. Auflage, 2012, ISBN 3540428496</li> <li>R. J. Baker, CMOS - Circuit Design, Layout and Simulation, J. Wiley &amp; Sons Inc., 3. Auflage, 2011, ISBN: 047170055S</li> <li>H. Göbel, Einführung in die Halbleiter-Schaltungstechnik, Berlin, Heidelberg Springer-Verlag Berlin Heidelberg, 2011, ISBN: 9783642208874 ISBN: 9783642208867</li> <li>URL: http://site.ebrary.com/lib/alltitles/docDetail.action?docID=10499499</li> <li>URL: http://dx.doi.org/10.1007/978-3-642-20887-4</li> <li>URL: http://ebooks.ciando.com/book/index.cfm/bok_id/319955</li> <li>URL: http://www.ciando.com/img/bo</li> </ul>

Module M0854	1: Mathematics IV			
Courses				
Title	2 (Partial Differential Equations) (L1043)	<b>Typ</b> Lecture	Hrs/wk	<b>CP</b>
•	2 (Partial Differential Equations) (L1044)	Recitation (small)	Section 1	1
Differential Equations	2 (Partial Differential Equations) (L1045)	Recitation (large)	Section 1	1
Complex Functions (L1	.038)	Lecture	2	1
Complex Functions (L1	.041)	Recitation (small)	Section 1	1
Complex Functions (L1	.042)	Recitation (large)	Section 1	1
Module Responsible	Prof. Anusch Taraz			
Admission Requirements	None			
Recommended	Mathematics 1 - III			
Educational Objectives	After taking part successfully, students	s have reached	the following learr	ning results
Professional Competence				
Knowledge	<ul> <li>Students can name the basic of explain them using appropriate</li> <li>Students can discuss logical concapable of illustrating these con</li> <li>They know proof strategies and</li> </ul>	examples. nnections betw nections with t	een these concept he help of example	ts. They ar
Skills	<ul> <li>Students can model problems in studied in this course. Moreo applying established methods.</li> <li>Students are able to discover a the concepts studied in the cour</li> <li>For a given problem, the student approach, and are able to critical</li> </ul>	ver, they are nd verify furtherse. dents can dev	capable of solving capable capable of solving capable	ons betwee
Personal Competence				
Social Competence	<ul> <li>Students are able to work to mathematics as a common lang</li> <li>In doing so, they can communic their cooperating partners. Mo and deepen the understanding of</li> </ul>	uage. cate new conce reover, they c	epts according to	the needs o
Autonomy	<ul> <li>Students are capable of checking on their own. They can specify get help in solving them.</li> <li>Students have developed sufficients.</li> </ul>	open question	s precisely and kn	ow where to

	periods in a goal-oriented manner on hard problems.
Workload in Hours	Independent Study Time 68, Study Time in Lecture 112
Credit points	
Course achievement	None
Examination	Written exam
Examination duration and scale	60 min (Complex Functions) + 60 min (Differential Equations 2)
the Following	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 semester): Specialisation Naval Architecture: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Theoretical Mechanical Engineering: Elective Compulsory Computer Science: Specialisation Computational Mathematics: Elective Compulsory Computer Science: Specialisation II. Mathematics and Engineering Science: Elective Compulsory Computer Science: Specialisation Electrical Engineering: Compulsory Engineering Science: Specialisation Electrical Engineering: Compulsory General Engineering Science (English program, 7 semester): Specialisation Electrical Engineering: Compulsory General Engineering Science (English program, 7 semester): Specialisation Electrical Engineering: Compulsory General Engineering Science (English program, 7 semester): Specialisation Mechanical Engineering, Focus Mechatronics: Compulsory General Engineering Science (English program, 7 semester): Specialisation Mechanical Engineering, Focus Theoretical Mechanical Engineering: Compulsory General Engineering Science (English program, 7 semester): Specialisation Naval Architecture: Compulsory Computational Science and Engineering: Specialisation II. Mathematics & Engineering Science: Elective Compulsory Mechanical Engineering: Specialisation Mechatronics: Compulsory Mechanical Engineering: Specialisation Theoretical Mechanical Engineering: Elective Compulsory Mechanical Engineering: Specialisation Theoretical Mechanical Engineering: Elective Compulsory Mechanical Engineering: Specialisation: Compulsory Mechanical Engineering: Specialisation: Compulsory Mechanical Engineering: Core qualification: Compulsory Mechanical Engineering: Elective Compulsory

Course L1043: Differential Equations 2 (Partial Differential Equations)		
Тур	Lecture	
Hrs/wk	2	
СР	1	
<b>Workload in Hours</b>	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  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	
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	
<b>Workload in Hours</b>	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	
<b>Workload in Hours</b>	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	
<b>Workload in Hours</b>	Independent Study Time 2, Study Time in Lecture 28	
Lecturer	Dozenten des Fachbereiches Mathematik der UHH	
Language	DE	
Cycle	SoSe	
Content	<ul> <li>Main features of complex analysis</li> <li>Functions of one complex variable</li> <li>Complex differentiation</li> <li>Conformal mappings</li> <li>Complex integration</li> <li>Cauchy's integral theorem</li> <li>Cauchy's integral formula</li> <li>Taylor and Laurent series expansion</li> <li>Singularities and residuals</li> <li>Integral transformations: Fourier and Laplace transformation</li> </ul>	
Literature	http://www.math.uni-hamburg.de/teaching/export/tuhh/index.html	

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

## **Focus Product Development and Production**

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

Courses				
Γitle		Тур	Hrs/wk	СР
Production Engineering	I (L0608)	Lecture	2 Saction	2
Production Engineering	I (L0612)	Recitation (large)	Section 1	1
Production Engineering	II (L0610)	Lecture	2 Sastian	2
Production Engineering	II (L0611)	Recitation (large)	Section 1	1
Module Responsible	Prof. Wolfgang Hintze			
Admission Requirements	None			
	no course assessments required			
Previous Knowledge	internship recommended			
Educational Objectives	After taking part successfully, st	tudents have reached	the following learn	ning results
Professional Competence				
Knowledge	<ul> <li>name basic criteria for th</li> <li>name the main groups of</li> <li>name the application are</li> <li>name boundaries, advanuaries, advanufacturing process.</li> <li>describe elements, georequirements for tools, w</li> <li>explain the essential mod</li> </ul>	Manufacturing Techn as of different manufa vantages and disa ometric properties a orkpiece and process.	ology. acturing processes. dvantages of th and kinematic va	ie differe
Skills Personal	<ul> <li>select manufacturing pro</li> <li>design manufacturing pro</li> <li>tolerances of the compor</li> <li>assess components in ter</li> </ul>	processes for simple nent to be produced.	tasks to meet t	he require
Competence	Students are able to			

Social Competence	<ul> <li>develop solutions in a production environment with qualified personnel at technical level and represent decisions.</li> </ul>
Autonomy	<ul> <li>Students are able to</li> <li>interpret independently the manufacturing process.</li> <li>assess own strengths and weaknesses in general.</li> <li>assess their learning progress and define gaps to be improved.</li> <li>assess possible consequences of their actions.</li> </ul>
<b>Workload in Hours</b>	Independent Study Time 96, Study Time in Lecture 84
Credit points	
Course achievement	None
Examination	Written exam
Examination duration and scale	120 min
the Following	General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Product Development and Production: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Theoretical Mechanical Engineering: Elective Compulsory Digital Mechanical Engineering: Core qualification: Compulsory 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, Focus Product Development and Production: Compulsory General Engineering Science (English program, 7 semester): Specialisation Mechanical Engineering, Focus Theoretical Mechanical Engineering: Elective Compulsory Logistics and Mobility: Specialisation Engineering Science: Elective Compulsory Mechanical Engineering: Core qualification: Compulsory Mechatronics: Core qualification: Compulsory

Course L0608: Production Engineering I		
<b>Typ</b> Lecture		
Hrs/wk	2	
СР	2	
<b>Workload in Hours</b>	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: Prod	Course L0612: Production Engineering I		
Тур	Recitation Section (large)		
Hrs/wk	1		
СР	1		
<b>Workload in Hours</b>	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: Prod	duction Engineering II
Тур	Lecture
Hrs/wk	2
СР	2
<b>Workload in Hours</b>	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Prof. Wolfgang Hintze, Prof. Claus Emmelmann
Language	DE
Cycle	SoSe
Content	<ul> <li>Geometrically undefined machining (grinding, lapping, honing)</li> <li>Introduction into erosion technology</li> <li>Introduction into blastig processes</li> <li>Introduction to the manufacturing process forming (Casting, Powder Metallurgy, Composites)</li> <li>Fundamentals of Laser Technology</li> <li>Process versions and Fundamentals of Laser Joining Technology</li> </ul>
Literature	Klocke, F., König, W.: Fertigungsverfahren Bd. 2 Schleifen, Honen, Läppen, 4. Aufl., Springer (2005)  Klocke, F., König, W.: Fertigungsverfahren Bd. 3 Abtragen, Generieren und Lasermaterialbearbeitung. 4. Aufl., Springer (2007)  Spur, Günter (Stöferle, Theodor.;): Urformen. München [u.a.]: Hanser, 1981  Schatt, Werner (Wieters, Klaus-Peter,; Kieback, Bernd,;): Pulvermetallurgie: Technologien und Werkstoffe. Berlin [u.a.]: Springer, 2007

Course L0611: Prod	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		

	7: Advanced Mechanical	Linginieering	Design				
Courses							
<b>Title</b> Advanced Mechanical	Engineering Design II (L0264)	<b>Typ</b> Lecture	Hrs/wk	<b>CP</b> 2			
Advanced Mechanical	Engineering Design II (L0265)	Recitation (large)	Section 2	1			
Advanced Mechanical	Engineering Design I (L0262)	Lecture	2	2			
Advanced Mechanical	Engineering Design I (L0263)	Recitation (large)	Section 2	1			
Module Responsible	Prof. Dieter Krause						
Admission Requirements	None						
Recommended Previous Knowledge	<ul> <li>Fundamentals of Mechanical Engineering Design</li> <li>Mechanics</li> <li>Fundamentals of Materials Science</li> <li>Production Engineering</li> </ul>						
Educational Objectives	After taking part successfully, stud	ents have reached	the following learr	ning results			
Professional							
Competence	After passing the module, students						
Knowledge	<ul> <li>explain complex working principles and functions of machine elements and of basic elements of fluidics,</li> <li>explain requirements, selection criteria, application scenarios and practical examples of complex machine elements,</li> <li>indicate the background of dimensioning calculations.</li> </ul>						
Skills	<ul> <li>After passing the module, students are able to:</li> <li>accomplish dimensioning calculations of covered machine elements,</li> <li>transfer knowledge learned in the module to new requirements and tasks (problem solving skills),</li> <li>recognize the content of technical drawings and schematic sketches,</li> <li>evaluate complex designs, technically.</li> </ul>						
Personal Competence							
Social Competence	<ul> <li>Students are able to discuss technical information in the lecture supported by activating methods.</li> </ul>						
Autonomy	<ul> <li>Students are able to independently deepen their acquired knowledge in exercises.</li> <li>Students are able to acquire additional knowledge and to recapitulate poorly understood content e.g. by using the video recordings of the lectures.</li> </ul>						
	Independent Study Time 68, Study	Time in Lecture 11	12				
Credit points	6						
Course achievement	None						
Examination	Written exam						
Examination duration and							

scale	
	General Engineering Science (German program, 7 semester): Specialisation
	Mechanical 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 Energy Systems: Compulsory
	General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Aircraft Systems Engineering: Compulsory
	General Engineering Science (German program, 7 semester): Specialisation
	Mechanical Engineering, Focus Materials in Engineering Sciences: Compulsory
	General Engineering Science (German program, 7 semester): Specialisation
	Mechanical Engineering, Focus Mechatronics: Compulsory
	General Engineering Science (German program, 7 semester): Specialisation
	Mechanical Engineering, Focus Product Development and Production: Compulsory
	General Engineering Science (German program, 7 semester): Specialisation
	Mechanical Engineering, Focus Theoretical Mechanical Engineering: Compulsory
	Energy Systems: Technical Complementary Course Core Studies: Elective
Assignment for	
	Engineering Science: Specialisation Mechanical Engineering: Compulsory
Curricuia	General Engineering Science (English program, 7 semester): Specialisation Mechanical Engineering: Compulsory
	General Engineering Science (English program, 7 semester): Specialisation
	Mechanical Engineering, Focus Biomechanics: Compulsory
	General Engineering Science (English program, 7 semester): Specialisation
	Mechanical Engineering, Focus Energy Systems: Compulsory
	General Engineering Science (English program, 7 semester): Specialisation
	Mechanical Engineering, Focus Aircraft Systems Engineering: Compulsory
	General Engineering Science (English program, 7 semester): Specialisation
	Mechanical Engineering, Focus Materials in Engineering Sciences: Compulsory
	General Engineering Science (English program, 7 semester): Specialisation
	Mechanical Engineering, Focus Mechatronics: Compulsory
	General Engineering Science (English program, 7 semester): Specialisation Mechanical Engineering, Focus Product Development and Production: Compulsory
	General Engineering Science (English program, 7 semester): Specialisation
	Mechanical Engineering, Focus Theoretical Mechanical Engineering: Compulsory
	Mechanical Engineering: Core qualification: Compulsory
	Naval Architecture: Core qualification: Compulsory
[	,

anced Mechanical Engineering Design II
Lecture
2
2
Independent Study Time 32, Study Time in Lecture 28
Prof. Dieter Krause, Prof. Otto von Estorff
DE
SoSe
Advanced Mechanical Engineering Design I & II  Lecture  • Fundamentals of the following machine elements:  • Linear rolling bearings  • Axes & shafts  • Seals  • Clutches & brakes  • Belt & chain drives  • Gear drives  • Epicyclic gears  • Crank drives  • Sliding bearings  • Elements of fluidics  Exercise  • Calculation methods of the following machine elements:  • Linear rolling bearings  • Axes & shafts  • Clutches & brakes  • Belt & chain drives  • Gear drives  • Gear drives  • Epicyclic gears  • Crank gears  • Cliding bearings
<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>

Course L0265: Adv	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 L0263: Advanced Mechanical Engineering Design I		
Тур	Recitation Section (large)	
Hrs/wk	2	
СР	1	
<b>Workload in Hours</b>	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	

Courses							
Title					ур	Hrs/wk	СР
Advanced Mechanical	Design	Project (L0266)			roject-/problem- ased Learning	4	6
Module Responsible	Dr. Je	ns Schmidt					
Admission Requirements	None						
Recommended Previous Knowledge	•	Mechanical Er Advanced Me			esign		
Educational Objectives	After	taking part suc	ccessfully, st	udents hav	e reached the foll	owing learn	ing results
Professional Competence							
	After	passing the mo	odule, stude	nts are able	e to:		
Knowledge	<ul> <li>express the procedure for systematically handling of</li> <li>complex design tasks ,</li> <li>describe working principles, their use and combination possibilities,</li> <li>explain guidelines for designing for function and manufacturing,</li> <li>explain advanced use-oriented knowledge of machine elements.</li> </ul>						
	After passing the module, students are able to:						
Skills	•	convert princi use methods solution-orien create a tech to understand	iple solution to design ar ited, nical docum I the functio	s into a det id solve end ientation in ns of the sy	gineering design t cluding all neces	asks systen	natically a
Personal							
Competence							
	After	passing the mo	odule, stude	nts are able	e to:		
Social Competence					chnical drawings roups of the cours		os,
	After	passing the mo	odule, stude	nts are able	e to:		
Autonomy			essary know	ledge and	n projects, while selecting appropr	_	
Workload in Hours	Indep	endent Study	 Гіте 124, St	udy Time i	n Lecture 56		
Credit points							
Course achievement	Compulsor <b>B</b> onus Form Description						
Examination	Writte	en exam					
Examination duration and scale							

## the Following

General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Product Development and Production: Compulsory General Engineering Science (German program, 7 semester): Specialisation Assignment for Mechanical Engineering, Focus Theoretical Mechanical Engineering: Elective Compulsory

Curricula General Engineering Science (English program, 7 semester): Specialisation Mechanical Engineering, Focus Aircraft Systems Engineering: 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 Mechanical Engineering: Core qualification: Compulsory

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

Courses						
Title		Тур	Hrs/wk	СР		
Introduction to Control	Systems (L0654)	Lecture	2 Continu	4		
ntroduction to Control	Systems (L0655)	Recitation (small)	Section 2	2		
Module Responsible	Prof. Herbert Werner					
Admission Requirements	None					
Recommended Previous Knowledge	Representation of signals and systems in time and frequency domain, Laplace transform					
Educational Objectives	LATTOR FAVING NART CHECOCCTIIIIV CTI	udents have reached t	he following learr	ning results		
Professional Competence						
Knowledge	<ul> <li>Students can represent dynamic system behavior in time and frequency domain, and can in particular explain properties of first and second order systems</li> <li>They can explain the dynamics of simple control loops and interpret dynamicy properties in terms of frequency response and root locus</li> <li>They can explain the Nyquist stability criterion and the stability marging derived from it.</li> <li>They can explain the role of the phase margin in analysis and synthesis of control loops</li> <li>They can explain the way a PID controller affects a control loop in terms of it frequency response</li> <li>They can explain issues arising when controllers designed in continuous time domain are implemented digitally</li> </ul>					
Skills	<ul> <li>Students can transform models of linear dynamic systems from time to frequency domain and vice versa</li> <li>They can simulate and assess the behavior of systems and control loops</li> <li>They can design PID controllers with the help of heuristic (Ziegler-Nichols tuning rules</li> <li>They can analyze and synthesize simple control loops with the help of roc locus and frequency response techniques</li> <li>They can calculate discrete-time approximations of controllers designed in continuous-time and use it for digital implementation</li> <li>They can use standard software tools (Matlab Control Toolbox, Simulink) for carrying out these tasks</li> </ul>					
Personal Competence Social Competence	Students can work in small g		ve technical pro	oblems, a		
Autonomy	Students can obtain informatio documentation, experiment guid  They can assess their knowledg	n from provided sour es) and use it when so	olving given probl	ems.		

<b>Workload in Hours</b>	Independent Study Time 124, Study Time in Lecture 56
Credit points	
Course achievement	None
Examination	Written exam
Examination duration and scale	
the Following	General Engineering Science (German program, 7 semester): Core qualification: Compulsory Bioprocess Engineering: Core qualification: Compulsory Computer Science: Specialisation Computational Mathematics: Elective Compulsory Data Science: Core qualification: Elective Compulsory Electrical Engineering: Core qualification: Compulsory Electrical Engineering: Core qualification: Compulsory Energy and Environmental Engineering: Core qualification: Compulsory General Engineering Science (English program, 7 semester): Specialisation Electrical Engineering: Compulsory General Engineering Science (English program, 7 semester): Specialisation Civil Engineering: Compulsory General Engineering Science (English program, 7 semester): Specialisation Bioprocess Engineering: Compulsory General Engineering: Compulsory General Engineering: Compulsory General Engineering Science (English program, 7 semester): Specialisation Energy and Environmental Engineering: Compulsory General Engineering Science (English program, 7 semester): Specialisation Computer Science: Compulsory General Engineering Science (English program, 7 semester): Specialisation Mechanical Engineering, Focus Biomechanics: Compulsory General Engineering, Science (English program, 7 semester): Specialisation Mechanical Engineering, Focus Energy Systems: Compulsory General Engineering Science (English program, 7 semester): Specialisation Mechanical Engineering, Focus Materials in 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 Mechanicals in Engineering Sciences: Compulsory General Engineering Science (English program, 7 semester): Specialisation Mechanical Engineering, Focus Mechanical Engineering: Compulsory General Engineering Science (English program, 7 semester): Specialisation Mechanical Engineering, Focus Product Development and Produc

Course L0654: Intr	oduction to 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	
<b>Workload in Hours</b>	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	

Courses				
<b>Title</b> Fundamentals of Mach	ine Tools (L0689)	<b>Typ</b> Lecture	Hrs/wk	<b>CP</b> 2
Fundamentals of Mach		Recitation	Section 1	1
Forming and Cutting To		(large) Lecture	2	2
Forming and Cutting To		Recitation (large)	Section 1	1
Module Responsible	Prof. Wolfgang Hintze			
Admission Requirements	None			
•	without major course assessment			
Recommended Previous	internship recommended			
Knowledge	Previous knowledge in mathematic	s, mechanics and e	lectrical engineeri	ng
Educational Objectives	After taking part successfully, stud	ents have reached	the following learn	ing results
Professional				
Competence	Students are able to			
Knowledge	<ul> <li>explain the basics of chill machining.</li> <li>explain methods and param machining processes and too</li> <li>explain technical concepts of trends in the machine tool in</li> <li>explain types, construction overview on multi-machine sexplain equipment componer</li> </ul>	neters for design a ols. of machine tool bui ndustry. s and functions of systems.	nd analysis of me	etal formin
	Students are able to			
Skills	<ul> <li>select tool geometry, cutting materials, process parameters and appropriate measuring technique in accordance with the requirements.</li> </ul>			
Personal Competence				
Competence	Students are able to			
Social Competence	<ul> <li>develop solutions in a prod</li> </ul>		nt with qualified p	ersonnel
	Students are able to			

	<ul> <li>assess their learning progress and define gaps to be improved.</li> <li>assess possible consequences of their actions.</li> </ul>		
Workload in Hours	Independent Study Time 96, Study Time in Lecture 84		
Credit points	6		
Course achievement	None		
Examination	Written exam		
Examination duration and scale	180 min		
Assignment for the Following Curricula	General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Product Development and Production: Compulsory General Engineering Science (English program, 7 semester): Specialisation Mechanical Engineering, Focus Product Development and Production: Compulsory Mechanical Engineering: Specialisation Product Development and Production: Compulsory Product Development, Materials and Production: Technical Complementary Course Core Studies: Elective Compulsory		

Course L0689: Fun	damentals of Machine Tools		
Тур	Lecture		
Hrs/wk	2		
СР	2		
	Independent Study Time 32, Study Time in Lecture 28		
	Prof. Thorsten Schüppstuhl		
Language			
Cycle			
	Terminology and trends in machine tool building		
	CNC controls		
	NC programming and NC programming systems		
Content	Types, construction and function of CNC machines		
	Multi-machinesystems		
	Equipmentcomponents for machine tools		
	Assessment of machine tools		
	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
Literature	Berlin [u.a.]: Springer, 2005
	Weck, Manfred; Brecher, Christian
	Werkzeugmaschinen 4 - Automatisierung von Maschinen und Anlagen
	ISBN: 3540225072
	Berlin [u.a.]: Springer, 2006
	Weck, Manfred; Brecher, Christian
	Werkzeugmaschinen 5 - Messtechnische Untersuchung und Beurteilung, dynamische Stabilität
	ISBN: 3540225056
	Berlin [u.a.]: Springer, 2006

Course L1992: Fundamentals of Machine Tools		
Тур	Recitation Section (large)	
Hrs/wk	1	
СР	1	
<b>Workload in Hours</b>	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: For	ming and Cutting Technology		
Тур	Lecture		
Hrs/wk	2		
СР	2		
<b>Workload in Hours</b>	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 Massivumformung, 4. Auflage, VDI-Verlag (1996)  König, W., Klocke, F.; Fertigungsverfahren Bd. 5 Blechbearbeitung, 3. Auflage, VDI-Verlag (1995)  Klocke, F., König, W.; Fertigungsverfahren Schleifen, Honen, Läppen, 4. Auflage, Springer Verlag (2005)  König, W., Klocke, F.: Fertigungsverfahren Drehen, Fräsen, Bohren, 7. Auflage, Springer Verlag (2002)		

Course L0614: Forming and Cutting Technology		
Тур	Recitation Section (large)	
Hrs/wk	1	
СР	1	
<b>Workload in Hours</b>	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 M0730	D: Computer Enginee	ering				
Courses						
<b>Title</b> Computer Engineering Computer Engineering			Typ Lecture Recitation (small)	Section	<b>Hrs/wk</b> 3	<b>CP</b> 4 2
Module Responsible	Prof. Heiko Falk	<u> </u>	(Siriall)			
Admission Requirements	None					
Recommended Previous Knowledge	Basic knowledge in electrical (	engineering				
Educational Objectives	After taking part successfully,	students ha	ve reached	the follo	wing learn	ing 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 functions, hardware synthesis, combinational networks • Sequential logic: Flip-flops, automata, systematic hardware design • Technological foundations • Computer arithmetic: Integer addition, subtraction, multiplication and division • Basics of computer architecture: Programming models, MIPS single-cycle architecture, pipelining • Memories: Memory hierarchies, SRAM, DRAM, caches • Input/output: I/O from the perspective of the CPU, principles of passing data, point-to-point connections, busses  The students perceive computer systems from the architect's perspective, i.e., they					
Skills	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 a 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 has on the hardware-centric abstraction layers from the assembly language down to gates. This way, they will be enabled to evaluate the impact that these low abstraction levels have on an entire system's performance and to propose feasible options.					
Personal Competence		milar probler	ns alone or	in a gro	up and to	present the
Autonomy	Students are able to acqui associate this knowledge with			m spec	ific literat	ure and to
Workload in Hours	Independent Study Time 124,	Study Time	in Lecture 5	56		
Credit points		-				

	Compulsor <b>B</b> onus	Form	Description
achievement	Yes 10 %	Excercises	
Examination \	Written exam		
Examination duration and scale	90 minutes, contents of	f course and labs	
Assignment for the Following Curricula	General Engineering Computer Science: Com General Engineering Bioprocess Engineering General Engineering General Engineering General Engineering Electrical Engineering General Engineering Mechanical Engineering Mechanical Engineering Mechanical Engineering Mechanical Engineering General Engineering Mechanical Engineering Mechanical Engineering Mechanical Engineering General Engineering Mechanical Engineering Mechanical Engineering General Engineering Mechanical Engineering Mechanical Engineering General Engineering Mechanical Engineering Mechanical Engineering General Engineering Mechanical Engineering	Science (German inpulsory Science (German property Science (English property Science (Engli	program, 7 semester): Specialisation Process program, 7 semester): Specialisation cs: Compulsory program, 7 semester): Specialisation ics: Compulsory program, 7 semester): Specialisation stems Engineering: Compulsory program, 7 semester): Specialisation Engineering Sciences: Compulsory program, 7 semester): Specialisation Mechanical Engineering: Compulsory program, 7 semester): Specialisation velopment and Production: Compulsory program, 7 semester): Specialisation tems: Compulsory program, 7 semester): Specialisation tems: Compulsory rogram, 7 semester): Specialisation Civ npulsory Compulsory Compulsory compulsory ram, 7 semester): Specialisation Electric rogram, 7 semester): Specialisation Civ program, 7 semester): Specialisation Energy program, 7 semester): Specialisation

General Engineering Science (English program, 7 semester): Specialisation Mechanical Engineering, Focus Theoretical Mechanical Engineering: Compulsory General Engineering Science (English program, 7 semester): Specialisation Naval Architecture: Compulsory
General Engineering Science (English program, 7 semester): Specialisation Process Engineering: Compulsory
General Engineering Science (English program, 7 semester): Specialisation Biomedical Engineering: Compulsory
Computational Science and Engineering: Core qualification: Compulsory
Mechatronics: Core qualification: Compulsory
Technomathematics: Specialisation II. Informatics: Elective Compulsory

Course L0321: Com	puter Engineering
Тур	Lecture
Hrs/wk	3
СР	4
<b>Workload in Hours</b>	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: Com	Course L0324: Computer Engineering		
Тур	Recitation Section (small)		
Hrs/wk	1		
СР	2		
<b>Workload in Hours</b>	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 M059 Design	9: Integrated	Product	Development	and LigI	ntweight
Courses					
<b>Title</b> CAE-Team Project (L02 Development of Lightw Integrated Product Dev	veight Design Products (I	L0270)	<b>Typ</b> Project-/problem- based Learning Lecture Lecture	Hrs/wk 2 2 2 2	<b>CP</b> 2 2 2 2
Module	Prof. Dieter Krause		Lecture	2	
Responsible Admission	1				
Requirements			win a donien.		
Recommended Previous Knowledge	Advanced Knowledge Fundamentals of Mecl Mechanical Engineerin	hanical Engine			
1	Advanced Mechanical	Engineering [	)esign		
Educational Objectives	LATTER TAKING NATT SHEET	essfully, stude	nts have reached the	following learr	ning results
Professional Competence	After completing the module, students are capable of:				
Knowledge	<ul> <li>explaining the functional principle of 3D-CAD-Systems, PDM- and FEM-Systems</li> <li>describing the interaction of the different CAE-Systems in the product development process</li> </ul>				
Skills	After completing the r		nts are able to: d PDM-Systems with	regards to	the desired
JAIIS	requirements s	uch as classifi mplary produ	cation schemes and pr ct using CAD-,PDM-	oduct structu	ring
Personal Competence	<u>.</u> 1				
Social Competence	<ul> <li>After completing the module, students are able to:</li> <li>To develop a project plan and allocate work appropriate work packages in the framework of group discussions</li> <li>Present project results as a team for instance in a presentation</li> </ul>				
Autonomy	Students are capable  • independently		E-Tool and complete a	given practica	ıl task with it
Workload in Hours	Independent Study Tir	me 96, Study	Fime in Lecture 84		
Credit points	6				
Course	Compulsor <b>₽</b> onus	Form	Desc	ription	

achievement	Yes	20 %	Subject practica				Teamprojekt Ausarbeitung		Vortrag
Examination	Written e	exam							
Examination duration and scale	90								
Assignment for the Following Curricula	Mechanic General Mechanic General Mechanic General Mechanic Mechanic Mechanic Compulse Mechanic Product I	Engineering cal Engineering Engineering cal Engineering ing Science: Sengineering cal Engineering cal Engineer	g, Focus A Science g, Focus P pecialisat Science g, Focus A Science g, Focus P Science g: Elective ng: Special Materials	dircraft Sys (German Product Devion Mecha (English dircraft Sys (English (English E Compulso ialisation	tems Engi program, velopment nical Engir program, tems Engi program, velopment program, ory Product I	neer 7 and neeri 7 neer 7 and 7 Deve	ing: Compuls semester): Production: ng: Elective semester): ing: Compuls semester): Production: semester): elopment an	Sory Spec Comp Spec Sory Spec Comp Spec Comp	ialisation oulsory ulsory ialisation oulsory ialisation oduction: ulsory

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> </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	<u>-</u>

Course L0270: Development of Lightweight Design Products			
Тур	Lecture		
Hrs/wk	2		
СР	2		
<b>Workload in Hours</b>	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>		

Carres I 02C0c lasts	weeked Duedwek Davidenment I
Course L0269: Inte	grated Product Development I
Тур	Lecture
Hrs/wk	2
СР	2
<b>Workload in Hours</b>	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Prof. Dieter Krause
Language	DE
Cycle	SoSe
Content	<ul> <li>Introduction to Integrated Product Development</li> <li>3D CAD -Systems and CAD interfaces</li> <li>Administration of part lists / PDM systems</li> <li>PDM in different industries</li> <li>Selection of CAD-/PDM Systems</li> <li>Simulation</li> <li>Construction methods</li> <li>Design for X</li> </ul>
Literature	<ul> <li>Ehrlenspiel, K.: Integrierte Produktentwicklung, München, Carl Hanser Verlag</li> <li>Lee, K.: Principles of CAD / CAM / CAE Systems, Addison Wesles</li> <li>Schichtel, M.: Produktdatenmodellierung in der Praxis, München, Carl Hanser Verlag</li> <li>Anderl, R.: CAD Schnittstellen, München, Carl Hanser Verlag</li> <li>Spur, G., Krause, F.: Das virtuelle Produkt, München, Carl Hanser Verlag</li> </ul>

Module M1005	5: Enhanced Fundamentals	of Materi	ials Science	
Courses				
<b>Title</b> Enhanced Fundamenta	als: Ceramics and Polymers (L1233)	Typ Lecture	Hrs/wk	<b>CP</b> 2
Enhanced Fundamenta	als: Ceramics and Polymers (L1234)	Recitation (large)	Section 1	1
Enhanced Fundamenta	als: Metals (L1086)	Lecture	2	3
Module Responsible	Prof. Gerold Schneider			
Admission Requirements	None			
	Module "Fundamentals of Materials Scier	nce"		
Previous				
Knowledge	Module "Advanced Materials"			
	After taking part successfully, students h	nave reached	the following learn	ing 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 of ceramics, metals and polymers. The profoundness of their knowledge.			
Workload in Hours	Independent Study Time 110, Study Tim	e in Lecture	70	
Credit points	6			
Course achievement	None			
Examination	Written exam			
Examination duration and scale				
Assignment for the Following Curricula	General Engineering Science (Germa Mechanical Engineering, Focus Materials General Engineering Science (Germa Mechanical Engineering, Focus Product Data Science: Core qualification: Elective General Engineering Science (English Mechanical Engineering, Focus Materials General Engineering, Focus Product Description	in Engineering program, Development e Compulsory hopogram, in Engineering program, hopogram,	ng Sciences: Compo 7 semester): Spand Production: Co 7 semester): Spand Sciences: Compo 7 semester): Spand Sciences: Compo 7 semester): Spands	ulsory pecialisation pmpulsory pecialisation ulsory pecialisation

Mechanical Engineering: Specialisation Materials in Engineering Sciences: Compulsory
Technomathematics: Specialisation III. Engineering Science: Elective Compulsory

	Anced Fundamentals: Ceramics and Polymers  Lecture
Hrs/wk	
CP	
	Independent Study Time 32, Study Time in Lecture 28
	Prof. Gerold Schneider, Prof. Robert Meißner
Language	
Cycle	
	1. Einführung
	Natürliche "Keramiken" - Steine "Künstliche" Keramik - vom Porzellan bis zur Hochleistungskeramik Anwendunger 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)
Content	4. Sintern
	Triebkraft des Sinterns Effekt von gekrümmten Oberflächen und Diffusionswegen Sinterstadien des isothermen Festphasensinterns Herring scaling laws Heißisostatisches Pressen
	5. Mechanische Eigenschaften von Keramiken
	Elastisches und plastisches Materialverhalten Bruchzähigkeit - Linear-elastische Bruchmechanik Festigkeit - Festigkeitsstreuung
	6. Elektrische Eigenschaften von Keramiken
	Ferroelektische Keramiken
	Piezo-, ferroelektrische Materialeigenschaften Anwendungen
	Keramische Ionenleiter
	lonische Leitfähigkeit Dotiertes Zirkonoxid in der Brennstoffzelle und Lambdasonde
	D R H Jones, Michael F. Ashby, Engineering Materials 1, An Introduction t 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

**Literature** 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: Enh	Course L1234: Enhanced Fundamentals: Ceramics and Polymers			
Тур	Recitation Section (large)			
Hrs/wk	1			
СР	1			
<b>Workload in Hours</b>	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			

Course L1086: Enh	anced Fundamentals: Metals
Тур	Lecture
Hrs/wk	2
СР	3
<b>Workload in Hours</b>	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Prof. Jörg Weißmüller, Prof. Patrick Huber
Language	DE
Cycle	SoSe
Content	<ul> <li>Enhanced Fundamentals of Metals:</li> <li>Introduction to phenomenological thermodynamics</li> <li>Elasticity</li> <li>Thermal materials behavior (heat capacity, thermal expansion)</li> <li>Conductors, semiconductors, isolators: conduction mechanisms and band structure</li> <li>Superconductors</li> <li>Dry corrosion</li> <li>Electrochemistry in the material sciences</li> <li>Wet corrosion</li> <li>Alloy corrosion</li> <li>Corrosion protection</li> <li>Stainless steel</li> <li>Battery materials</li> <li>Supercapacitors</li> <li>Fuel cells</li> <li>Materials for hydrogen storage</li> <li>Magnetism: phenomenology, Magnetometers, atomistics, micromagnetism</li> <li>Magnetic materials</li> <li>Magnetic materials: applications</li> </ul> Vorlesungsskript
Literature	

Module M0829	9: Foundations of Managem	nent		
Courses				
<b>Title</b> Management Tutorial (		<b>Typ</b> Recitation (small)	Hrs/wk Section 2	<b>CP</b> 3
Introduction to Manage		Lecture	3	3
1100 011011010				
Admission Requirements				
Recommended Previous Knowledge	Basic Knowledge of Mathematics and B	usiness		
Educational Objectives	LATTER TAKING NART CHCCECCTURY CTURENTS	have reached	the following learn	ning results
Professional Competence				
Knowledge	<ul> <li>describe and explain basic bust and sourcing, supply chain mana management, information ma marketing</li> <li>explain the relevance of planning situations under multiple objection methods from mathematical Final state basics from accounting and</li> </ul>	t and Controllice t and Controllice t and Controllice to name imposents of and gotreprneurial priness function agement, organ nagement, in the second control ince to sting and second costing and second costing and second costing and second control ince to the second control ince the second control ince the second control ince the second control incomplete	and Organisation to ing. In particular the and Management a rtant definitions from pals in Management rojects is as production, particular inization and human innovation managed on making in Busing tainty, and explain	ney are able and the sub- om the field and name or ocurement and name ement and name ement and name ement and ness, esp. in a some basic methods.
Skills	Students are able to analyse busine (organization, objectives, strategies e project in a team. In particular, they are  analyse Management goals and so analyse organisational and staff so apply methods for decision uncertainty and under risk analyse production and procur systems analyse and apply basic methods select and apply basic methods problems apply basic methods from according to the problems	tc.) and to ceable to structure them structures of ceable making unde rement system s of marketing s from mathe	arry out an Entre appropriately ompanies r multiple object ms and Business matical finance to	epreneurship cives, unde information o predefined
Personal Competence	Students are able to  work successfully in a team of students.		n antranronourchin	nroiget and
	to apply their knowledge from th  [576]	ie iecture to di	n endepreneursnip	project and

Social Competence	write a coherent report on the project  to communicate appropriately and to cooperate respectfully with their fellow students.
Autonomy	Students are able to  • work in a team and to organize the team themselves • to write a report on their project.
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	several written exams during the semester
the Following	General Engineering Science (German program, 7 semester): Core qualification: Compulsory Civil- and Environmental Engineering: Core qualification: Compulsory Civil- and Environmental Engineering: Specialisation Civil Engineering: Elective Compulsory Civil- and Environmental Engineering: Specialisation Water and Environment: Elective Compulsory Civil- and Environmental Engineering: Specialisation Water and Environment: Elective Compulsory Civil- and Environmental Engineering: Specialisation Traffic and Mobility: Elective Compulsory Bioprocess Engineering: Core qualification: Compulsory Bioprocess Engineering: Core qualification: Compulsory Data Science: Core qualification: Compulsory Electrical Engineering: Core qualification: Compulsory Energy and Environmental Engineering: Core qualification: Compulsory General Engineering Science (English program, 7 semester): Specialisation Electrical Engineering: Compulsory General Engineering Science (English program, 7 semester): Specialisation Civil Engineering: Compulsory General Engineering: Compulsory General Engineering: Compulsory General Engineering: Compulsory General Engineering Science (English program, 7 semester): Specialisation Energy and Environmental Engineering: Compulsory General Engineering Science (English program, 7 semester): Specialisation Computer Science: Compulsory General Engineering Science (English program, 7 semester): Specialisation Mechanical Engineering, Focus Biomechanics: Compulsory General Engineering Science (English program, 7 semester): Specialisation Mechanical Engineering, Focus Energy Systems: Compulsory General Engineering Science (English program, 7 semester): Specialisation Mechanical Engineering, Focus Aircraft Systems Engineering: Compulsory General Engineering, Focus Materials in Engineering Sciences: Compulsory General Engineering, Focus Product Development and Production: Compulsory General Engineering, Science (English program, 7 semester): Specialisation Mechanical Engineering, Focus Product Development and Production: Co

Mechatronics: Core qualification: Compulsory

Orientierungsstudium: Core qualification: Elective Compulsory

Naval Architecture: Core qualification: Compulsory Technomathematics: Core qualification: Compulsory Process Engineering: Core qualification: Compulsory

Course L0882: Man	agement Tutorial
Тур	Recitation Section (small)
Hrs/wk	2
СР	3
<b>Workload in Hours</b>	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Prof. Christoph Ihl, Katharina Roedelius, Tobias Vlcek
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 self-selected projects that focus on the elaboration of an innovative business idea from the point of view of an established company or a startup. Again, the business knowledge from the lecture should come to practical use. The group projects are guided by a mentor.
Literature	Relevante Literatur aus der korrespondierenden Vorlesung.

Course L0880: Intro	oduction to Management			
Тур	Lecture			
Hrs/wk	3			
СР	3			
Workload in Hours	Independent Study Time 48, Study Time in Lecture 42			
Lecturer	Prof. Christoph Ihl, Prof. Thorsten Blecker, Prof. Christian Lüthje, Prof. Christian Ringle, Prof. Kathrin Fischer, Prof. Cornelius Herstatt, Prof. Wolfgang Kersten, Prof. Matthias Meyer, Prof. Thomas Wrona			
Language	DE			
Cycle	WiSe/SoSe			
Content	<ul> <li>Introduction to Business and Management, Business versus Economics, relevant areas in Business and Management</li> <li>Important definitions from Management,</li> <li>Developing Objectives for Business, and their relation to important Business functions</li> <li>Business Functions: Functions of the Value Chain, e.g. Production and Procurement, Supply Chain Management, Innovation Management, Marketing and Sales 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. 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 Rechnungsler, 7. Aufl., Stuttgart 2008.  Schweitzer, M.: Planung und Steuerung, in: Bea/Friedl/Schweitzer: Allger Betriebswirtschaftslehre, Bd. 2: Führung, 9. Aufl., Stuttgart 2005.  Weber, J., Schäffer, U.: Einführung in das Controlling, 12. Auflage, Stuttgart 2006.  Weber, J./Weißenberger, B.: Einführung in das Rechnungswesen, 7. Auf Stuttgart 2006.			

## **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.

Module M0597	7: Advanced Mechanical	Engineering	Design		
Courses					
Title Advanced Mechanical   Advanced Mechanical   Advanced Mechanical   Advanced Mechanical	Typ Lecture Recitation (large) Lecture Recitation (large)	Hrs/wk 2 Section 2 2 Section 2	<b>CP</b> 2 1 2 1		
Module Responsible	Prof. Dieter Krause	(large)			
Admission Requirements	None				
Recommended Previous Knowledge	<ul> <li>Fundamentals of Mechanical</li> <li>Mechanics</li> <li>Fundamentals of Materials Sc</li> <li>Production Engineering</li> </ul>		jn		
Educational Objectives	After taking part successfully, stude	nts have reached	the following learn	ing results	
Professional Competence					
Knowledge	<ul> <li>After passing the module, students are able to:</li> <li>explain complex working principles and functions of machine elements and of basic elements of fluidics,</li> <li>explain requirements, selection criteria, application scenarios and practical examples of complex machine elements,</li> <li>indicate the background of dimensioning calculations.</li> </ul>				
Skills	<ul> <li>After passing the module, students are able to:</li> <li>accomplish dimensioning calculations of covered machine elements,</li> <li>transfer knowledge learned in the module to new requirements and tasks (problem solving skills),</li> <li>recognize the content of technical drawings and schematic sketches,</li> <li>evaluate complex designs, technically.</li> </ul>				
Personal Competence					
Social Competence	<ul> <li>Students are able to discuss t activating methods.</li> </ul>	echnical informat	ion in the lecture s	upported by	
	<ul> <li>Students are able to indep exercises.</li> </ul>	endently deepen	their acquired k	nowledge ir	

Workload in Hours Independ Credit points 6  Course achievement Examination Written 6  Examination	dent Study Time 68, Study Time in Lecture 112
Course achievement  Examination Written 6	:xam
Examination Written 6	:xam
	exam
Evamination	
duration and 120	
Mechanic General Mechanic Energy Compuls Engineer General Mechanic General	Engineering Science (German program, 7 semester): Specialisation cal Engineering: Compulsory Engineering Science (German program, 7 semester): Specialisation cal Engineering, Focus Biomechanics: Compulsory Engineering Science (German program, 7 semester): Specialisation cal Engineering, Focus Energy Systems: Compulsory Engineering Science (German program, 7 semester): Specialisation cal Engineering, Focus Aircraft Systems Engineering: Compulsory Engineering Science (German program, 7 semester): Specialisation cal Engineering, Focus Materials in Engineering Sciences: Compulsory Engineering Science (German program, 7 semester): Specialisation cal Engineering, Focus Mechatronics: Compulsory Engineering Science (German program, 7 semester): Specialisation cal Engineering, Focus Product Development and Production: Compulsory Engineering Science (German program, 7 semester): Specialisation cal Engineering, Focus Theoretical Mechanical Engineering: Compulsory Systems: Technical Complementary Course Core Studies: Elective ory ing Science: Specialisation Mechanical Engineering: Compulsory Engineering Science (English program, 7 semester): Specialisation cal Engineering Science (English program, 7 semester): Specialisation cal Engineering Science (English program, 7 semester): Specialisation cal Engineering, Focus Biomechanics: Compulsory Engineering Science (English program, 7 semester): Specialisation cal Engineering, Focus Aircraft Systems Engineering: Compulsory Engineering Science (English program, 7 semester): Specialisation cal Engineering, Focus Aircraft Systems Engineering: Compulsory Engineering Science (English program, 7 semester): Specialisation cal Engineering, Focus Aircraft Systems Engineering: Compulsory Engineering Science (English program, 7 semester): Specialisation cal Engineering, Focus Mechatronics: Compulsory Engineering Science (English program, 7 semester): Specialisation cal Engineering, Focus Mechatronics: Compulsory Engineering Science (English program, 7 semester): Specialisation cal Enginee

(Hrsg.); Springer-Verlag, aktuelle Auflage.	Course L0264: Adv	anced Mechanical Engineering Design II		
Workload in Hours  Lecturer Prof. Dieter Krause, Prof. Otto von Estorff  Language Cycle SoSe  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 • Sliding bearings  • Content  Content  • Calculation methods of the following machine elements: • Linear rolling bearings • Elements of fluidics  Exercise  • Calculation methods of the following machine elements: • Linear rolling bearings • Chain drives • Siding bearings • Clutches & brakes • Belt & chain drives • Gear drives • Siding bearings • Clutches & brakes • Seals • Clutches & brakes • Sear drives • Siding bearings • Calculation of the following machine elements: • Cluches & brakes • Sear drives • Gear drives • Siding bearings • Calculations of hydrostatic systems (fluidics)	Тур	Lecture		
Independent Study Time 32, Study Time in Lecture 28   Lecturer	Hrs/wk	2		
Lecturer Language DE Cycle SoSe  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 • Sliding bearings • Sliding bearings • Content  Exercise  • Calculation methods of the following machine elements: • Linear rolling bearings • Axes & shafts • Clutches & brakes • Belt & chain drives • Sliding bearings • Axes & shafts • Clutches & brakes • Belt & chain drives • Gear drives • Belt & chain drives • Gear drives • Gear drives • Calculation methods of the following machine elements: • Clutches & brakes • Belt & chain drives • Gear drives • Gear drives • Calculations of hydrostatic systems (fluidics)  • Dubbel, Taschenbuch für den Maschinenbau; Grote, KH., Feldhusen, (Hrsg.); Springer-Verlag, aktuelle Auflage.	СР	2		
Language Cycle SoSe  Advanced Mechanical Engineering Design I & II  Lecture  • Fundamentals of the following machine elements:	Workload in Hours	Independent Study Time 32, Study Time in Lecture 28		
Advanced Mechanical Engineering Design I & II  Lecture  • Fundamentals of the following machine elements:	Lecturer	Prof. Dieter Krause, Prof. Otto von Estorff		
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  • Sliding bearings  Content  Content  • Calculation methods of the following machine elements:  • Linear rolling bearings  • Axes & shafts  • Clutches & brakes  • Belt & chain drives  • Belt & chain drives  • Gear drives  • Belevents of fluidics  Exercise  • Calculation methods of the following machine elements:  • Linear rolling bearings  • Axes & shafts  • Clutches & brakes  • Belt & chain drives  • Gear drives  • Gear drives  • Gear drives  • Clutches & brakes  • Belt & chain drives  • Gear drives  • Clutches & brakes  • Belt & chain drives  • Gear drives  • Clutches & brakes  • Belt & chain drives  • Gear drives  • Clutches & brakes  • Belt & chain drives  • Gear drives  • Clutches & brakes  • Belt & chain drives  • Calculations of hydrostatic systems (fluidics)	Language	DE		
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 • Axes & shafts • Clutches & brakes • Belt & chain drives • Gear drives • Epicyclic gears • Crank gears • Sliding bearings • Calculations of hydrostatic systems (fluidics)  • Dubbel, Taschenbuch für den Maschinenbau; Grote, KH., Feldhusen, (Hrsg.); Springer-Verlag, aktuelle Auflage.	Cycle	SoSe		
Gear drives     Epicyclic gears     Crank drives     Sliding bearings  Content  Content		<ul> <li>► Fundamentals of the following machine elements:</li> <li>○ Linear rolling bearings</li> <li>○ Axes &amp; shafts</li> <li>○ Seals</li> </ul>		
<ul> <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>Calculations of hydrostatic systems (fluidics)</li> <li>Dubbel, Taschenbuch für den Maschinenbau; Grote, KH., Feldhusen, (Hrsg.); Springer-Verlag, aktuelle Auflage.</li> </ul>	Content	<ul> <li>Gear drives</li> <li>Epicyclic gears</li> <li>Crank drives</li> <li>Sliding bearings</li> <li>Elements of fluidics</li> </ul>		
(Hrsg.); Springer-Verlag, aktuelle Auflage.		<ul> <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> </ul>		
<ul> <li>Auflage.</li> <li>Maschinen- und Konstruktionselemente; Steinhilper, W., Röper, R., Springe 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, F. Bodenstein, F., Springer-Verlag, aktuelle Auflage.</li> </ul>	Literature	<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,</li> </ul>		

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 L0263: Advanced Mechanical Engineering Design I		
Тур	Recitation Section (large)	
Hrs/wk	2	
СР	1	
<b>Workload in Hours</b>	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	

Courses						
<b>Title</b> Signals and Systems (I	L0432)	<b>Typ</b> Lecture	<b>Hrs</b> /	wk CP		
Signals and Systems (I	L0433)	Recitation (small)	Section 2	2		
Module Responsible	Prof. Gerhard Bauch					
Admission Requirements	INONE					
•	Mathematics 1-3					
Previous	The modul is an introduction to the thecin maths as covered by the moduls Mathwith spectral transformations (Fourier so is useful but not required.	hematik 1-3 is	s expected. Fu	rther experien		
Educational Objectives		nave reached	the following l	earning result		
Professional Competence						
Knowledge	The students are able to classify and describe signals and linear time-invariant (LTI) systems using methods of signal and system theory. They are able to apply the fundamental transformations of continuous-time and discrete-time signals and systems. They can describe and analyse deterministic signals and systems mathematically in both time and image domain. In particular, they understand the effects in time domain and image domain which are caused by the transition of a continuous-time signal to a discrete-time signal.					
Skills	The students are able to describe and an invariant systems using methods of sign design basic systems regarding importa response, stability, linearity etc They can signal properties in time and frequency of	al and systen int properties can assess the	n theory. They such as magr	can analyse a nitude and pha		
Personal Competence						
	The students can jointly solve specific pr	roblems.				
Autonomy	The students are able to acquire relev- sources. They can control their level of solving tutorial problems, software tools	of knowledge	during the le			
Workload in Hours	Independent Study Time 110, Study Tim	e in Lecture 7	70			
Credit points						
Course achievement	LNONE					
Examination	Written exam					
Examination duration and scale	90 min					
	General Engineering Science (German Compulsory Computer Science: Core qualification: Co Data Science: Core qualification: Compu	ompulsory	semester): Co	ore qualification		

				(English	program,	7	semester):	Specialisation
		er Science: Cor Engineering		(English	program.	7	semester):	Specialisation
		cal Engineerin						
Assignment for	General	Engineering	Science	(English	program,	7	semester):	Specialisation
the Following								
Curricula								Specialisation
	Mechanic	cal Engineerin	g, Focus A	ircraft Sys	stems Engir	neei	ing: Compuls	sory
	General	Engineering	Science	(English	program,	7	semester):	Specialisation
	Mechanic	cal Engineerin	g, Focus M	laterials ir	n Engineerir	ng S	Sciences: Con	npulsory
	General	Engineering	Science	(English	program,	7	semester):	Specialisation
	Mechanic	cal Engineerin	g, Focus M	1echatroni	cs: Compul	sor	y	
	General	Engineering	Science	(English	program,	7	semester):	Specialisation
	Mechanic	cal Engineerin	g, Focus T	heoretical	Mechanica	l Er	ngineering: C	ompulsory
	General I	Engineering S	cience (Er	nglish prog	gram, 7 ser	nes	ter): Speciali	sation Process
	Engineer	ing: Compulso	ory					
	General	Engineering	Science	(English	program,	7	semester):	Specialisation
	Biomedic	cal Engineering	g: Compul	sory				
	Computa	tional Science	and Engi	neering: C	ore qualific	atio	n: Compulso	ry
	Mechatro	onics: Core qua	alification:	Compulso	ory			
	Technom	nathematics: S	Specialisat	ion III. Eng	ineering So	ien	ce: Elective (	Compulsory

Course L0432: Sign	nals and Systems
Тур	Lecture
Hrs/wk	3
СР	4
Workload in Hours	Independent Study Time 78, Study Time in Lecture 42
	Prof. Gerhard Bauch
Language	DE/EN
Cycle	SoSe
	<ul> <li>Introduction to signal and system theory</li> <li>Signals         <ul> <li>Classification of signals</li> <li>Analog and digital signals</li> <li>Deterministic and random signals</li> <li>Description of LTI systems by differential equations or difference equations, respectively</li> <li>Basic properties of signals and operations on signals</li> <li>Elementary signals</li> <li>Distributions (Generalized Functions)</li> <li>Power and energy of signals</li> <li>Correlation functions of deterministic signals</li> <li>Autocorrelation function</li> <li>Crosscorrelation function</li> <li>Orthogonal signals</li> <li>Applications of correlation</li> </ul> </li> <li>Linear time-invariant (LTI) systems         <ul> <li>Linearity</li> <li>Time-invariance</li> <li>Description of LTI systems by impulse response and frequency response</li> <li>Convolution</li> <li>Convolution and correlation</li> <li>Properties of LTI-systems</li> <li>Causal systems</li> <li>Stable systems</li> <li>Memoryless systems</li> </ul> </li> </ul>
	<ul> <li>Fourier Series and Fourier Transform</li> <li>Fourier transform of continuous-time signals, discrete-time signals</li> </ul>

periodic signals, non-periodic signals • Properties of the Fourier transform Fourier transform of some basic signals Parseval's theorem Analysis of LTI-systems and signals in the frequency domain Frequency response, magnitude response and phase response Transmission factor, attenuation, gain Frequency-flat and frequency-selective LTI-systems Bandwidth definitions o Basic types of systems (filters), lowpass, highpass, bandpass, bandstop systems Phase delay and group delay Linear-phase systems Distortion-free systems Content Spectrum analysis with limited observation window: Leakage effect Laplace Transform Relation of Fourier transform and Laplace transform Properties of the Laplace transform Laplace transform of some basic signals Analysis of LTI-systems in the s-domain Transfer function of LTI-systems • Relation of Laplace transform, magnitude response and phase response Analysis of LTI-systems using pole-zero plots Allpass filters Minimum-phase, maximum-phase and mixed phase filters Stable systems Sampling Sampling theorem · Reconstruction of continuous-time signals in frequency domain and time domain Oversampling Aliasing Sampling with pulses of finite duration, sample and hold Decimation and interpolation Discrete-Time Fourier Transform (DTFT) Relation of Fourier transform and DTFT Properties of the DTFT Discrete Fourier Transform (DFT) Relation of DTFT and DFT Cyclic properties of the DFT DFT matrix Zero padding Cyclic convolution Fast Fourier Transform (FFT) o Application of the DFT: Orthogonal Frequency Division Multiplex (OFDM) Z-Transform • Relation of Laplace transform, DTFT, and z-transform Properties of the z-transform Z-transform of some basic discrete-time signals Discrete-time systems, digital filters FIR and IIR filters Z-transform of digital filters • Analysis of discrete-time systems using pole-zero plots in the z-domain Stability Allpass filters • Minimum-phase, maximum-phase and mixed-phase filters Linear phase filters T. Frey , M. Bossert , Signal- und Systemtheorie, B.G. Teubner Verlag 2004 K. Kammeyer, K. Kroschel, Digitale Signalverarbeitung, Teubner Verlag.

## Literature

- B. Girod ,R. Rabensteiner , A. Stenger , Einführung in die Systemtheorie, B.G. Teubner, Stuttgart, 1997
- J.R. Ohm, H.D. Lüke , Signalübertragung, Springer-Verlag 8. Auflage, 2002
- S. Haykin, B. van Veen: Signals and systems. Wiley.
- Oppenheim, A.S. Willsky: Signals and Systems. Pearson.
- Oppenheim, R. W. Schafer: Discrete-time signal processing. Pearson.

Course L0433: Signals and Systems	
Тур	Recitation Section (small)
Hrs/wk	2
СР	2
<b>Workload in Hours</b>	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 M1320	0: Simulation and Desigr	of Mechatronic	Systems	5
Courses				
Title		Тур	Hrs/wk	СР
	of Mechatronic Systems (L1822)	Lecture	2	2
Simulation and Design	of Mechatronic Systems (L1823)	Recitation Secti (large)	on <sub>1</sub>	2
Simulation and Design	of Mechatronic Systems (L1824)	Practical Course	1	2
Module Responsible	Prof. Uwe Weltin			
Admission Requirements	None			
	Fundatmentals of mechanics, contr	ol theory and electrical e	ngineering	
Knowledge				
Objectives	After taking part successfully, stude	ents have reached the fol	lowing learn	ing results
Professional Competence				
Knowledge	Students are able to describe methods and calculations for design, modeling simulation and optimization of mechatronic 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-orie to target groups.	ented in small mixed gro	ups and pre	esent result
	Students are able to recognize and	improve knowledge defic	its independ	dently.
Autonomy	With instructor assistance, students and define a further course of study		eir own kno	wledge leve
Workload in Hours	Independent Study Time 124, Study			
Credit points		,		
Course achievement	None			
Examination	Written exam			
Examination duration and scale	90 min			
the Following	General Engineering Science (G Mechanical Engineering, Focus Mec General Engineering Science (G Mechanical Engineering, Focus Airc Digital Mechanical Engineering: Cor General Engineering Science (E Mechanical Engineering, Focus Airc General Engineering Science (E Mechanical Engineering, Focus Mec General Engineering, Focus Mechanical Engineering, Focus Compulsory Mechanical Engineering: Specialisat Mechanical Engineering: Specialisat Mechanical Engineering: Specialisat Mechanical Engineering: Specialisat	chatronics: Compulsory ferman program, 7 se raft Systems Engineering re qualification: Compulsor raft Systems Engineering raft Systems Engineering raft Systems Engineering raft Systems Compulsory raglish program, 7 se Theoretical Mechanical tion Aircraft Systems Engition Mechatronics: Compulsory raft Systems Engitics raft Systems Engit S	mester): Silicompulsor ory mester): Silicompulsor mester): Silicompulsor mester): Silicompulsor mester): Silicompulsor mester): Silicompulsor mester): Silicompulsor	pecialisatio y pecialisatio y pecialisatio pecialisatio ge: Electiv

M C	Compulsory Mechanical Engineering: Specialisation Theoretical Mechanical Engineering: Elective Compulsory Mechatronics: Core qualification: Compulsory
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Course L1822: Simulation and Design of Mechatronic Systems		
Тур	Lecture	
Hrs/wk	2	
СР	2	
<b>Workload in Hours</b>	Independent Study Time 32, Study Time in Lecture 28	
Lecturer	Prof. Uwe Weltin	
Language	DE	
Cycle	WiSe	
Content	Mechatronic Design  Modeling  Model Identifikation  Numerical Methods in simulation  Applications and examples in Matlab ® and Simulink®	
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
<b>Workload in Hours</b>	Independent Study Time 46, Study Time in Lecture 14
Lecturer	Prof. Uwe Weltin
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	
<b>Workload in Hours</b>	Independent Study Time 46, Study Time in Lecture 14	
Lecturer	Prof. Uwe Weltin	
Language	DE	
Cycle	WiSe	
Content	See interlocking course	
Literature	See interlocking course	

Caa =				
Courses				
<b>Title</b> Production Engineering	a I (I 0609)	<b>Typ</b> Lecture	Hrs/wk	<b>CP</b> 2
		Recitation	Section <sub>1</sub>	1
Production Engineering		(large)	_	_
Production Engineering		Lecture Recitation	2 Section <sub>1</sub>	2
Production Engineering	g II (L0611)	(large)	1	1
Module Responsible	Prof. Wolfgang Hintze			
Admission Requirements	None			
Recommended	no course assessments required			
Previous Knowledge	internship recommended			
Educational Objectives	LATTER TAKING NART SHCCESSTHIIV STIME	nts have reached	the following lear	ning results
Professional				
Competence	Students are able to			
Knowledge	<ul> <li>name basic criteria for the selection of manufacturing processes.</li> <li>name the main groups of Manufacturing Technology.</li> <li>name the application areas of different manufacturing processes.</li> <li>name boundaries, advantages and disadvantages of the different manufacturing process.</li> <li>describe elements, geometric properties and kinematic variables ar requirements for tools, workpiece and process.</li> <li>explain the essential models of manufacturing technology.</li> </ul>			
Skills	Students are able to  • select manufacturing process • design manufacturing procestolerances of the component • assess components in terms	esses for simple to be produced.	tasks to meet	the require
Personal Competence	Students are able to			
Social Competence	<ul> <li>develop solutions in a prod- technical level and represent</li> </ul>		nt with qualified	personnel a
	Students are able to			
Autonomy	<ul> <li>interpret independently the r</li> <li>assess own strengths and we</li> <li>assess their learning progres</li> <li>assess possible consequence</li> </ul>	aknesses in gene ss and define gaps	ral. s to be improved.	

<b>Workload in Hours</b>	Independent Study Time 96, Study Time in Lecture 84
Credit points	
Course achievement	None
Examination	Written exam
Examination duration and scale	120 min
the Following	General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Product Development and Production: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Theoretical Mechanical Engineering: Elective Compulsory Digital Mechanical Engineering: Core qualification: Compulsory 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, Focus Product Development and Production: Compulsory General Engineering Science (English program, 7 semester): Specialisation Mechanical Engineering, Focus Theoretical Mechanical Engineering: Elective Compulsory Logistics and Mobility: Specialisation Engineering Science: Elective Compulsory Mechanical Engineering: Core qualification: Compulsory Mechatronics: Core qualification: Compulsory

Course L0608: Prod	duction Engineering I
Тур	Lecture
Hrs/wk	2
СР	2
<b>Workload in Hours</b>	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
<b>Workload in Hours</b>	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 Engineering II		
Тур	Lecture	
Hrs/wk	2	
СР	2	
<b>Workload in Hours</b>	Independent Study Time 32, Study Time in Lecture 28	
Lecturer	Prof. Wolfgang Hintze, Prof. Claus Emmelmann	
Language	DE	
Cycle	SoSe	
Content	<ul> <li>Geometrically undefined machining (grinding, lapping, honing)</li> <li>Introduction into erosion technology</li> <li>Introduction into blastig processes</li> <li>Introduction to the manufacturing process forming (Casting, Powder Metallurgy, Composites)</li> <li>Fundamentals of Laser Technology</li> <li>Process versions and Fundamentals of Laser Joining Technology</li> </ul>	
Literature	Klocke, F., König, W.: Fertigungsverfahren Bd. 2 Schleifen, Honen, Läppen, 4. Aufl., Springer (2005)  Klocke, F., König, W.: Fertigungsverfahren Bd. 3 Abtragen, Generieren und Lasermaterialbearbeitung. 4. Aufl., Springer (2007)  Spur, Günter (Stöferle, Theodor.;): Urformen. München [u.a.]: Hanser, 1981  Schatt, Werner (Wieters, Klaus-Peter,; Kieback, Bernd,;): Pulvermetallurgie: Technologien und Werkstoffe. Berlin [u.a.]: Springer, 2007	

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

Courses					
Title	Docian Project (10266)		<b>Typ</b> Project-/problem-	Hrs/wk	СР
Advanced Mechanical I	Design Project (LU266)		based Learning	4	6
Module Responsible	Dr. Jens Schmidt				
Admission Requirements	None				
Recommended Previous Knowledge	Mechanical English	gineering: Design hanical Engineerir	ng Design		
Educational Objectives	After taking part succ	essfully, students	have reached the fol	lowing learn	ing results
Professional Competence					
Knowledge	<ul><li>complex designed</li><li>describe working</li><li>explain guideli</li></ul>	ocedure for syster n tasks , ng principles, thei nes for designing ced use-oriented k	natically handling of r use and combination for function and manu nowledge of machine	ıfacturing,	°S,
Skills	<ul> <li>convert princip</li> <li>use methods to solution-orient</li> <li>create a techn to understand</li> </ul>	le solutions into a design and solve ed, ical documentation the functions of the	e engineering design to on including all neces	asks systen	natically an
Personal Competence					
Social Competence		scuss solutions an	able to: d technical drawings rk groups of the cours		os,
Autonomy		solve complex do	esign projects, while and selecting appropr		
Workload in Hours	Independent Study Ti	me 124, Study Tir	me in Lecture 56		
Credit points					
Course achievement	Yes None	<b>Form</b> Attestation	Descrip	otion	
Examination					
Examination duration and					

## the Following

General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Product Development and Production: Compulsory General Engineering Science (German program, 7 semester): Specialisation Assignment for Mechanical Engineering, Focus Theoretical Mechanical Engineering: Elective Compulsory

Curricula General Engineering Science (English program, 7 semester): Specialisation Mechanical Engineering, Focus Aircraft Systems Engineering: 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 Mechanical Engineering: Core qualification: Compulsory

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

Module M0833	3: Introduction to Contro	ol Systems		
Courses				
Title Introduction to Control Introduction to Control		<b>Typ</b> Lecture Recitation (small)	Hrs/wk 2 Section 2	<b>CP</b> 4 2
Module	Prof. Herbert Werner	(Siliali)		
Кезропзівіс	1			
Admission Requirements	INODE			
Recommended Previous Knowledge		stems in time and	d frequency dom	nain, Laplace
Educational Objectives	TATTOL TAKING NALL CHECKDECTHING CHING	ents have reached	the following lear	ning results
Professional Competence				
Knowledge	<ul> <li>Students can represent dyr domain, and can in particul systems</li> <li>They can explain the dynam properties in terms of freque</li> <li>They can explain the Nyqu derived from it.</li> <li>They can explain the role or control loops</li> <li>They can explain the way a frequency response</li> <li>They can explain issues arisi domain are implemented dig</li> </ul>	lar explain propertics of simple controller on the controller affecting when controller affecting when controller	cies of first and soll loops and interproof locus on and the stab	second orde pret dynamic vility margin synthesis o n terms of its
Skills	<ul> <li>Students can transform monogrephic frequency domain and vice well they can simulate and asses.</li> <li>They can design PID controphic tuning rules.</li> <li>They can analyze and synthesis locus and frequency respons.</li> <li>They can calculate discrete continuous-time and use it for they can use standard softwom carrying out these tasks.</li> </ul>	rersa s the behavior of state llers with the help lesize simple contract e techniques -time approximation or digital implement	ystems and controllers of controllers	ol loops egler-Nichols help of roo designed in
Personal Competence Social Competence	Students can work in small gro		lve technical pr	oblems, and
Autonomy	Students can obtain information f documentation, experiment guides; They can assess their knowledge i	from provided sou and use it when s	olving given prob	lems.

<b>Workload in Hours</b>	Independent Study Time 124, Study Time in Lecture 56
Credit points	
Course achievement	None
Examination	Written exam
Examination duration and scale	
the Following	General Engineering Science (German program, 7 semester): Core qualification: Compulsory Bioprocess Engineering: Core qualification: Compulsory Computer Science: Specialisation Computational Mathematics: Elective Compulsory Data Science: Core qualification: Elective Compulsory Electrical Engineering: Core qualification: Compulsory Electrical Engineering: Core qualification: Compulsory Energy and Environmental Engineering: Core qualification: Compulsory General Engineering Science (English program, 7 semester): Specialisation Electrical Engineering: Compulsory General Engineering Science (English program, 7 semester): Specialisation Civil Engineering: Compulsory General Engineering Science (English program, 7 semester): Specialisation Bioprocess Engineering: Compulsory General Engineering: Compulsory General Engineering Science (English program, 7 semester): Specialisation Energy and Environmental Engineering: Compulsory General Engineering Science (English program, 7 semester): Specialisation Computer Science: Compulsory General Engineering Science (English program, 7 semester): Specialisation Mechanical Engineering, Focus Biomechanics: Compulsory General Engineering Science (English program, 7 semester): Specialisation Mechanical Engineering, Focus Energy Systems: Compulsory General Engineering Science (English program, 7 semester): Specialisation Mechanical Engineering, Focus Materials in 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 Mechanicals in Engineering Sciences: Compulsory General Engineering Science (English program, 7 semester): Specialisation Mechanical Engineering, Focus Mechanical Engineering: Compulsory General Engineering Science (English program, 7 semester): Specialisation Mechanical Engineering, Focus Product Development and Production: Compulsory General Engineer

Course L0654: Intro	oduction to 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		
<b>Workload in Hours</b>	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 M0662	2: Numerical Mathematic	s I		
Courses				
<b>Title</b> Numerical Mathematic		<b>Typ</b> Lecture Recitation (small)	Hrs/wk 2 Section 2	<b>CP</b> 3
Module Responsible	IPINI SANINE LE BOINE			
Admission Requirements	None			
Recommended Previous Knowledge	Linear Algebra I + II for Techr		man or english) <b>o</b>	<b>r</b> Analysis &
Educational Objectives	After taking part successfully, stude	nts have reached t	he following learn	ing results
Professional Competence				
Knowledge	<ul> <li>name numerical methods problems, eigenvalue problems, explain their core ideas,</li> <li>repeat convergence statement explain aspects for the practition to computational and storage</li> </ul>	ems, nonlinear ronts for the numericated and execution of nu	ot finding problea	ems and to
Skills	<ul> <li>Students are able to</li> <li>implement, apply and compa</li> <li>justify the convergence behaproblem and solution algorith</li> <li>select and execute a suitable</li> </ul>	viour of numerical m,	methods with re	spect to the
Personal Competence				
Social Competence	work together in heterog	nd background kno ach other with pra	owledge), explain	theoretical
Autonomy	<ul> <li>to assess whether the supp better solved individually or i</li> <li>to assess their individual pr seek help.</li> </ul>	n a team,	·	
Workload in Hours	Independent Study Time 124, Study	Time in Lecture 56	5	
Credit points	· · · · · · · · · · · · · · · · · · ·			
Course achievement	INone			
Examination	Written exam			
Examination				Ī

duration and scale	
	General Engineering Science (German program, 7 semester): Specialisation
	Computer Science: Compulsory
	General Engineering Science (German program, 7 semester): Specialisation
	Mechanical Engineering, Focus Materials in Engineering Sciences: Compulsory
	General Engineering Science (German program, 7 semester): Specialisation
	Biomedical Engineering: Compulsory
	General Engineering Science (German program, 7 semester): Specialisation
	Mechanical Engineering, Focus Biomechanics: Compulsory
	General Engineering Science (German program, 7 semester): Specialisation
	Mechanical Engineering, Focus Theoretical Mechanical Engineering: Compulsory
	Bioprocess Engineering: Specialisation A - General Bioprocess Engineering: Elective
	Compulsory
	Computer Science: Specialisation Computational Mathematics: Elective Compulsory
	Computer Science: Specialisation II. Mathematics and Engineering Science: Elective
	Compulsory
	Data Science: Core qualification: Compulsory
	Electrical Engineering: Core qualification: Elective Compulsory
	Engineering Science: Core qualification: Compulsory
	General Engineering Science (English program, 7 semester): Specialisation
Assignment for	Mechanical Engineering, Focus Theoretical Mechanical Engineering: Elective
the Following	Compulsory
Curricula	General Engineering Science (English program, / semester): Core qualification
	Compulsory
	General Engineering Science (English program, 7 semester): Specialisation
	Computer Science: Compulsory
	General Engineering Science (English program, 7 semester): Specialisation
	Mechanical Engineering, Focus Biomechanics: Compulsory
	General Engineering Science (English program, 7 semester): Specialisation
	Mechanical Engineering, Focus Materials in Engineering Sciences: Compulsory
	General Engineering Science (English program, 7 semester): Specialisation
	Mechanical Engineering, Focus Theoretical Mechanical Engineering: Compulsory
	General Engineering Science (English program, 7 semester): Specialisation
	Biomedical Engineering: Compulsory
	Computational Science and Engineering: Core qualification: Compulsory
	Mechanical Engineering: Specialisation Theoretical Mechanical Engineering: Elective
	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 Mathematics I			
Тур	Lecture		
Hrs/wk	2		
СР	3		
<b>Workload in Hours</b>	Independent Study Time 62, Study Time in Lecture 28		
Lecturer	Prof. Sabine Le Borne		
Language	EN		
Cycle	WiSe		
Content	<ol> <li>Error analysis: Number representation, error types, conditioning and stability</li> <li>Interpolation: polynomial and spline interpolation</li> <li>Numerical integration and differentiation: order, Newton-Cotes formula, error estimates, Gaussian quadrature, adaptive quadrature, difference formulas</li> <li>Linear systems: LU and Cholesky factorization, matrix norms, conditioning</li> <li>Linear least squares problems: normal equations, Gram.Schmidt and Householder orthogonalization, singular value decomposition, regularization</li> <li>Eigenvalue problems: power iteration, inverse iteration, QR algorithm</li> <li>Nonlinear systems of equations: Fixed point iteration, root-finding algorithms for real-valued functions, Newton and Quasi-Newton methods for systems</li> </ol>		
Literature	<ul> <li>Stoer/Bulirsch: Numerische Mathematik 1, Springer</li> <li>Dahmen, Reusken: Numerik für Ingenieure und Naturwissenschaftler, Springer</li> </ul>		

Course L0418: Numerical Mathematics I			
Тур	Recitation Section (small)		
Hrs/wk	2		
СР	3		
<b>Workload in Hours</b>	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 M073(	0: Computer Engineeri	ng		
Courses				
Title Computer Engineering		<b>Typ</b> Lecture Recitation	Hrs/wk 3 Section 1	<b>CP</b> 4
Computer Engineering	(L0324)	(small)	1	2
Module Responsible	Prof. Heiko Falk			
Admission Requirements	LNODE			
Recommended Previous Knowledge	Basic knowledge in electrical eng	gineering		
Educational Objectives	I A II AF I AKINN NAN SIIK (ASSIIIIIV) SI	udents have reached	the following learr	ning 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 functions, hardware synthesis, combinational networks • Sequential logic: Flip-flops, automata, systematic hardware design			
Skills	The students perceive computer identify the internal structure a The students can analyze, how hased on a collection of few an between and to explain the constraint systems - from gates and circuit.  After successful completion of interdependencies between a phon it. In particular, they shall usoftware has on the hardward language down to gates. This was these low abstraction levels hardward propose feasible options.	nd the physical companighly specific and ind disimple components different abstraction is up to complete proceed the module, the study sical computer system of the consecuted and the consecuted and the consecuted the consecuted and the consecution are the consecution are the consecution and the consecution are the consecution and the consecution are the consecution are the consecution and the consecution are the consecution and the consecution are t	position of computers ividual computers are able to layers of today's essors.  Idents are able to em and the software are the layers from the ed to evaluate the	ter systems. can be built o distinguish s computing to judge the executed execution of the assembly e impact that
Personal Competence Social Competence		ar problems alone or	in a group and to	present the
Autonomy	Students are able to acquire associate this knowledge with ot		m specific litera	ture and to
Workload in Hours	Independent Study Time 124, St	udy Time in Lecture 5	6	
Credit points	6			

Course	Compulsor <b>B</b> onus	Form	Description	
achievement		Excercises	Description	
Examination	Written exam			
Examination				
duration and scale	90 minutes, contents of			
	Computer Science: Com	npulsory	program, 7 semester): 5	
	<b>Bioprocess Engineering</b>	: Compulsory	program, 7 semester): 9	
	Architecture: Compulso	ry	pgram, 7 semester): Special program, 7 semester): 9	
	Electrical Engineering: (	Compulsory	program, 7 semester): 9	
	<b>Biomedical Engineering</b>	: Compulsory	gram, 7 semester): Specialis	
	and Enviromental Engin	eering: Compulsory		
	Engineering: Compulsor	y	program, 7 semester): 9	
	Mechanical Engineering	, Focus Mechatronio		
	Mechanical Engineering			Cnecialization
	Mechanical Engineering	, Focus Aircraft Syst	program, 7 semester): Stems Engineering: Compulso	ory
	Mechanical Engineering	, Focus Materials in	program, 7 semester): S Engineering Sciences: Com	pulsory
			program, 7 semester): 9 Mechanical Engineering: Co	
	General Engineering	Science (German	program, 7 semester): 5	Specialisation
			velopment and Production: C program, 7 semester): S	
	Mechanical Engineering			Specialisation
	General Engineering Mechanical Engineering		program, 7 semester): S	Specialisation
	General Engineering So	cience (German pro	ogram, 7 semester): Speci	alisation Civil
	Engineering: Compulsor Computer Science: Core		nulsorv	
	Data Science: Core qua	lification: Elective C	ompulsory	
	Electrical Engineering: (		ompulsory ram, 7 semester): Specialisa	tion Floctrical
Curricula	Engineering: Compulsor		am, 7 semester). Specialisa	tion Electrical
	General Engineering S Engineering: Compulsor		ogram, 7 semester): Specia	alisation Civil
	<b>Bioprocess Engineering</b>	: Compulsory	program, 7 semester): 9	
	General Engineering Sc and Environmental Engin		gram, 7 semester): Specialis	sation Energy
		Science (English	program, 7 semester): 9	Specialisation
	Mechanical Engineering	, Focus Biomechani		
	General Engineering Mechanical Engineering		program, 7 semester): !	Specialisation
	General Engineering	Science (English	program, 7 semester): 9	
			tems Engineering: Compulso program, 7 semester): 9	
	Mechanical Engineering	, Focus Materials in	Engineering Sciences: Com	pulsory
	General Engineering Mechanical Engineering		program, 7 semester): !	Specialisation
	General Engineering	Science (English	program, 7 semester): 9 /elopment and Production: 0	
1	3	[606]	•	. ,

General Engineering Science (English program, 7 semester): Specialisation Mechanical Engineering, Focus Theoretical Mechanical Engineering: Compulsory General Engineering Science (English program, 7 semester): Specialisation Naval Architecture: Compulsory General Engineering Science (English program, 7 semester): Specialisation Process Engineering: Compulsory General Engineering Science (English program, 7 semester): Specialisation Biomedical Engineering: Compulsory Computational Science and Engineering: Core qualification: Compulsory Mechatronics: Core qualification: Compulsory Technomathematics: Specialisation II. Informatics: Elective Compulsory

Course L0321: Com	nputer Engineering
Тур	Lecture
Hrs/wk	3
СР	4
<b>Workload in Hours</b>	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	
<b>Workload in Hours</b>	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 M0829: Foundations of Management					
Courses					
Title		Тур		Hrs/wk	СР
Management Tutorial	(L0882)	Recitation	Section	12	3
Introduction to Manage	ement (L0880)	(small) Lecture		3	3
Module Responsible	Prof. Christoph Ihl				
Admission Requirements					
Recommended Previous Knowledge	Basic Knowledge of Mathematics and Business				
Educational Objectives	After taking part successfully, students have reached the following learning results				
Professional Competence					
Knowledge	<ul> <li>After taking this module, students know the important basics of many different areas in Business and Management, from Planning and Organisation to Marketing and Innovation, and also to Investment and Controlling. In particular they are able to</li> <li>explain the differences between Economics and Management and the sub-disciplines in Management and to name important definitions from the field of Management</li> <li>explain the most important aspects of and goals in Management and name the most important aspects of entreprneurial projects</li> <li>describe and explain basic business functions as production, procurement and sourcing, supply chain management, organization and human ressource management, information management, innovation management and marketing</li> <li>explain the relevance of planning and decision making in Business, esp. in situations under multiple objectives and uncertainty, and explain some basic methods from mathematical Finance</li> <li>state basics from accounting and costing and selected controlling methods.</li> </ul>				
Skills	Students are able to analyse busines (organization, objectives, strategies et project in a team. In particular, they are  analyse Management goals and soanlyse organisational and staff soapply methods for decision runcertainty and under risk analyse production and procursystems analyse and apply basic methods select and apply basic methods problems apply basic methods from accouproblems	able to  tructure them structures of comaking under ement system of marketing from mather	approprompanie multip	an Entre iately s le objecti Business finance to	preneurship ives, under information predefined
Personal Competence	Students are able to  • work successfully in a team of stu	udents			
	to apply their knowledge from the		entrepr	eneurship	project and
	[608]				

Social Competence	<ul> <li>write a coherent report on the project</li> <li>to communicate appropriately and</li> <li>to cooperate respectfully with their fellow students.</li> </ul>		
Autonomy	Students are able to  work in a team and to organize the team themselves  to write a report on their project.		
<b>Workload in Hours</b>	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	several written exams during the semester		
the Following	General Engineering Science (German program, 7 semester): Core qualification: Compulsory Civil- and Environmental Engineering: Core qualification: Compulsory Civil- and Environmental Engineering: Specialisation Civil Engineering: Elective Compulsory Civil- and Environmental Engineering: Specialisation Water and Environment: Elective Compulsory Civil- and Environmental Engineering: Specialisation Traffic and Mobility: Elective Compulsory Civil- and Environmental Engineering: Specialisation Traffic and Mobility: Elective Compulsory Bioprocess Engineering: Core qualification: Compulsory Bioprocess Engineering: Core qualification: Compulsory Computer Science: Core qualification: Compulsory Data Science: Core qualification: Compulsory Electrical Engineering: Core qualification: Compulsory Energy and Environmental Engineering: Core qualification: Compulsory General Engineering Science (English program, 7 semester): Specialisation Electrical Engineering: Compulsory General Engineering Science (English program, 7 semester): Specialisation Dioprocess Engineering: Compulsory General Engineering Science (English program, 7 semester): Specialisation Energy and Environmental Engineering: Compulsory General Engineering Science (English program, 7 semester): Specialisation Computer Science: Compulsory General Engineering Science (English program, 7 semester): Specialisation Computer Science: Compulsory General Engineering Science (English program, 7 semester): Specialisation Mechanical Engineering, Focus Biomechanics: Compulsory General Engineering Science (English program, 7 semester): Specialisation Mechanical Engineering, Focus Horty Systems: Compulsory General Engineering Science (English program, 7 semester): Specialisation Mechanical Engineering, Focus Materials in Engineering: Compulsory General Engineering Science (English program, 7 semester): Specialisation Mechanical Engineering, Focus Mechatronics: Compulsory General Engineering Science (English program, 7 semester): Specialisation Mechanical Engineering, Focus Me		

Mechatronics: Core qualification: Compulsory

Orientierungsstudium: Core qualification: Elective Compulsory

Naval Architecture: Core qualification: Compulsory Technomathematics: Core qualification: Compulsory Process Engineering: Core qualification: Compulsory

Course L0882: Management Tutorial		
Тур	Recitation Section (small)	
Hrs/wk	2	
СР	3	
<b>Workload in Hours</b>	Independent Study Time 62, Study Time in Lecture 28	
Lecturer	Prof. Christoph Ihl, Katharina Roedelius, Tobias Vlcek	
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 self-selected projects that focus on the elaboration of an innovative business idea from the point of view of an established company or a startup. Again, the business knowledge from the lecture should come to practical use. The group projects are guided by a mentor.	
Literature	Relevante Literatur aus der korrespondierenden Vorlesung.	

Course L0880: Intr	roduction to Management		
Тур	Lecture		
Hrs/wk	3		
СР	3		
Workload in Hours	Independent Study Time 48, Study Time in Lecture 42		
Lecturer	Prof. Christoph Ihl, Prof. Thorsten Blecker, Prof. Christian Lüthje, Prof. Christian Ringle, Prof. Kathrin Fischer, Prof. Cornelius Herstatt, Prof. Wolfgang Kersten, Prof. Matthias Meyer, Prof. Thomas Wrona		
Language	DE		
Cycle	WiSe/SoSe		
Content	<ul> <li>Introduction to Business and Management, Business versus Economics, relevant areas in Business and Management</li> <li>Important definitions from Management,</li> <li>Developing Objectives for Business, and their relation to important Business functions</li> <li>Business Functions: Functions of the Value Chain, e.g. Production and Procurement, Supply Chain Management, Innovation Management, Marketing and Sales         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 M1573: Modeling, Simulation and Optimization (GES)					
Courses					
<b>Title</b> Modeling, Simulation a	nd Optimization (L2446)	Typ Integrated Lecture	Hrs/wk	<b>CP</b> 6	
Module Responsible	Prof. Benedikt Kriegesmann				
Admission Requirements	None				
Recommended Previous Knowledge					
Educational Objectives	After taking part successfully, students l	nave reached the follo	owing learn	ing results	
Professional Competence <i>Knowledge</i>					
<i>Skills</i> <b>Personal</b>					
Competence Social Competence					
Autonomy Workload in Hours	Independent Study Time 124, Study Tim	oo in Locturo 56			
Credit points		ie iii Lecture 30			
Course achievement	None				
Examination	Oral exam				
Examination duration and scale	30 min				
the Following	General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Theoretical Mechanical Engineering: Elective Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Theoretical Mechanical Engineering: Compulsory Engineering Science: Core qualification: Compulsory General Engineering Science (English program, 7 semester): Core qualification: Compulsory General Engineering Science (English program, 7 semester): Specialisation Mechanical Engineering, Focus Theoretical Mechanical Engineering: Elective Compulsory Mechanical Engineering: Specialisation Theoretical Mechanical Engineering: Elective Compulsory Mechanical Engineering: Specialisation Theoretical Mechanical Engineering: Compulsory				

Course L2446: Modeling, Simulation and Optimization		
Тур	Integrated Lecture	
Hrs/wk	4	
СР	6	
	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		
Literature		

Module M0854	1: Mathematics IV			
Courses				
Title	2 (Partial Differential Equations) (L1043)	<b>Typ</b> Lecture	Hrs/wk	<b>CP</b>
·	2 (Partial Differential Equations) (L1044)	Recitation (small)	Section 1	1
Differential Equations	2 (Partial Differential Equations) (L1045)	Recitation (large)	Section 1	1
Complex Functions (L1	038)	Lecture	2	1
Complex Functions (L1	.041)	Recitation (small)	Section 1	1
Complex Functions (L1	042)	Recitation (large)	Section 1	1
Module Responsible	Prof. Anusch Taraz			
Admission Requirements	None			
Recommended	Mathematics 1 - III			
Educational Objectives	After taking part successfully, students	s have reached	the following learr	ning results
Professional Competence				
Knowledge	<ul> <li>Students can name the basic concepts in Mathematics IV. They are able to explain them using appropriate examples.</li> <li>Students can discuss logical connections between these concepts. They are capable of illustrating these connections with the help of examples.</li> <li>They know proof strategies and can reproduce them.</li> </ul>			
Skills	<ul> <li>Students can model problems in studied in this course. Moreo applying established methods.</li> <li>Students are able to discover a the concepts studied in the cour</li> <li>For a given problem, the stu approach, and are able to critical</li> </ul>	ver, they are nd verify furthorse. dents can dev	capable of solving capable capable of solving capable capable capable of solving capable capab	ng them by
Personal Competence				
Social Competence	<ul> <li>Students are able to work to mathematics as a common lang</li> <li>In doing so, they can communic their cooperating partners. Mo and deepen the understanding of</li> </ul>	uage. cate new conce reover, they c	epts according to	the needs o
Autonomy	<ul> <li>Students are capable of checking on their own. They can specify get help in solving them.</li> <li>Students have developed suffice</li> </ul>	open question	s precisely and kn	ow where to

	periods in a goal-oriented manner on hard problems.
	Independent Study Time 68, Study Time in Lecture 112
Credit points	6
Course achievement	INODE
Examination	Written exam
Examination duration and scale	60 min (Complex Functions) + 60 min (Differential Equations 2)
the Following	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 semester): Specialisation Naval Architecture: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Theoretical Mechanical Engineering: Elective Compulsory Computer Science: Specialisation Computational Mathematics: Elective Compulsory Computer Science: Specialisation II. Mathematics and Engineering Science: Elective Compulsory Computer Science: Specialisation Electrical Engineering: Compulsory Engineering Science: Specialisation Electrical Engineering: Compulsory General Engineering Science (English program, 7 semester): Specialisation Electrical Engineering: Compulsory General Engineering Science (English program, 7 semester): Specialisation Electrical Engineering: Compulsory General Engineering Science (English program, 7 semester): Specialisation Mechanical Engineering, Focus Mechatronics: Compulsory General Engineering Science (English program, 7 semester): Specialisation Mechanical Engineering, Focus Theoretical Mechanical Engineering: Compulsory General Engineering Science (English program, 7 semester): Specialisation Naval Architecture: Compulsory Computational Science and Engineering: Specialisation II. Mathematics & Engineering Science Elective Compulsory Mechanical Engineering: Specialisation Mechatronics: Compulsory Mechanical Engineering: Specialisation Theoretical Mechanical Engineering: Elective Compulsory Mechanical Engineering: Specialisation Theoretical Mechanical Engineering: Elective Compulsory Mechanical Engineering: Specialisation: Compulsory Mechanical Engineering: Specialisation: Compulsory Mechanical Engineering: Specialisation: Compulsory Mechanical Engineering: Specialisation: Compulsory

Course L1043: Differential Equations 2 (Partial Differential Equations)		
Тур	Lecture	
Hrs/wk	2	
СР	1	
<b>Workload in Hours</b>	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  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	
Literature	http://www.math.uni-hamburg.de/teaching/export/tuhh/index.html	

Course L1044: Differential Equations 2 (Partial Differential Equations)		
	Recitation Section (small)	
Hrs/wk		
СР		
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	
<b>Workload in Hours</b>	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	
<b>Workload in Hours</b>	Independent Study Time 2, Study Time in Lecture 28	
Lecturer	Dozenten des Fachbereiches Mathematik der UHH	
Language	DE	
Cycle	SoSe	
Content	<ul> <li>Main features of complex analysis</li> <li>Functions of one complex variable</li> <li>Complex differentiation</li> <li>Conformal mappings</li> <li>Complex integration</li> <li>Cauchy's integral theorem</li> <li>Cauchy's integral formula</li> <li>Taylor and Laurent series expansion</li> <li>Singularities and residuals</li> <li>Integral transformations: Fourier and Laplace transformation</li> </ul>	
Literature	http://www.math.uni-hamburg.de/teaching/export/tuhh/index.html	

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

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

## **Specialization Biomedical Engineering**

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

Module M0933	3: Fundamentals of Material	s Science		
Courses				
Title Fundamentals of Materials Science I (L1085) Fundamentals of Materials Science II (Advanced Ceramic Materials, Polymers and Composites) (L0506) Physical and Chemical Basics of Materials Science (L1095)		Typ Lecture Lecture Lecture	Hrs/wk 2 2 2	<b>CP</b> 2 2 2
Module Responsible	Prof. Jörg Weißmüller			
Admission Requirements	None			
Recommended Previous Knowledge	Highschool-level physics, chemistry und	mathematics		
Educational Objectives	After taking part successfully, students h	ave reached the follo	wing learn	ing results
Professional Competence				
Knowledge	The students have acquired a fundamental knowledge on metals, ceramics and polymers and can describe this knowledge comprehensively. Fundamental knowledge here means specifically the issues of atomic structure, microstructure, phase diagrams, phase transformations, corrosion and mechanical properties. The students know about the key aspects of characterization methods for materials and can identify relevant approaches for characterizing 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 and chemical laws of nature. Material properties such as strength, ductility, corrosion resistance, and to phase precipitation, or melting. The students conditions and the materials microstruct microstructure on the material's behavio	Is phenomena here and stiffness, chemic transformations an explain the relationere, and they can according to the state of	refers to cal propert such as s on betweer	mechanica ies such as olidification processing
Personal Competence				
	[618]			

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: Fun and Composites)	damentals of Materials Science II (Advanced Ceramic Materials, Polymers
Тур	Lecture
Hrs/wk	2
СР	2
<b>Workload in Hours</b>	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

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

Module M0730	0: Computer Engineerin	g		
Courses				
Title Computer Engineering		<b>Typ</b> Lecture Recitation	Hrs/wk 3 Section 1	<b>CP</b> 4
Computer Engineering	(LU324)	(small)	1	2
- Responsible	Prof. Heiko Falk			
Admission Requirements	None			
Recommended Previous Knowledge	Basic knowledge in electrical engi	neering		
Educational Objectives	LATTOR FAKING NART CHACACCTHING CTHA	dents have reached t	he following learr	ing results
Professional				
Competence	! !			
	This module deals with the foundation covers the layers from the assemincludes the following topics:		•	
Knowledge	<ul> <li>Introduction</li> <li>Combinational logic: Gates, Boolean algebra, Boolean functions, hardware synthesis, combinational networks</li> <li>Sequential logic: Flip-flops, automata, systematic hardware design</li> <li>Technological foundations</li> <li>Computer arithmetic: Integer addition, subtraction, multiplication and division</li> <li>Basics of computer architecture: Programming models, MIPS single-cycle architecture, pipelining</li> <li>Memories: Memory hierarchies, SRAM, DRAM, caches</li> <li>Input/output: I/O from the perspective of the CPU, principles of passing data point-to-point connections, busses</li> </ul>			
Skills	The students perceive computer sidentify the internal structure and The students can analyze, how his based on a collection of few and between and to explain the disystems - from gates and circuits  After successful completion of tinterdependencies between a phy on it. In particular, they shall une software has on the hardware language down to gates. This way these low abstraction levels ha propose feasible options.	d the physical composition of the physical components. If the process of the module, the study of the computer system of the consequence of the module of the consequence of the position of the process of the process of the position of the position of the process of the position of the process of the	osition of compuvidual computers They are able to ayers of today's essors.  Idents are able to mean and the softwall along the layers from the decomposition to evaluate the softwall along the softwall al	ter systems. can be built distinguish computing o judge the are executed execution of e assembly impact that
Personal Competence		problems alone or i	n a group and to	present the
	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, Stu	dy Time in Lecture 56	5	
Credit points				

Course	Compulsor <b>B</b> onus	Form	Description
achievement		Excercises	Description
Examination	Written exam		
Examination duration and scale	90 minutes, contents of	course and labs	
Assignment for the Following Curricula	General Engineering Computer Science: Com General Engineering: Bioprocess Engineering: General Engineering Biomedical Engineering General Engineering General Engineering: General Engineering: General Engineering: General Engineering: General Engineering: Mechanical Engineering: General Engineering: Mechanical Engineering: General Engineering: Mechanical Engineering: General Engineering: Mechanical Engineering: General Engineering Mechanical Engineering General Engineering General Engineering Mechanical Engineering General Engineering	Science (German pulsory Science (German prory Science (German prory Science (German prory Science (German progering: Compulsory ience (German progering: Compulsory ience (German progering: Compulsory ience (German progering: Compulsory ience (German progering: German progering: German progering: German procus Mechatronic Science (German procus Aircraft Systematics (German procus Product Devision progering: German progering	program, 7 semester): Specialisation Processions, 7 semester): Specialisation program, 7 semester): Specialisation program
	wecnanicai Engineering	, rocus Product Dev	reiopment and Production: Compulsory

General Engineering Science (English program, 7 semester): Specialisation Mechanical Engineering, Focus Theoretical Mechanical Engineering: Compulsory General Engineering Science (English program, 7 semester): Specialisation Naval Architecture: Compulsory
General Engineering Science (English program, 7 semester): Specialisation Process Engineering: Compulsory
General Engineering Science (English program, 7 semester): Specialisation Biomedical Engineering: Compulsory
Computational Science and Engineering: Core qualification: Compulsory
Mechatronics: Core qualification: Compulsory
Technomathematics: Specialisation II. Informatics: Elective Compulsory

Course L0321: Com	puter Engineering
Тур	Lecture
Hrs/wk	3
СР	4
<b>Workload in Hours</b>	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	
<b>Workload in Hours</b>	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 M0960: Mechanics IV (Oscillations, Analytical Mechanics, **Multibody Systems, Numerical Mechanics)** Courses Title Hrs/wk CP Typ Mechanics IV (Oscillations, Analytical Mechanics, Numerical Lecture 3 Mechanics) (L1137) Section 2 Mechanics IV (Oscillations, Analytical Mechanics, Numerical Recitation 2 Mechanics) (L1138) (small) Section 1 Mechanics IV (Oscillations, Analytical Mechanics, Numerical Recitation 1 Mechanics) (L1139) (large) Module Prof. Robert Seifried Responsible **Admission** None Requirements Recommended Mathematics I-III and Mechanics I-III **Previous Knowledge Educational** After taking part successfully, students have reached the following learning results **Objectives Professional** Competence The students can describe the axiomatic procedure used in mechanical contexts; Knowledge explain important steps in model design; present technical knowledge. The students can explain the important elements of mathematical / mechanical analysis and model formation, and apply it to the context of their own problems; apply basic methods to engineering problems; Skills estimate the reach and boundaries of the methods and extend them to be applicable to wider problem sets. **Personal** Competence The students can work in groups and support each other to overcome difficulties. Social Competence Students are capable of determining their own strengths and weaknesses and to Autonomy organize their time and learning based on those. Workload in Hours Independent Study Time 96, Study Time in Lecture 84 **Credit points** 6 Course None achievement **Examination** Written exam **Examination** duration and 120 min scale General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Biomedical Engineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Naval

	Architecture: Compulsory
	Energy Systems: Technical Complementary Course Core Studies: Elective
	Compulsory
Assignment for	General Engineering Science (English program, 7 semester): Specialisation
	Mechanical Engineering: Compulsory
Curricula	General Engineering Science (English program, 7 semester): Specialisation Naval
	Architecture: Compulsory
	General Engineering Science (English program, 7 semester): Specialisation
	Biomedical Engineering: Compulsory
	Mechanical Engineering: Core qualification: Compulsory
	Mechatronics: Core qualification: Compulsory
	Naval Architecture: Core qualification: Compulsory
	Technomathematics: Specialisation III. Engineering Science: Elective Compulsory
	Theoretical Mechanical Engineering: Technical Complementary Course Core Studies:
	Elective Compulsory

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

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	D: Fluid Dynamics			
Courses				
Title		Тур	Hrs/wk	СР
Fluid Mechanics (L045	4)	Lecture	3	4
Fluid Mechanics (L045)	5)	Recitation (large)	Section 2	2
Module Responsible	Prof. Momas Rung			
Admission Requirements	None			
	Sound knowledge of engineering thermodynamics.	mathematics,	engineering me	chanics and
Educational Objectives	After taking part successfully, student	s have reached	the following lear	ning results
Professional Competence				
Knowledge	Students will have the required sound fluid engineering and physics of flu rationale of flow physics using mather for the performance analysis and the process of the performance analysis and the performance anal	uids. Students matical models	can scientifically and are familiar	outline the with methods
Skills	Students are able to apply fluid-enging the analysis of technical systems. The necessary theoretical calculations for devices on a scientific level.	e lecture enabl	es the student to	carry out all
Personal Competence Social Competence	The students are able to discuss probl	ems and jointly	develop solution	strategies.
Autonomy	The students are able to develop so consistent and crtically analyse results		es for complex p	roblems self-
<b>Workload in Hours</b>	Independent Study Time 110, Study T	ime in Lecture	70	
Credit points	6			
Course achievement	None			
Examination	Written exam			
Examination duration and scale				
Assignment for the Following Curricula	General Engineering Science (Gerr Mechanical Engineering: Compulsory General Engineering Science (Gerr Biomedical Engineering: Compulsory General Engineering Science (German Architecture: Compulsory General Engineering Science (Eng Mechanical Engineering: Compulsory General Engineering Science (English Architecture: Compulsory General Engineering Science (Eng	man program, n program, 7 s lish program, n program, 7 s	7 semester): 9 emester): Special 7 semester): 9 emester): Special	Specialisation isation Naval Specialisation Naval

Biomedical Engineering: Compulsory
Computational Science and Engineering: Specialisation Engineering Sciences:
Elective Compulsory
Mechanical Engineering: Core qualification: Compulsory
Naval Architecture: Core qualification: Compulsory
Technomathematics: Specialisation III. Engineering Science: Elective Compulsory

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

Course L0455: Fluid Mechanics		
Тур	Recitation Section (large)	
Hrs/wk	2	
СР	2	
<b>Workload in Hours</b>	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 M0672	2: Signals and Systems			
Courses				
Title		Тур	Hrs/wk	СР
Signals and Systems (	L0432)	Lecture	3	4
Signals and Systems (I	L0433)	Recitation (small)	Section 2	2
Module Responsible	IPINI GERNAM BAHAN			
Admission Requirements	INONE			
	Mathematics 1-3			
Previous	The modul is an introduction to the the in maths as covered by the moduls M with spectral transformations (Fourier is useful but not required.	athematik 1-3 is	expected. Further	experience
Educational Objectives	After taking part successfully, student	s have reached	the following learn	ing results
Professional				
Competence	:	doceribo cianole	and linear times in	variant (ITI)
Knowledge	The students are able to classify and describe signals and linear time-invariant (LTI) systems using methods of signal and system theory. They are able to apply the fundamental transformations of continuous-time and discrete-time signals and systems. They can describe and analyse deterministic signals and systems mathematically in both time and image domain. In particular, they understand the effects in time domain and image domain which are caused by the transition of a continuous-time signal to a discrete-time signal.			
Skills	The students are able to describe and invariant systems using methods of si design basic systems regarding imporesponse, stability, linearity etc The signal properties in time and frequence	gnal and system rtant properties y can assess the	theory. They can such as magnitude	analyse and e and phase
Personal Competence				
Social Competence	The students can jointly solve specific	problems.		
Autonomy	The students are able to acquire rel sources. They can control their leve solving tutorial problems, software too	l of knowledge	during the lectur	
Workload in Hours	Independent Study Time 110, Study T	ime in Lecture 7	0	
Credit points	6			
Course achievement	LNONE			
Examination	Written exam			
Examination duration and scale	90 min			
	General Engineering Science (Germa Compulsory Computer Science: Core qualification: Data Science: Core qualification: Com Electrical Engineering: Core qualificati General Engineering Science (English Engineering: Compulsory General Engineering Science (Eng Bioprocess Engineering: Compulsory	Compulsory pulsory on: Compulsory program, 7 sem	ester): Specialisati	on Electrica

		Engineering er Science: Cor		(English	program,	7	semester):	Specialisation
	•			(English	nrogram	7	semester).	Specialisation
		cal Engineerin						Specialisation
Assignment for								Specialisation
the Following				_				
		•	_			•	•	Specialisation
	Mechanic	cal Engineerin	g, Focus A	ircraft Sys	stems Engir	neei	ring: Compuls	sory
	General	Engineering	Science	(English	program,	7	semester):	Specialisation
	Mechanic	cal Engineerin	g, Focus N	laterials ir	n Engineerir	ng S	Sciences: Con	npulsory
					. •			Specialisation
		cal Engineerin	_		•		•	
					. •			Specialisation
		cal Engineerin	-				-	
				nglish prog	gram, 7 ser	nes	ter): Speciali	sation Process
		ing: Compulso	•			_		
					program,	7	semester):	Specialisation
		cal Engineering	•	-				
		itional Science	_	_	•	atio	n: Compulso	ry
		onics: Core qu		•	,			
	Technom	nathematics: S	pecialisat	ion III. Eng	ineering Sc	cien	ce: Elective (	Compulsory

Course L0432: Signals and Systems				
Тур	Lecture			
Hrs/wk	3			
СР	4			
Workload in Hours	Independent Study Time 78, Study Time in Lecture 42			
	Prof. Gerhard Bauch			
Language	DE/EN			
Cycle	SoSe			
	Introduction to signal and system theory  Signals  Classification of signals  Analog and digital signals  Deterministic and random signals  Description of LTI systems by differential equations or difference equations, respectively  Basic properties of signals and operations on signals  Elementary signals  Distributions (Generalized Functions)  Power and energy of signals  Correlation functions of deterministic signals  Autocorrelation function  Crosscorrelation function  Applications of correlation  Linear time-invariant (LTI) systems  Linearity  Time-invariance  Description of LTI systems by impulse response and frequency response  Convolution  Convolution  Convolution and correlation  Properties of LTI-systems  Causal systems  Stable systems			
	<ul> <li>Memoryless systems</li> <li>Fourier Series and Fourier Transform</li> <li>Fourier transform of continuous-time signals, discrete-time signals</li> </ul>			

- periodic signals, non-periodic signals • Properties of the Fourier transform • Fourier transform of some basic signals Parseval's theorem Analysis of LTI-systems and signals in the frequency domain Frequency response, magnitude response and phase response Transmission factor, attenuation, gain Frequency-flat and frequency-selective LTI-systems Bandwidth definitions o Basic types of systems (filters), lowpass, highpass, bandpass, bandstop systems Phase delay and group delay Linear-phase systems Distortion-free systems Content • Spectrum analysis with limited observation window: Leakage effect Laplace Transform Relation of Fourier transform and Laplace transform Properties of the Laplace transform Laplace transform of some basic signals Analysis of LTI-systems in the s-domain Transfer function of LTI-systems • Relation of Laplace transform, magnitude response and phase response Analysis of LTI-systems using pole-zero plots Allpass filters Minimum-phase, maximum-phase and mixed phase filters Stable systems Sampling Sampling theorem · Reconstruction of continuous-time signals in frequency domain and time domain Oversampling Aliasing Sampling with pulses of finite duration, sample and hold Decimation and interpolation Discrete-Time Fourier Transform (DTFT) Relation of Fourier transform and DTFT Properties of the DTFT Discrete Fourier Transform (DFT) Relation of DTFT and DFT Cyclic properties of the DFT DFT matrix Zero padding Cyclic convolution Fast Fourier Transform (FFT) o Application of the DFT: Orthogonal Frequency Division Multiplex (OFDM) Z-Transform • Relation of Laplace transform, DTFT, and z-transform Properties of the z-transform Z-transform of some basic discrete-time signals Discrete-time systems, digital filters FIR and IIR filters Z-transform of digital filters • Analysis of discrete-time systems using pole-zero plots in the z-domain Stability Allpass filters • Minimum-phase, maximum-phase and mixed-phase filters Linear phase filters T. Frey , M. Bossert , Signal- und Systemtheorie, B.G. Teubner Verlag 2004
  - K. Kammeyer, K. Kroschel, Digitale Signalverarbeitung, Teubner Verlag.

## Literature

- B. Girod ,R. Rabensteiner , A. Stenger , Einführung in die Systemtheorie, B.G. Teubner, Stuttgart, 1997
- J.R. Ohm, H.D. Lüke , Signalübertragung, Springer-Verlag 8. Auflage, 2002
- S. Haykin, B. van Veen: Signals and systems. Wiley.
- Oppenheim, A.S. Willsky: Signals and Systems. Pearson.
- Oppenheim, R. W. Schafer: Discrete-time signal processing. Pearson.

Course L0433: Signals and Systems		
Тур	Recitation Section (small)	
Hrs/wk	2	
СР	2	
<b>Workload in Hours</b>	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 M1277	7: MED I: Introduction to Anatomy
Courses	
<b>Title</b> Introduction to Anatom	Typ Hrs/wk CP ny (L0384) Lecture 2 3
Module Responsible	Prof. Udo Schumacher
Admission Requirements	None
Recommended Previous Knowledge	
	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. The students can describe the basic macroscopy and microscopy of those systems.
Skills	The students can recognize the relationship between given anatomical facts and the development of some common diseases; they can 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 level.
Autonomy	The students are able to access anatomical knowledge by themselves, can participate in conversations on the topic and acquire the relevant knowledge themselves.
<b>Workload in Hours</b>	Independent Study Time 62, Study Time in Lecture 28
Credit points	3
Course achievement	None
Examination Examination duration and scale	
	General Engineering Science (German program, 7 semester): Specialisation Biomedical Engineering: Compulsory 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 Mechanical Engineering Science (English program, 7 semester): Specialisation
the Following	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: Intr	oduction to Anat	omy
Тур	Lecture	
Hrs/wk	2	
СР	3	
		y Time 62, Study Time in Lecture 28
	Prof. Tobias Lange	
Language		
Cycle	l	
	General Anatom  1 <sup>st</sup> week:	The Eucaryote Cell
	2 <sup>nd</sup> week:  3 <sup>rd</sup> week:  4 <sup>th</sup> week:	The Tissues  Cell Cycle, Basics in Development
	5 <sup>th</sup> week:	Musculoskeletal System  Cardiovascular System
	6 <sup>th</sup> week: 7 <sup>th</sup> week:	Respiratory System  Genito-urinary System
Content	8 <sup>th</sup> week:	Immune system
	10 <sup>th</sup> week:	Digestive System I  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 Stuttgart, 2016	el Schünke, Der Körper des Menschen, 17. Auflage, Thieme Verlag

Module M127 Therapy	8: MED I: Introduction to Radiology and Radiation
Courses	
<b>Title</b> Introduction to Radiolo	Typ Hrs/wk CP ogy and Radiation Therapy (L0383) Lecture 2 3
Admission Requirements	None
Recommended Previous Knowledge	None
Educational Objectives	After taking part successfully, students have reached the following learning results
Professional Competence	
	Therapy The students can distinguish different types of currently 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' passage from their initial admittance through to follow-up care.
Knowledge	<b>Diagnostics</b> The students can illustrate the technical base concepts of projection radiography including angiography and mammography, as 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 those 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.
	<b>Therapy</b> The students can distinguish curative and palliative situations and motivate why they came to that conclusion.
	The students can develop adequate therapy concepts and relate it to the radiation biological aspects.
	The students can use the therapeutic 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).
Skills	The student can assess what an individual psychosocial service should look like (e.g. follow-up treatment, sports, social help groups, self-help groups, social services, psycho-oncology).
	Diagnostics
	[635]

	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 of 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 therapeutic measures and can meet them appropriately.
	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.
Autonomy	The students are able to access anatomical knowledge by themselves, can participate competently in conversations on the topic and acquire the relevant knowledge themselves.
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Credit points	
Course achievement	None
Examination	Written exam
Examination duration and scale	90 minutes
the Following	General Engineering Science (German program, 7 semester): Specialisation Biomedical Engineering: Compulsory 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 Mechanical Engineering, Focus Biomechanics: Compulsory General Engineering Science (English program, 7 semester): Specialisation Biomedical Engineering: Compulsory General Engineering: Compulsory General Engineering: Specialisation Biomechanics: 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 L0383: Introduction to Radiology and Radiation Therapy		
Тур	Lecture	
Hrs/wk	2	
СР	3	
<b>Workload in Hours</b>	Independent Study Time 62, Study Time in Lecture 28	
Lecturer	Prof. Ulrich Carl, Prof. Thomas Vestring	
Language	DE	

Cvcle	SoSo
	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
	• "Technik der medizinischen Radiologie" von T. + J. Laubenberg –
	7. Auflage – Deutscher Ärzteverlag – erschienen 1999
	<ul> <li>"Klinische Strahlenbiologie" von Th. Herrmann, M. Baumann und W. Dörr –</li> </ul>
	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
Literature	<ul> <li>"Taschenatlas der Physiologie" von S. Silbernagel und A. Despopoulus-</li> </ul>
	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 M127 Biology	9: MED II: Introduction	to Biochemist	ry and N	1olecular
Courses				
Title Introduction to Biocher	mistry and Molecular Biology (L0386)	<b>Typ</b> Lecture	Hrs/wk	<b>CP</b> 3
Module Responsible				
Admission Requirements	INONE			
Recommended Previous Knowledge	None			
Educational Objectives	After taking part successfully, stude	ents have reached the	following lear	ning results
Professional Competence				
Knowledge	• doscribo basis biomoloculos:		Α;	
Skills	<ul> <li>The students can</li> <li>recognize the importance of molecular parameters for the course of a disease;</li> <li>describe selected molecular-diagnostic procedures;</li> <li>explain the relevance of these procedures for some diseases</li> </ul>			
Personal Competence Social Competence	The students can participate in disc	cussions in research ar	nd medicine o	on a technical
Autonomy	The students can develop understa literature, by themselves.	nding of topics from t	he course, us	ing technical
Workload in Hours	Independent Study Time 62, Study	Time in Lecture 28		
Credit points				
Course achievement	None			
	Written exam			
Examination duration and scale	60 minutes			
Assignment for the Following		y erman program, 7 nechanics: Compulsory ne: Compulsory n Medical Technology: Biomedical Engineerin nglish program, 7 y nglish program, 7 nechanics: Compulsory	semester): S Elective Com ig: Compulsor semester): S semester): S	Specialisation pulsory y Specialisation

Biomedical Engineering: Specialisation Management and Business Administration: Elective Compulsory
Biomedical Engineering: Specialisation Artificial Organs and Regenerative Medicine: Elective Compulsory
Biomedical Engineering: Specialisation Medical Technology and Control Theory: Elective Compulsory
Biomedical Engineering: Specialisation Implants and Endoprostheses: Elective Compulsory
Technomathematics: Specialisation III. Engineering Science: Elective Compulsory

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

Module M1333	3: BIO I: Implants and F	racture Healing	l	
Courses				
Title Implants and Fracture	Healing (L0376)	<b>Typ</b> Lecture	Hrs/wk 2	<b>CP</b> 3
Module Responsible	Prof. Michael Morlock			
Admission Requirements	None			
	It is recommended to participate "Implants and Fracture Healing".	e in "Introduction into A	Anatomie" befo	re attending
Educational Objectives	After taking part successfully, stu	dents have reached the	following lear	ning results
Professional Competence				
Knowledge	The students can describe the differ their existence. The students can name different given fracture morphologies.	•		•
Skills	The students can determine the static situations under specific as		e human body	under quasi-
Personal Competence				
Social Competence	The students can, in groups, calculation of internal forces.	solve basic numerica	l modeling ta	isks for the
Autonomy	The students can, in groups, calculation of internal forces.	solve basic numerica	l modeling ta	isks for the
<b>Workload in Hours</b>	Independent Study Time 62, Stud	ly Time in Lecture 28		
Credit points	3			
Course achievement	None			
Examination	Written exam			
Examination duration and scale	90 min			
Assignment for the Following Curricula	General Engineering Science Mechanical Engineering, Focus Bi General Engineering Science Biomedical Engineering: Compuls Engineering Science: Specialisation General Engineering Science Biomedical Engineering: Compuls General Engineering: Compuls General Engineering Science Mechanical Engineering; Specialis Mechanical Engineering: Specialis Biomedical Engineering: Specialis Elective Compulsory	omechanics: Compulsor (German program, 7 sory on Biomedical Engineeri (English program, 7 sory (English program, 7 omechanics: Compulsor sation Biomechanics: Co sation Artificial Organs a disation Implants and	semester): Sing: Compulsor semester): Singuistry semester): Singuistry and Regeneration Endoprosthes	pecialisation pecialisation pecialisation pecialisation we Medicine: ses: Elective trol Theory:

Orientierungsstudium: Core qualification: Elective Compulsory Technomathematics: Specialisation III. Engineering Science: Elective Compulsory

Course L0376: Imp	lants and Fracture Healing
Тур	Lecture
Hrs/wk	2
СР	
	Independent Study Time 62, Study Time in Lecture 28
Lecturer Language	Prof. Michael Morlock
Cycle	
	Topics to be covered include:
	Introduction (history, definitions, background importance)
	2. Bone (anatomy, properties, biology, adaptations in femur, tibia, humerus, radius)
	3. Spine (anatomy, biomechanics, function, vertebral bodies, intervertebral disc, ligaments)
	3.1 The spine in its entirety
	3.2 Cervical spine
	3.3 Thoracic spine
	3.4 Lumbar spine
	3.5 Injuries and diseases
Content	4. Pelvis (anatomy, biomechanics, fracture treatment)
Content	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
	Cochran V.B.: Orthopädische Biomechanik
Literature	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 M0684	1: Heat Transfer			
Courses				
<b>Title</b> Heat Transfer (L0458) Heat Transfer (L0459)		Typ Lecture Recitation (large)	Hrs/wk 3 Section 2	<b>CP</b> 4 2
Module Responsible	Dr. Andreas Moschallski	(large)		
Admission Requirements	None			
Knowledge	Technical Thermodynamics I, II and Fluid	Dynamics		
Educational Objectives	After taking part successfully, students h	ave reached the	e following learn	ing results
Professional Competence				
Knowledge	The students are able to - describe the different physical mechanism of Heat Transfer,			
	- to analyse comlex heat transfer processes in a critical way.  The students are able to  - understand the physics of Heat Transfer,			
Skills	· ·			
Personal Competence Social Competence		groups and dev	velop an approac	ch.
,	The students are able to develop a complex problem self-consistent and analyse the results in a critical way. A qualified exchange with other students is given.			
Workload in Hours	Independent Study Time 110, Study Time	e in Lecture 70		
Credit points	6			
Course achievement	None			
Examination	Written exam			
Examination duration and scale				
Assignment for	General Engineering Science (Germa Mechanical Engineering, Focus Energy Sy General Engineering Science (Germa Biomedical Engineering: Compulsory General Engineering Science (Germa Mechanical Engineering, Focus Theol Compulsory General Engineering Science (Germa Mechanical Engineering, Focus Theoretic Energy Systems: Technical Complement	rstems: Compul n program, 7 n program, 7 retical Mechan n program, 7 al Mechanical E	sory semester): Specifical Engineering semester): Specifical Speci	pecialisation pecialisation g: Elective pecialisation pulsory

the Following	Compulsory
Curricula	General Engineering Science (English program, 7 semester): Specialisation
	Mechanical Engineering, Focus Theoretical Mechanical Engineering: Elective
	Compulsory
	General Engineering Science (English program, 7 semester): Specialisation
	Mechanical Engineering, Focus Energy Systems: Compulsory
	General Engineering Science (English program, 7 semester): Specialisation
	Biomedical Engineering: 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	
<b>Workload in Hours</b>	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
<b>Workload in Hours</b>	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Dr. Andreas Moschallski
Language	DE
Cycle	WiSe
Content	See interlocking course
Literature	See interlocking course

Courses				
Title Introduction to Contro		<b>Typ</b> Lecture Recitation	Hrs/wk 2 Section 2	<b>CP</b> 4
Introduction to Contro	l Systems (L0655)	(small)	2	2
responsible	 			
Admission Requirements	INODE			
Recommended Previous Knowledge	transform	Representation of signals and systems in time and frequency domain, Laplace transform		
Educational Objectives	After taking part successfully, stud	ents have reached	the following lear	ning results
Professional Competence				
Knowledge	<ul> <li>Students can represent dynamic system behavior in time and frequency domain, and can in particular explain properties of first and second order systems</li> <li>They can explain the dynamics of simple control loops and interpret dynamic properties in terms of frequency response and root locus</li> <li>They can explain the Nyquist stability criterion and the stability margins derived from it.</li> <li>They can explain the role of the phase margin in analysis and synthesis of control loops</li> <li>They can explain the way a PID controller affects a control loop in terms of its frequency response</li> <li>They can explain issues arising when controllers designed in continuous time domain are implemented digitally</li> </ul>			
Skills	<ul> <li>Students can transform models of linear dynamic systems from time to frequency domain and vice versa</li> <li>They can simulate and assess the behavior of systems and control loops</li> <li>They can design PID controllers with the help of heuristic (Ziegler-Nichols) tuning rules</li> <li>They can analyze and synthesize simple control loops with the help of root locus and frequency response techniques</li> <li>They can calculate discrete-time approximations of controllers designed in continuous-time and use it for digital implementation</li> <li>They can use standard software tools (Matlab Control Toolbox, Simulink) for carrying out these tasks</li> </ul>			
Personal Competence	:			
Social Competence	Students can work in small gro experimentally validate their control Students can obtain information documentation, experiment guides	oller designs from provided sou	rces (lecture not	tes, softwar
Autonomy	They can assess their knowledge learning progress.	in weekly on-line to	ests and thereby	control the

<b>Workload in Hours</b>	Independent Study Time 124, Study Time in Lecture 56
Credit points	
Course achievement	None
Examination	Written exam
Examination duration and scale	120 min
the Following	General Engineering Science (German program, 7 semester): Core qualification: Compulsory Bioprocess Engineering: Core qualification: Compulsory Computer Science: Specialisation Computational Mathematics: Elective Compulsory Data Science: Core qualification: Elective Compulsory Electrical Engineering: Core qualification: Compulsory Energy and Environmental Engineering: Core qualification: Compulsory Engineering Science (English program, 7 semester): Specialisation Electrical Engineering: Compulsory General Engineering Science (English program, 7 semester): Specialisation Civil Engineering: Compulsory General Engineering Science (English program, 7 semester): Specialisation Engineering: Compulsory General Engineering Science (English program, 7 semester): Specialisation Bioprocess Engineering: Compulsory General Engineering Science (English program, 7 semester): Specialisation Energy and Environmental Engineering: Compulsory General Engineering Science (English program, 7 semester): Specialisation Computer Science: Compulsory General Engineering Science (English program, 7 semester): Specialisation Mechanical Engineering, Science (English program, 7 semester): Specialisation Mechanical Engineering Science (English program, 7 semester): Specialisation Mechanical Engineering, Focus Energy Systems: Compulsory General Engineering Science (English program, 7 semester): Specialisation Mechanical Engineering, Focus Materials in Engineering: Compulsory General Engineering Science (English program, 7 semester): Specialisation Mechanical Engineering, Focus Methatronics: Compulsory General Engineering Science (English program, 7 semester): Specialisation Mechanical Engineering, Focus Methatronics: Compulsory General Engineering Science (English program, 7 semester): Specialisation Mechanical Engineering, Focus Methatronics: Compulsory General Engineering Science (English program, 7 semester): Specialisation Mechanical Engineering, Focus Methatronics: Compulsory General Engineering Science (English program, 7 semester): Spec

Course L0654: Intr	oduction to 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	
	<ul> <li>Linear systems, differential equations and transfer functions</li> <li>First and second order systems, poles and zeros, impulse and step response</li> <li>Stability</li> <li>Feedback systems</li> <li>Principle of feedback, open-loop versus closed-loop control</li> </ul>
	<ul> <li>Reference tracking and disturbance rejection</li> <li>Types of feedback, PID control</li> <li>System type and steady-state error, error constants</li> <li>Internal model principle</li> </ul> Root locus techniques
	<ul> <li>Root locus plots</li> <li>Root locus design of PID controllers</li> </ul>
Content	<ul> <li>Frequency response techniques</li> <li>Bode diagram</li> <li>Minimum and non-minimum phase systems</li> <li>Nyquist plot, Nyquist stability criterion, phase and gain margin</li> <li>Loop shaping, lead lag compensation</li> <li>Frequency response interpretation of PID control</li> </ul>
	Time delay systems
	<ul> <li>Root locus and frequency response of time delay systems</li> <li>Smith predictor</li> </ul>
	Digital control
	<ul><li>Sampled-data systems, difference equations</li><li>Tustin approximation, digital implementation of PID controllers</li></ul>
	Software tools
	<ul> <li>Introduction to Matlab, Simulink, Control toolbox</li> <li>Computer-based exercises throughout the course</li> </ul>
Literature	<ul> <li>Werner, H., Lecture Notes "Introduction to Control Systems"</li> <li>G.F. Franklin, J.D. Powell and A. Emami-Naeini "Feedback Control of Dynamic Systems", Addison Wesley, Reading, MA, 2009</li> <li>K. Ogata "Modern Control Engineering", Fourth Edition, Prentice Hall, Uppe 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	
<b>Workload in Hours</b>	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	

Courses							
<b>Title</b> Practical Course: Meas				<b>Typ</b> Practical Cou	ırse	Hrs/wk 2	<b>CP</b> 2
Measurement Technolo	ogy for Me	chanical Engin	eering (L1116)	Lecture	C t'	2	3
Measurement Technology	ogy for Me	chanical Engin	eering (L1118)	Recitation (large)	Section	1	1
Module Responsible	Prof. Tho	rsten Kern					
Admission Requirements	None						
Recommended Previous Knowledge	Basic kn	owledge of ph	ysics, chemistry a	and electrical	engineeri	ng	
Educational Objectives	After tak	ing part succe	essfully, students	have reached	the follow	wing learn	ing results
Professional Competence							
	Technolo	gy (Quantitie	name the most i s and Units, Und and Systems).				
Knowledge	They can outline the most important measuring methods for different kinds of quantities to be maesured (Electrical Quantities, Temperature, mechanical quantities, Flow, Time, Frequency).						
			important meth romatography)	ods of cher	nical Ana	alysis (Ga	as Sensors
	Students can select suitable measuring methods to given problems and can us refering measurement devices in practice.  The students are able to orally explain issues in the subject area of measurement technology and solution approaches as well as place the issues into the right context and application area.				ind can use		
Skills							
Personal Competence							
Social Competence	Students can arrive at work results in groups and document them in a common report.						
Autonomy	Students	Students are able to familiarize themselves with new measurement technologies.					
Workload in Hours	Independ	dent Study Tir	ne 110, Study Tin	ne in Lecture	70		
Credit points	6						
Course achievement	CompulsorBonus Form Description  Yes None Subject theoretical and practical work						
Examination	Written e	exam					
Examination duration and scale							

Mechanical Engineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Biomedical Engineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Energy and Environmental Engineering: Compulsory Digital Mechanical Engineering: Core qualification: Compulsory Energy and Environmental Engineering: Core qualification: Compulsory Engineering Science: Specialisation Mechatronics: Compulsory Engineering Science: Specialisation Mechanical Engineering: Compulsory Engineering Science: Specialisation Biomedical Engineering: Elective Compulsory Assignment for General Engineering Science (English program, 7 semester): Specialisation Energy the Following and Environmental Engineering: Compulsory Curricula General Engineering Science (English program, 7 semester): Specialisation Mechanical Engineering: Compulsory General Engineering Science (English program, 7 semester): Specialisation Biomedical Engineering: Compulsory General Engineering Science (English program, 7 semester): Specialisation Mechatronics: Compulsory General Engineering Science (English program, 7 semester): Specialisation Mechanical Engineering: Compulsory General Engineering Science (English program, 7 semester): Specialisation Biomedical Engineering: Elective Compulsory Mechanical Engineering: Core qualification: Compulsory Mechatronics: Core qualification: Compulsory Process Engineering: Core qualification: Compulsory

Course L1119: Prac	ctical Course: Measurement and Control Systems
	Practical Course
Hrs/wk	
СР	
	Independent Study Time 32, Study Time in Lecture 28
	Prof. Thorsten Kern
Language	
	WiSe/SoSe
Cycle	Experiment 1: Emission and immission measurement of gaseous pollutants:
Content	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	<ul> <li>Versuch 1:</li> <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> <li>Versuch 2:</li> <li>Grundlagen über elektrische Maschinen, speziell: Asynchronmotoren</li> <li>Simulationsmethoden, speziell: Verwendung von Blockschaltbildern</li> <li>Betriebsverhalten von Kreispumpen, speziell: Kennlinien, Ähnlichkeitsgesetze</li> <li>Versuch 3:</li> <li>Unger, HG.: Optische Nachrichtentechnik, Teil 1: Optische Wellenleiter. Hüthing Verlag, Heidelberg, 1984</li> <li>Dakin, J., Cushaw, B.: Optical Fibre Sensors: Principles and Components. Artech House Boston, 1988</li> <li>Culshaw, B., Dakin, J.: Optical Fibre Sensors: Systems and Application. Artech House Boston, 1989</li> <li>Versuch 4:</li> <li>Leonhard: Einführung in die Regelungstechnik. Vieweg Verlag, Braunschweig-Wiesbaden</li> <li>Jan Lunze: Systemtheoretische Grundlagen, Analyse und Entwurf einschleifiger Regelungen</li> </ul>

Course L1116: Mea	surement Technology for Mechanical Engineering			
Тур	Lecture			
Hrs/wk	2			
СР				
	Independent Study Time 62, Study Time in Lecture 28			
	Prof. Thorsten Kern, Dennis Kähler			
Language Cycle				
Сусіе	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			
Content	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			
	Lerch, R.: "Elektrische Messtechnik; Analoge, digitale und computergestützte Verfahren", Springer, 2006, ISBN: 978-3-540-34055-3.			
Literature	Profos, P. Pfeifer, T.: "Handbuch der industriellen Messtechnik", Oldenbourg, 2002, ISBN: 978-3486217940.			

Course L1118: Mea	Course L1118: Measurement Technology for Mechanical Engineering			
Тур	Recitation Section (large)			
Hrs/wk	1			
СР	1			
<b>Workload in Hours</b>	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 M0598	3: Mechanical Engineeri	ng: Design		
Courses				
<b>Title</b> Embodiment Design ar	nd 3D-CAD (L0268)	<b>Typ</b> Lecture	Hrs/wk	<b>CP</b> 1
Mechanical Design Pro	ject I (L0695)	Project-/problem- based Learning	3	2
Mechanical Design Pro	ject II (L0592)	Project-/problem- based Learning Project-/problem-	3	2
Team Project Design M	lethodology (L0267)	based Learning	2	1
Module Responsible	Prof. Dieter Krause			
Admission Requirements	None			
Recommended Previous Knowledge	Eundamontals of Matorials S			
Educational Objectives	After taking part successfully, stud	ents have reached the foll	lowing learn	ing results
Professional Competence		are able to		
Knowledge	<ul> <li>After passing the module, students are able to:</li> <li>explain design guidelines for machinery parts e.g. considering load situation, materials and manufacturing requirements,</li> <li>describe basics of 3D CAD,</li> <li>explain basics methods of engineering designing.</li> </ul>			
Skills	<ul> <li>After passing the module, students are able to:</li> <li>independently create sketches, technical drawings and documentations e.g. using 3D CAD,</li> <li>design components based on design guidelines autonomously,</li> <li>dimension (calculate) used components,</li> <li>use methods to design and solve engineering design tasks systamtically and solution-oriented,</li> <li>apply creativity techniques in teams.</li> </ul>			
Personal Competence	After passing the module, students	s are able to:		
Social Competence	develop and evaluate solutions in groups including making and documenting decisions			
Autonomy	Students are able  • to estimate their level of knowledge using activating methods within the lectures (e.g. with clickers),  • To solve engineering design tasks systematically.			
Workload in Hours	Independent Study Time 40, Study	Time in Lecture 140		
Credit points	6			

	Compulso	r <b>₿</b> onus	Form				cription	
Course	Yes	None	Written elaboration Teamprojeki Konstruktior		mprojekt struktionsme			
achievement	Yes	None	Written elaboration		Konstruktionsprojekt 1			
	Yes	None	Written	elaboratio	n	Kon	struktionspro	jekt 2
	Yes	None	Written	elaboratio	n	3D-0	CAD-Praktiku	m
Examination	Written exa	m						
Examination duration and scale								
Assignment for the Following Curricula	Mechanical General Er Biomedical General En and Environ Digital Mech Energy and General En and Environ General Er Mechanical	Engineering agineering Engineering Schental Engineering Schental Engineering Schental Engineering	: Compul Science : Compul ience (Gineering: Coneering: Coneering: Compul science (Eneering: Compul Science : Compul : Core quilification	Isory (German sory erman pro Compulsory Core qualification (English pro (English lsory (English sory ualification Compulsory	program gram, 7 s y fication: Core qualification, 7 s y program program cry cry cry	omp catio eme	semester): ster): Specia ulsory n: Compulsor ster): Special semester):	

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

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

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

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

Module M0662	2: Numerical Mathemati	cs I		
Courses				
<b>Title</b> Numerical Mathematic		<b>Typ</b> Lecture Recitation (small)	Hrs/wk 2 Section 2	<b>CP</b> 3
Module Responsible	Prof. Sabine Le Borne	<u>`</u>		
Admission Requirements	None			
Recommended Previous Knowledge	Linear Algebra I + II for Tech		nan or english) <b>o</b>	<b>r</b> Analysis &
Educational Objectives	After taking part successfully, stud	ents have reached th	ne following learn	ing results
Professional Competence				
Knowledge	<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	<ul> <li>Students are able to</li> <li>implement, apply and comp</li> <li>justify the convergence beh problem and solution algorit</li> <li>select and execute a suitable</li> </ul>	naviour of numerical hm,	methods with re	spect to the
Personal Competence	Students are able to			
Social Competence	<ul><li>work together in hetero</li></ul>	and background kno each other with pra	wledge), explain	theoretical
Autonomy	<ul> <li>Students are capable</li> <li>to assess whether the supporting theoretical and practical excercises are better solved individually or in a team,</li> <li>to assess their individual progess and, if necessary, to ask questions and seek help.</li> </ul>			
<b>Workload in Hours</b>	Independent Study Time 124, Stud	ly Time in Lecture 56	j	
Credit points	6			
Course achievement	None			
Examination	Written exam			
Examination				Ī

duration and scale	
	General Engineering Science (German program, 7 semester): Specialisati
	Computer Science: Compulsory
	General Engineering Science (German program, 7 semester): Specialisati
	Mechanical Engineering, Focus Materials in Engineering Sciences: Compulsory
	General Engineering Science (German program, 7 semester): Specialisati
	Biomedical Engineering: Compulsory
	General Engineering Science (German program, 7 semester): Specialisati
	Mechanical Engineering, Focus Biomechanics: Compulsory
	General Engineering Science (German program, 7 semester): Specialisat
	Mechanical Engineering, Focus Theoretical Mechanical Engineering: Compulsory
	Bioprocess Engineering: Specialisation A - General Bioprocess Engineering: Elect
	Compulsory
	Computer Science: Specialisation Computational Mathematics: Elective Compulso
	Computer Science: Specialisation II. Mathematics and Engineering Science: Elect
	Compulsory
	Data Science: Core qualification: Compulsory
	Electrical Engineering: Core qualification: Elective Compulsory
	Engineering Science: Core qualification: Compulsory
	General Engineering Science (English program, 7 semester): Specialisate
	Mechanical Engineering, Focus Theoretical Mechanical Engineering: Elect
ignment for	Compulsory
e Following	General Engineering Science (English program, 7 semester): Core qualificati
Curricula	Compulsory
	General Engineering Science (English program, 7 semester): Specialisat
	Computer Science: Compulsory
	General Engineering Science (English program, 7 semester): Specialisat
	Mechanical Engineering, Focus Biomechanics: Compulsory
	General Engineering Science (English program, 7 semester): Specialisat
	Mechanical Engineering, Focus Materials in Engineering Sciences: Compulsory
	General Engineering Science (English program, 7 semester): Specialisat
	Mechanical Engineering, Focus Theoretical Mechanical Engineering: Compulsory
	General Engineering Science (English program, 7 semester): Specialisat
	Biomedical Engineering: Compulsory
	Computational Science and Engineering: Core qualification: Compulsory
	Mechanical Engineering: Specialisation Theoretical Mechanical Engineering: Elect
	Compulsory
	Mechanical Engineering: Specialisation Theoretical Mechanical Engineeri
	Compulsory
	Mechanical Engineering: Specialisation Energy Systems: Elective Compulsory
	Theoretical Mechanical Engineering: Technical Complementary Course Core Studi
	Elective Compulsory
	Process Engineering: Specialisation Process Engineering: Elective Compulsory

Course L0417: Nun	nerical Mathematics I
Тур	Lecture
Hrs/wk	2
СР	3
<b>Workload in Hours</b>	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Prof. Sabine Le Borne
Language	EN
Cycle	WiSe
Content	<ol> <li>Error analysis: Number representation, error types, conditioning and stability</li> <li>Interpolation: polynomial and spline interpolation</li> <li>Numerical integration and differentiation: order, Newton-Cotes formula, error estimates, Gaussian quadrature, adaptive quadrature, difference formulas</li> <li>Linear systems: LU and Cholesky factorization, matrix norms, conditioning</li> <li>Linear least squares problems: normal equations, Gram.Schmidt and Householder orthogonalization, singular value decomposition, regularization</li> <li>Eigenvalue problems: power iteration, inverse iteration, QR algorithm</li> <li>Nonlinear systems of equations: Fixed point iteration, root-finding algorithms for real-valued functions, Newton and Quasi-Newton methods for systems</li> </ol>
Literature	<ul> <li>Stoer/Bulirsch: Numerische Mathematik 1, Springer</li> <li>Dahmen, Reusken: Numerik für Ingenieure und Naturwissenschaftler, Springer</li> </ul>

Course L0418: Nun	Course L0418: Numerical Mathematics I	
Тур	Recitation Section (small)	
Hrs/wk	2	
СР	3	
<b>Workload in Hours</b>	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 M063	4: Introduction	into Medical	Technology an	d Syst	ems
Courses					
Courses					
<b>Title</b> Introduction into Medic	cal Technology and Syste	ems (L0342)	<b>Typ</b> Lecture	Hrs/wk 2	<b>CP</b> 3
	cal Technology and Syste		Project Seminar	2	2
Introduction into Medi	cal Technology and Syste	ems (L1876)	Recitation Section (large)	1	1
Module Responsible	TPINI DIEVANNEI SCHIAF	efer			
Admission Requirements					
Recommended	principles of math (algebra, analysis/calculus)				
Previous Knowledge	Inrinciples of programs				
Educational Objectives	TALLEL LAKING DALL SUCC	essfully, students h	nave reached the follow	wing learn	ing results
Professional					
Competence		xplain principles (	of medical technolog	v. includi	ng imaging
Knowledge	The students can explain principles of medical technology, including imaging systems, computer aided surgery, and medical information systems. They are able to give an overview of regulatory affairs and standards in medical technology.				
Skills	The students are able to evaluate systems and medical devices in the context of clinical applications.				
Personal					
Competence	1	e a problem in m	edical technology as	a project	and define
Social Competence	tasks that are solved		edical technology as	a project,	and define
Autonomy	The students can refl They can present the		ge and document the priate manner.	results of	their work.
<b>Workload in Hours</b>	Independent Study Tir	me 110, Study Tim	e in Lecture 70		
Credit points	6				
Course achievement	10 %	<b>Form</b> Presentation Written elaborat	<b>Descript</b> ion	ion	
Examination	Written exam				
Examination duration and scale	90 minutes				
Assignment for the Following	Biomedical Engineering Computer Science: Science	ng: Compulsory Specialisation Com Decialisation II. Mat Dalification: Elective Core qualification Specialisation Biom Science (Englising: Compulsory Compu	: Elective Compulsory nedical Engineering: Co h program, 7 seme ering: Specialisation	Engineerii ering Scier ompulsory ester): Sp	ng: Elective nce: Elective , pecialisation
_	•	[661]			

Curricula	Computational Science and Engineering: Specialisation Computer Science: Elective Compulsory
	Computational Science and Engineering: Specialisation Engineering Sciences: Elective Compulsory
	Biomedical Engineering: Specialisation Artificial Organs and Regenerative Medicine: Elective Compulsory
	Biomedical Engineering: Specialisation Implants and Endoprostheses: Elective
	Compulsory Biomedical Engineering: Specialisation Medical Technology and Control Theory:
	Elective Compulsory Biomedical Engineering: Specialisation Management and Business Administration:
	Elective Compulsory Technomathematics: Specialisation III. Engineering Science: Elective Compulsory

Course L0342: Intro	oduction into Medical Technology and Systems
Тур	Lecture
Hrs/wk	2
СР	3
<b>Workload in Hours</b>	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Prof. Alexander Schlaefer
Language	DE
Cycle	SoSe
Content	<ul> <li>imaging systems</li> <li>computer aided surgery</li> <li>medical sensor systems</li> <li>medical information systems</li> <li>regulatory affairs</li> <li>standard in medical technology</li> <li>The students will work in groups to apply the methods introduced during the lecture using problem based learning.</li> </ul>
Literature	Wird in der Veranstaltung bekannt gegeben.

Course L0343: Introduction into Medical Technology and Systems	
Тур	Project Seminar
Hrs/wk	2
СР	2
<b>Workload in Hours</b>	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: Intro	oduction 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	<ul> <li>imaging systems</li> <li>computer aided surgery</li> <li>medical sensor systems</li> <li>medical information systems</li> <li>regulatory affairs</li> <li>standard in medical technology</li> <li>The students will work in groups to apply the methods introduced during the lecture using problem based learning.</li> </ul>
Literature	Wird in der Veranstaltung bekannt gegeben.

Module M1332	2: BIO I: Experimental M	ethods in Biom	echanics	
Courses				
<b>Title</b> Experimental Methods	in Biomechanics (L0377)	<b>Typ</b> Lecture	Hrs/wk	<b>CP</b> 3
Module Responsible	Prof. Michael Morlock			
Admission Requirements	None			
	It is recommended to participat attending "Experimentelle Methode		nd Frakturheilu	ıng" before
Educational Objectives	After taking part successfully, stude	ents have reached the	following learn	ing results
Professional Competence				
Knowledge	The students can describe the different ways how bones heal, and the requirements for their existence.  The students can name different treatments for the spine and hollow bones under given fracture morphologies.  The students can describe different measurement techniques for forces and			
Skills	movements, and choose the adequate technique for a given task.  The students can describe the basic handling of several experimental techniques used in biomechanics.			
Personal Competence				
Social Competence	The students can, in groups, solve l			
Autonomy	The students can, in groups, solve I	· 	ks.	
	Independent Study Time 62, Study	Time in Lecture 28		
Credit points				
Course achievement				
Examination				
Examination duration and scale				
Assignment for the Following Curricula	General Engineering Science (G Mechanical Engineering, Focus Bior General Engineering Science (G Biomedical Engineering: Compulsor Engineering Science: Specialisation General Engineering Science (E Mechanical Engineering, Focus Bior General Engineering Science (E Biomedical Engineering: Compulsor General Engineering: Compulsor General Engineering: Elective Co Mechanical Engineering: Specialisation Biomedical Engineering: Specialisation Elective Compulsory Biomedical Engineering: Specialisation Compulsory Biomedical Engineering: Specialisation	nechanics: Compulsory erman program, 7  y Biomedical Engineerir nglish program, 7 nechanics: Compulsory nglish program, 7 y nglish program, 7 ompulsory cion Biomechanics: Con cion Artificial Organs a	semester): S  ng: Elective Co semester): S  y semester): S  semester): S  mpulsory nd Regenerativ  Endoprosthes	pecialisation mpulsory pecialisation pecialisation pecialisation ve Medicine: es: Elective

Elective Compulsory Biomedical Engineering: Specialisation Management and Business Administration: Elective Compulsory
Technomathematics: Specialisation III. Engineering Science: Elective Compulsory

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

Module M0829	9: Foundations of Manage	ment		
Courses				
<b>Title</b> Management Tutorial (		<b>Typ</b> Recitation (small)	Hrs/wk Section 2	<b>CP</b> 3
Introduction to Manage		Lecture	3	3
Admission Requirements	110000			
Recommended Previous Knowledge	Basic Knowledge of Mathematics and	Business		
Educational Objectives	LATTER TAKING NART CHCCECCTHIN CTHOON	s have reached	the following learn	ing results
Professional Competence				
Knowledge	<ul> <li>describe and explain basic bu and sourcing, supply chain man management, information m marketing</li> <li>explain the relevance of plann situations under multiple object methods from mathematical Fir</li> <li>state basics from accounting an</li> </ul>	from Planning ant and Controllicen Economics at to name important process of and goentreprneurial process functions angement, organagement, ir ing and decisions and uncertance and costing and so	and Organisation to ng. In particular the nd Management a rtant definitions from als in Management rojects is as production, production, production and human innovation management making in Busing tainty, and explain	no Marketing ney are able and the sub- om the field at and name are courement and ness, esp. in a some basic methods.
Skills	Students are able to analyse busing (organization, objectives, strategies project in a team. In particular, they are analyse Management goals and analyse organisational and staff apply methods for decision uncertainty and under risk analyse production and processystems analyse and apply basic method select and apply basic method problems apply basic methods from accomproblems	etc.) and to care able to structure them f structures of care making under urement system ds of marketing ds from mather	arry out an Entre appropriately ompanies r multiple object ns and Business matical finance to	epreneurship ives, under information predefined
Personal Competence	Students are able to  work successfully in a team of s			
	to apply their knowledge from t	the lecture to ar	ı entrepreneurship	project and

Social Competence	write a coherent report on the project  to communicate appropriately and  to cooperate respectfully with their fellow students.
Autonomy	Students are able to  • work in a team and to organize the team themselves  • to write a report on their project.
<b>Workload in Hours</b>	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	several written exams during the semester
the Following	General Engineering Science (German program, 7 semester): Core qualification: Compulsory Civil- and Environmental Engineering: Core qualification: Compulsory Civil- and Environmental Engineering: Specialisation Civil Engineering: Elective Compulsory Civil- and Environmental Engineering: Specialisation Water and Environment: Elective Compulsory Civil- and Environmental Engineering: Specialisation Traffic and Mobility: Elective Compulsory Computer Science: Core qualification: Compulsory Bioprocess Engineering: Core qualification: Compulsory Computer Science: Core qualification: Compulsory Data Science: Core qualification: Compulsory Electrical Engineering: Core qualification: Compulsory Energy and Environmental Engineering: Core qualification: Compulsory General Engineering Science (English program, 7 semester): Specialisation Electrical Engineering: Compulsory General Engineering Science (English program, 7 semester): Specialisation Civil Engineering: Compulsory General Engineering Science (English program, 7 semester): Specialisation Bioprocess Engineering: Compulsory General Engineering Science (English program, 7 semester): Specialisation Energy and Environmental Engineering: Compulsory General Engineering Science (English program, 7 semester): Specialisation Computer Science: Compulsory General Engineering Science (English program, 7 semester): Specialisation Mechanical Engineering, Focus Biomechanics: Compulsory General Engineering Science (English program, 7 semester): Specialisation Mechanical Engineering, Focus Biomechanics: Compulsory General Engineering Science (English program, 7 semester): Specialisation Mechanical Engineering, Focus Aircraft Systems Engineering; Compulsory General Engineering Science (English program, 7 semester): Specialisation Mechanical Engineering, Focus Meterials in Engineering; Compulsory General Engineering Science (English program, 7 semester): Specialisation Mechanical Engineering, Focus Mechatronics: Compulsory General Engineering Science (English program, 7 semester): Spe

Mechatronics: Core qualification: Compulsory

Orientierungsstudium: Core qualification: Elective Compulsory

Naval Architecture: Core qualification: Compulsory Technomathematics: Core qualification: Compulsory Process Engineering: Core qualification: Compulsory

Course L0882: Man	agement Tutorial
Тур	Recitation Section (small)
Hrs/wk	2
СР	3
<b>Workload in Hours</b>	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Prof. Christoph Ihl, Katharina Roedelius, Tobias Vlcek
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 self-selected projects that focus on the elaboration of an innovative business idea from the point of view of an established company or a startup. Again, the business knowledge from the lecture should come to practical use. The group projects are guided by a mentor.
Literature	Relevante Literatur aus der korrespondierenden Vorlesung.

Course L0880: Intr	oduction to Management
Тур	Lecture
Hrs/wk	3
СР	3
<b>Workload in Hours</b>	Independent Study Time 48, Study Time in Lecture 42
Lecturer	Prof. Christoph Ihl, Prof. Thorsten Blecker, Prof. Christian Lüthje, Prof. Christian Ringle, Prof. Kathrin Fischer, Prof. Cornelius Herstatt, Prof. Wolfgang Kersten, Prof. Matthias Meyer, Prof. Thomas Wrona
Language	DE
Cycle	WiSe/SoSe
Content	<ul> <li>Introduction to Business and Management, Business versus Economics, relevant areas in Business and Management</li> <li>Important definitions from Management,</li> <li>Developing Objectives for Business, and their relation to important Business functions</li> <li>Business Functions: Functions of the Value Chain, e.g. Production and Procurement, Supply Chain Management, Innovation Management, Marketing and Sales         <ul> <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> </ul> </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 M1280	): MED II: Introduc	tion to Physiology	
Courses			
Title		Тур	Hrs/wk CP
Introduction to Physiol		Lecture	2 3
Module Responsible	Dr. Roger Zimmermann		
Admission Requirements	None		
Recommended Previous Knowledge			
Educational Objectives	After taking part successfu	illy, students have reached the	e following learning results
Professional Competence			
Knowledge		of the energy metabolism; cal relations in selected fields	of muscle, heart/circulation,
Skills	transmission and process	physiology.  ribe the effects of basic listing of information, developed to similar technical systems.	
Personal Competence		to similar technical systems.	
Social Competence		discussions in research and m olutions to problems in the l.	
Autonomy		answers to questions arising technical literature, by themse	
		2, Study Time in Lecture 28	
Credit points	3		
Course achievement	None		
Examination	Written exam		
Examination duration and scale	60 minutes		
the Following	Biomedical Engineering: Co General Engineering Sci Mechanical Engineering, Fo Data Science: Specialisation Electrical Engineering: Spec Engineering Science: Spec General Engineering Sci Mechanical Engineering; Fo General Engineering: Sci Biomedical Engineering: Sci Biomedical Engineering: El Mechanical Engineering: Sci	ence (German program, 7 pocus Biomechanics: Compulson Medicine: Compulsory ecialisation Medical Technology ialisation Biomedical Engineer (English program, 7 pocus Biomechanics: Compulson ience (English program, 7 pompulsory ience (English program, 7 pompulsory ience (English program, 7	semester): Specialisation ry  y: Elective Compulsory ing: Elective Compulsory semester): Specialisation ry semester): Specialisation semester): Specialisation ompulsory

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: Intr	Course L0385: Introduction to Physiology		
Тур	Lecture		
Hrs/wk	2		
СР	3		
<b>Workload in Hours</b>	Independent Study Time 62, Study Time in Lecture 28		
Lecturer	Dr. Gerhard Engler, 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		

## **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 M0933	3: Fundamentals of Material	s Science		
Courses				
Polymers and Composi	rials Science II (Advanced Ceramic Materials,	Typ Lecture Lecture Lecture	<b>Hrs/wk</b> 2 2	<b>CP</b> 2 2
	Prof. Jörg Weißmüller			
Admission	None			
Recommended Previous Knowledge	Highschool-level physics, chemistry und	mathematics		
Educational Objectives	After taking part successfully, students h	ave reached the follo	wing learn	ing results
Professional Competence				
Knowledge	The students have acquired a fundam polymers and can describe this kr knowledge here means specifically the phase diagrams, phase transformations students know about the key aspects of can identify relevant approaches for cable to trace materials phenomena baclaws of nature.	nowledge comprehe issues of atomic stru , corrosion and mech characterization met haracterizing specifi	nsively. Foucture, mice anical properties for mice and the formal for mice and the formal for	undamental crostructure, perties. The naterials and s. They are
Skills	The students are able to trace materials and chemical laws of nature. Materia properties such as strength, ductility, corrosion resistance, and to phase precipitation, or melting. The students conditions and the materials microstruct microstructure on the material's behavio	Is phenomena here and stiffness, chemic transformations an explain the relationere, and they can according to the state of	refers to cal propert such as s on betweer	mechanical ies such as olidification, n processing
Personal Competence				
Social Competence	-			
Autonomy	-			
	Independent Study Time 96, Study Time	in Lecture 84		
Credit points	6			
Course				

achievement	None
Examination	Written exam
Examination duration and scale	180 min
Assignment for the Following Curricula	

Course L1085: Fundamentals of Materials Science I		
Тур	Lecture	
Hrs/wk	2	
СР	2	
<b>Workload in Hours</b>	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: Fun and Composites)	damentals of Materials Science II (Advanced Ceramic Materials, Polymers
Тур	Lecture
Hrs/wk	2
СР	2
<b>Workload in Hours</b>	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

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

Module M1118	8: Hydrostatics and Body Pla	n		
Courses				
Title		Тур	Hrs/wk	СР
Hydrostatics (L1260)		Lecture	2	3
Hydrostatics (L1261)		Recitation Section (large)	n <sub>2</sub>	1
Body Plan (L1452)		Project Seminar	2	2
Module Responsible	Prof. Stefan Krüger			
Admission Requirements	LNIANA			
Recommended	Good knowledge in Mathemathics I-III and	d Mechanics I-III.		
Previous	It is recommended that the students drawings, e.g. Body Plan, GA- Plan, Tank		/pical desi	gn relevant
Educational Objectives	After taking part successfully, students ha	ave reached the follo	wing learni	ng results
Professional Competence				
Knowledge	The lecture enables the student to carry for ship design on a scientific level. The lefectures in the subjects shipo design and	ecture is basic requir		
Skills	The student is able to carry out hydrosta sufficient stability. He is able to design his sinking.			
Personal				
Competence				
Social Competence	The student gets access to hydrostatical	problems.		
Autonomy				
	Independent Study Time 96, Study Time	in Lecture 84		
Credit points				
Course achievement	None			
Examination	Written exam			
Examination duration and scale				
the Following	General Engineering Science (German p Architecture: Compulsory General Engineering Science (German p Architecture: Compulsory General Engineering Science (English po Architecture: Compulsory General Engineering Science (English po Architecture: Compulsory Naval Architecture: Core qualification: Co	rogram, 7 semester rogram, 7 semester) rogram, 7 semester)	): Specialis	ation Naval ation Naval

Course L1260: Hydrostatics	
Тур	Lecture
Hrs/wk	2
СР	3

Lecturer	Prof. Stefan Krüger
Language	
Cycle	
	1. Numerical Integration, Diffrentation, Interpolation
	- Trapezoidal Rule, Simpson, Tschebyscheff, graphical Integration Methods
	- Determination of Areas, 1st and 2nd order Moments
	- Numerical Diffrentation, Spline Interpolation
	2. Buyoancy
	- Principle of Archimedes
	- Equlibrium Floating Condition
	- Equlibrium Computations
	- Hydrostatic Tables and Sounding Tables
	- Trim Tables
	3. Stability at large heeling angles
	- Stability Equation
	- Cross Curves of Stability and Righting Levers
	- Numerical and Graphical Determination of Cross Curves
	- Heeling Moments of Free Surfaces, Water on Deck, Water Ingress
	- Heeling Moments of Different Type
	- Balance of Heeling and Righting Moments acc. to BV 1030
	- Intact Stability Code (General Critaria)
	4. Linearization of Stability Problems
	- Linearization of Restoring Forces and Moments
	- Correlation between Metacentric Height and Righting Lever at small heeling angles
	- Computation of Path of Metacentric Height for Modern Hull Forms
	- Correlation between Righting Lever and Path of Metacentric Height
	- Hydrostatic Stiffness Matrix
	- Definition of MCT
	- Computation of Equilibrum Floating Conditions from Hydrostatic Tables
	- Effect of Free Surfaces on Initial GM
	- Roll Motions at Small Roll Angles
	6. Stability in Waves
	- Roll Motions at Large Amplitudes
	- Pure Loss of Stability on the Wave Crest
	- Principle of Parametric Excitation
	- Principle of Direct Wave Moments

- Grim's Equivalent Wave Concept
- 6 Longitudinal Strength
  - Longitudinal Mass Distribution, Shear Forces, Bending Moments
  - Longitudinal Strength in Stability Booklet
- 7. Deadweight Survey and Inclining Experiment
  - Deplacement Computations from Draft mark Readings
  - Weights to go on /come from board
  - Inclining Experiment with Heeling Moments from Weights and Heeling Tanks
  - Residual Sounding Volumes
  - Determination of COG from Metacentric height and from Cross Curves
  - Roll Decay Test
- 8. Launching and Docking
  - Launching Plan, Arrangement of Launching Blocks
  - Rigid Body Launching: Tilting, Dumping, Equation of Techel
  - Computation of Launching Event
  - Bottom Pressure and Longitudinal Strength
  - Linear- Elastic Effects
  - Transversal Stability on Slipway and in Dock
- 9. Grounding
  - Loss of Buoynacy when Grounded
  - Pointwise Grounding
  - Ship Grounds on Keel
- 10. Introduction into Damage Stability Problems
  - Added Mass Method
  - Loss of Buoyant Volume Method
  - Simple Equilibrium Computations
  - Intermediate Stages of Flooding (Addes Mass Method), Cross- and Downflooding
  - Water Ingress Through Openings
- 11. Special Problems (optional and agreed upon)
  - e.g. Heavy Lift Operations
  - e.g. Jacking of Jackup Vessels
  - e.g. Sinking After Water Ingress
- 1. Herner/Rusch: Die Theorie des Schiffes Fachbuchverlag Leipzig
- Henschke Schiffstechnisches Handbuch, Band 1 VEB Technik Verlag Berlin

Literature

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: Bod	v Plan
	Project Seminar
Hrs/wk	
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	<ol> <li>Herner/Rusch: Die Theorie des Schiffes Fachbuchverlag Leipzig</li> <li>Henschke Schiffstechnisches Handbuch, Band 1 VEB Technik Verlag Berlin</li> <li>Das Skript zur Vorlesung, Anwendungsbeispiele und Klausuren sind auf unserei Homepage abrufbar.</li> </ol>

Module M0730	0: Computer Engineerii	ng		
Courses				
<b>Title</b> Computer Engineering Computer Engineering		<b>Typ</b> Lecture Recitation	Hrs/wk 3 Section 1	<b>CP</b> 4
		(small)	-	
пезропзівіє	Prof. Heiko Falk			
Admission Requirements	None			
Recommended Previous Knowledge	Basic knowledge in electrical eng	ineering		
Educational Objectives	LATTER TAKING NART SHCCESSTILLV STI	udents have reached t	he following learr	ning 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 functions, hardware synthesis, combinational networks • Sequential logic: Flip-flops, automata, systematic hardware design			
Skills	The students perceive computer identify the internal structure at The students can analyze, how hosed on a collection of few and between and to explain the disystems - from gates and circuits. After successful completion of interdependencies between a phon it. In particular, they shall unsoftware has on the hardwar language down to gates. This was these low abstraction levels hoppose feasible options.	nd the physical compighly specific and indiction of simple components. Ifferent abstraction of the module, the studysical computer system of the consequence of the module, the study sical computer system of the consequence of the module, the consequence, they will be enable	osition of compuvidual computers They are able to layers of today's essors.  dents are able to mand the software and the layers from the document to evaluate the	ter systems. can be built distinguish computing o judge the executed execution of e assembly impact that
Personal Competence		ar problems alone or i	n a group and to	present the
Autonomy	Students are able to acquire associate this knowledge with otl		n specific litera	ture and to
Workload in Hours	Independent Study Time 124, Stu	udy Time in Lecture 56	5	
Credit points	6			

[	<del></del>				
Course achievement	Compulsor <b>₽</b> onus Yes 10 %	Form Excercises	Desc	ription	
Examination		Execteises			
-	,				
Examination duration and scale	90 minutes, contents of	course and labs			
	General Engineering Computer Science: Com		program, 7	semester):	Specialisation
	General Engineering Bioprocess Engineering	Science (German	program, 7	semester):	Specialisation
	General Engineering So Architecture: Compulso	cience (German pro	gram, 7 semes	ster): Specia	alisation Naval
	General Engineering Electrical Engineering: (	Ścience (German	program, 7	semester):	Specialisation
	General Engineering Biomedical Engineering	Science (German	program, 7	semester):	Specialisation
	General Engineering Sc and Enviromental Engin	cience (German prog		ter): Special	isation Energy
	General Engineering Sc Engineering: Compulsor	ience (German prog		er): Speciali	sation Process
	General Engineering Mechanical Engineering				Specialisation
	General Engineering Mechanical Engineering				Specialisation
	General Engineering Mechanical Engineering				
	General Engineering Mechanical Engineering				
	General Engineering Mechanical Engineering				
	General Engineering				
	Mechanical Engineering General Engineering	Science (German	program, 7	semester):	
	Mechanical Engineering General Engineering Mechanical Engineering	Science (German	program, 7	sémester):	Specialisation
	General Engineering So Engineering: Compulsor	cience (German pro			ialisation Civil
	Computer Science: Core		nulsory		
Assignment for	Data Science: Core qua				
	Electrical Engineering: (				
Curricula	General Engineering Sc Engineering: Compulsor		am, 7 semeste	r): Specialis	ation Electrical
	General Engineering S Engineering: Compulsor	cience (English pro	ogram, 7 seme	ester): Spec	ialisation Civil
	General Engineering Bioprocess Engineering	Science (English	program, 7	semester):	Specialisation
	General Engineering Sc and Enviromental Engin	cience (English prog		er): Special	isation Energy
	General Engineering Computer Science: Com		program, 7	semester):	Specialisation
	General Engineering Mechanical Engineering	, Focus Biomechani	cs: Compulsory	,	
	General Engineering Mechanical Engineering	, Focus Energy Syst	ems: Compulso	ory	
	General Engineering Mechanical Engineering	, Focus Aircraft Syst	tems Engineerir	ng: Compuls	sory
	General Engineering Mechanical Engineering	, Focus Materials in	Engineering Sc	iences: Con	npulsory
	General Engineering Mechanical Engineering	, Focus Mechatronic	s: Compulsory		
	General Engineering Mechanical Engineering				

General Engineering Science (English program, 7 semester): Specialisation Mechanical Engineering, Focus Theoretical Mechanical Engineering: Compulsory General Engineering Science (English program, 7 semester): Specialisation Naval Architecture: Compulsory General Engineering Science (English program, 7 semester): Specialisation Process Engineering: Compulsory General Engineering Science (English program, 7 semester): Specialisation Biomedical Engineering: Compulsory Computational Science and Engineering: Core qualification: Compulsory Mechatronics: Core qualification: Compulsory Technomathematics: Specialisation II. Informatics: Elective Compulsory

Course L0321: Com	puter Engineering
Тур	Lecture
Hrs/wk	3
СР	4
<b>Workload in Hours</b>	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	
<b>Workload in Hours</b>	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				
			Hara foods	CD
<b>Title</b> Mechanics IV (Oscillations, Analytical Mechanics, Numerical		Тур	Hrs/wk	СР
Mechanics) (L1137)		Lecture	3	3
Mechanics IV (Oscillati Mechanics) (L1138)	ons, Analytical Mechanics, Numerical	Recitation (small)	Section 2	2
	ons, Analytical Mechanics, Numerical	Recitation	Section 1	1
Mechanics) (L1139)	1	(large)		
Module Responsible	I Prof. Robert Seitrien			
Admission Requirements	LNODE			
Recommended Previous	Mathematics I-III and Mechanics I-III			
Previous Knowledge				
Educational Objectives	LATTER FAKING NART CHECKECTHING CHINENT	s have reached	the following learr	ning results
Professional				
Competence	  The students can			
Knowledge	<ul> <li>describe the axiomatic procedure used in mechanical contexts;</li> <li>explain important steps in model design;</li> </ul>			
	<ul> <li>present technical knowledge.</li> </ul>	, , , , , , , , , , , , , , , , , , ,		
	l The students can			
	explain the important element	es of mathemat	ical / machanical	analysis an
	model formation, and apply it t	o the context of		
Skills	<ul> <li>apply basic methods to engineering problems;</li> <li>estimate the reach and boundaries of the methods and extend them to be</li> </ul>			
	applicable to wider problem set		ctilous and exterio	them to b
Personal				
Competence				
Social Competence	The students can work in groups and	support each ot	her to overcome di	fficulties.
	Students are capable of determining	their own stre	ngths and weakne	esses and t
Autonomy	organize their time and learning base	d on those.	_	
Workload in Hours	Independent Study Time 96, Study Tir	me in Lecture 84	1	
Credit points	6			
Course achievement				
	J Written exam			
Examination				
duration and	120 min			
scale		man program	7 samastorly S	nacialicatio
	Mechanical Engineering: Compulsory			•
	General Engineering Science (Ger Biomedical Engineering: Compulsory	man program,	7 semester): S	pecialisatio
	General Engineering Science (Germa	n program 7 s	emester): Speciali	sation Nav

	Architecture: Compulsory		
	Energy Systems: Technical Complementary Course Core Studies: Elective		
	Compulsory		
Assignment for	General Engineering Science (English program, 7 semester): Specialisation		
	Mechanical Engineering: Compulsory		
Curricula	General Engineering Science (English program, 7 semester): Specialisation Naval		
	Architecture: Compulsory		
	General Engineering Science (English program, 7 semester): Specialisation		
	Biomedical Engineering: Compulsory		
	Mechanical Engineering: Core qualification: Compulsory		
	Mechatronics: Core qualification: Compulsory		
	Naval Architecture: Core qualification: Compulsory		
	Technomathematics: Specialisation III. Engineering Science: Elective Compulsory		
	Theoretical Mechanical Engineering: Technical Complementary Course Core Studies:		
	Elective Compulsory		

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

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	
<b>Workload in Hours</b>	Independent Study Time 16, Study Time in Lecture 14	
Lecturer	Prof. Robert Seifried	
Language	DE	
Cycle	SoSe	
Content	See interlocking course	
Literature	See interlocking course	

Module M0854	4: Mathematics IV			
Courses				
<b>Title</b> Differential Equations	2 (Partial Differential Equations) (L1043)	Typ Lecture	Hrs/wk	<b>CP</b> 1
Differential Equations	2 (Partial Differential Equations) (L1044)	Recitation (small)	Section 1	1
Differential Equations	2 (Partial Differential Equations) (L1045)	Recitation (large)	Section 1	1
Complex Functions (L1	.038)	Lecture	2	1
Complex Functions (L1	.041)	Recitation (small)	Section 1	1
Complex Functions (L1	.042)	Recitation (large)	Section 1	1
Module Responsible	Prof. Anusch Taraz			
Admission Requirements	None			
Recommended Previous Knowledge	Mathematics 1 - III			
Educational Objectives	After taking part successfully, students	have reached	the following learr	ning results
Professional Competence				
Knowledge	<ul> <li>Students can name the basic of explain them using appropriate of the students can discuss logical correspond to the students can discuss logical correspond to the students can discuss logical correspond to the students and students are students.</li> <li>They know proof strategies and students can be students.</li> </ul>	examples. nnections betw nections with t	een these concept he help of example	s. They are
Skills	<ul> <li>Students can model problems in Mathematics IV with the help of the concep studied in this course. Moreover, they are capable of solving them to 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 suitab approach, and are able to critically evaluate the results.</li> </ul>			ng them by
Personal Competence				
Social Competence	<ul> <li>Students are able to work tog mathematics as a common lange</li> <li>In doing so, they can communic their cooperating partners. Mor and deepen the understanding of</li> </ul>	uage. cate new conce reover, they c	epts according to 1	the needs o
Autonomy	<ul> <li>Students are capable of checking on their own. They can specify get help in solving them.</li> <li>Students have developed sufficing</li> </ul>	open questions	s precisely and kn	ow where to

	periods in a goal-oriented manner on hard problems.			
Workload in Hours	Independent Study Time 68, Study Time in Lecture 112			
Credit points				
Course achievement	None			
Examination	Written exam			
Examination duration and scale	60 min (Complex Functions) + 60 min (Differential Equations 2)			
the Following	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 semester): Specialisation Naval Architecture: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Theoretical Mechanical Engineering: Elective Compulsory Computer Science: Specialisation Computational Mathematics: Elective Compulsory Computer Science: Specialisation II. Mathematics and Engineering Science: Elective Compulsory Computer Science: Specialisation Electrical Engineering: Compulsory Engineering Science: Specialisation Electrical Engineering: Compulsory General Engineering Science (English program, 7 semester): Specialisation Electrical Engineering: Compulsory General Engineering Science (English program, 7 semester): Specialisation Electrical Engineering: Compulsory General Engineering Science (English program, 7 semester): Specialisation Mechanical Engineering, Focus Mechatronics: Compulsory General Engineering Science (English program, 7 semester): Specialisation Mechanical Engineering, Focus Theoretical Mechanical Engineering: Compulsory General Engineering Science (English program, 7 semester): Specialisation Naval Architecture: Compulsory Computational Science and Engineering: Specialisation II. Mathematics & Engineering Science: Elective Compulsory Mechanical Engineering: Specialisation Mechatronics: Compulsory Mechanical Engineering: Specialisation Theoretical Mechanical Engineering: Elective Compulsory Mechanical Engineering: Specialisation Theoretical Mechanical Engineering: Elective Compulsory Mechanical Engineering: Specialisation: Compulsory Mechanical Engineering: Specialisation: Compulsory Mechanical Engineering: Core qualification: Compulsory Mechanical Engineering: Elective Compulsory			

Course L1043: Diffe	erential Equations 2 (Partial Differential Equations)
Тур	Lecture
Hrs/wk	2
СР	1
<b>Workload in Hours</b>	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  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
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	
<b>Workload in Hours</b>	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	
<b>Workload in Hours</b>	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	
<b>Workload in Hours</b>	Independent Study Time 2, Study Time in Lecture 28	
Lecturer	Dozenten des Fachbereiches Mathematik der UHH	
Language	DE	
Cycle	SoSe	
Content	<ul> <li>Main features of complex analysis</li> <li>Functions of one complex variable</li> <li>Complex differentiation</li> <li>Conformal mappings</li> <li>Complex integration</li> <li>Cauchy's integral theorem</li> <li>Cauchy's integral formula</li> <li>Taylor and Laurent series expansion</li> <li>Singularities and residuals</li> <li>Integral transformations: Fourier and Laplace transformation</li> </ul>	
Literature	<ul> <li>http://www.math.uni-hamburg.de/teaching/export/tuhh/index.html</li> </ul>	

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

Module M0680	0: Fluid Dynamics	
Courses		
Title	Typ Hrs/v	wk CP
Fluid Mechanics (L0454		4
Fluid Mechanics (L045	Recitation Section 2 (large)	2
Module Responsible	Prof. Thomas Rung	
Admission Requirements	INONG	
Recommended Previous Knowledge	Sound knowledge of engineering mathematics, engineering thermodynamics.	mechanics and
Educational Objectives	I ATTOR TAKING NART CHECOCCILIIIV STUDONIS NAVO ROACNOO TOO TOUOWING I	earning results
Professional		
Competence	Students will have the required sound knowledge to explain the gen	eral principles of
Knowledge	fluid engineering and physics of fluids. Students can scientific rationale of flow physics using mathematical models and are familiar for the performance analysis and the prediciton of fluid engineering	ally outline the ar with methods
Skills	Students are able to apply fluid-engineering principles and flow-ph the analysis of technical systems. The lecture enables the student necessary theoretical calculations for the fluid dynamic design devices on a scientific level.	to carry out all
Personal Competence Social Competence	The students are able to discuss problems and jointly develop solution	on strategies.
Autonomy	The students are able to develop solution strategies for complex consistent and crtically analyse results.	c problems self-
Workload in Hours	Independent Study Time 110, Study Time in Lecture 70	
Credit points		
Course achievement	None	
Examination	Written exam	
Examination duration and scale	<b>1</b> 180 min	
Assignment for the Following Curricula	General Engineering Science (English program, 7 semester): Spec	<ul><li>Specialisation</li><li>Cialisation Naval</li><li>Specialisation</li><li>Cialisation Naval</li></ul>

Biomedical Engineering: Compulsory
Computational Science and Engineering: Specialisation Engineering Sciences:
Elective Compulsory
Mechanical Engineering: Core qualification: Compulsory
Naval Architecture: Core qualification: Compulsory
Technomathematics: Specialisation III. Engineering Science: Elective Compulsory

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

Course L0455: Fluid Mechanics		
Тур	Recitation Section (large)	
Hrs/wk	2	
СР	2	
<b>Workload in Hours</b>	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	

COLLEGGE					
Courses					<u></u>
<b>Title</b> Fundamentals of Ship Structural Design (L0411)		<b>Typ</b> Lecture		Hrs/wk 2	<b>CP</b> 2
·	Structural Design (L0413)	Recitation	Section	_	2
·	Structural Analysis (L0410)	(small) Lecture		2	2
	Structural Analysis (L0414)	Recitation	Section	=	2
r undamentals of Ship	oti detarar Ariary 313 (20414)	(small)			
Module Responsible	Prof. Sören Ehlers				
Admission Requirements	None				
Recommended Previous Knowledge	Mechanics I - III Fundamentals of Materials Scien Welding Technology I Fundamentals of Mechanical Des				
Educational Objectives	After taking part successfully, st	udents have reached	the follow	ving learn	ing results
Professional Competence					
Knowledge	Students can reproduce the basic contents of the structural behaviour of structures; they can explain the theory and methods for the calculation deformations and stresses in beam-like structures.  Furthermore, they can reproduce the basis contents of codes (rules), material semi-finished products, joining and principles of structural design of components the ship structure.				
Skille	Students are capable of applying deformations and stresses in t calculation models of typical ship	he above mentioned p structures.	d structur	res; they	can choo
SKIIIS	Furthermore, they are capable to structure; they can select suitab				
Personal Competence					
Social Competence	The students are able to commu in the shipbuilding and compone	unicate and cooperate ent supply industry.	e in a prot	fessional e	environme
	The students are capable to in select suitable methods for anal assess the results of structural a	alysis of beam-like s			
Autonomy	Furthermore, they are capable to design ship structures for variou				
Workload in Hours	Independent Study Time 156, St	udy Time in Lecture	34		

Course achievement	
Examination	Written exam
Examination duration and scale	3 hours
the Following Curricula	General Engineering Science (German program, 7 semester): Specialisation Naval Architecture: Compulsory General Engineering Science (English program, 7 semester): Specialisation Naval Architecture: Compulsory Naval Architecture: Core qualification: Compulsory

Course L0411: Fundamentals of Ship Structural Design		
Тур	Lecture	
Hrs/wk	2	
СР	2	
<b>Workload in Hours</b>	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 of Ship Structural Design		
Тур	Recitation Section (small)	
Hrs/wk	1	
СР	2	
<b>Workload in Hours</b>	Independent Study Time 46, Study Time in Lecture 14	
Lecturer	Prof. Sören Ehlers	
Language	DE	
Cycle	WiSe	
Content	Chapters:  1. Introduction  3. Class societies and their tasks  4. Materials for steel shipbuilding  5. Welding and Cutting  6. Semi-finished products in steel shipbuilding  7. Determining the scantlings for local loads  8. Longitudinal strength of the hull girder  9. Determining the scantlings of longitudinal structural members  10. Determining the scantlings of bottom and side structures  11. Decks and Hatch Openings  12. Effective breadth  13. Iterative determination of scantlings (POSEIDON)	
Literature	Vorlesungsskript mit weiteren Literaturangaben wird über das Internet verfügbar gemacht	

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

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

Module M0664	l: Structural Design and	l Construction	of Ships	
Courses				
<b>Title</b> Ship Structural Design Ship Structural Design		<b>Typ</b> Lecture Recitation (small)	Hrs/wk 2 Section 2	<b>CP</b> 3
Welding Technology (L	1123)	Lecture	3	3
Module Responsible	Prof. Sören Ehlers			
Admission Requirements	None			
Previous	Mechanics I - III Fundamentals of Materials Science Welding Technology I Fundamentals of Mechanical Desig			
Educational Objectives	After taking part successfully, stud	ents have reached t	he following learr	ning results
Professional Competence Knowledge	Students can reproduce design a areas of ship structures and of d describe calculation models for co	ifferent ship types (		
Skills	Students are capable to specify th of the hull, to define design c calculation models and to assess t	riteria for the com		
Personal Competence Social Competence Autonomy	Students are capable to present to constructively in a group.  Students are capable to design in hull and different ship types and to	dependently differer	nt structural area	s of the ship
Workload in Hours	Independent Study Time 172, Stud	ly Time in Lecture 98	3	
Credit points	9			
Course achievement	None			
Examination	Written exam			
Examination duration and scale				
Assignment for	General Engineering Science (Ger Architecture: Compulsory	man program, 7 se	mester): Speciali	sation Naval

**the Following** General Engineering Science (English program, 7 semester): Specialisation Naval **Curricula** Architecture: Compulsory

Naval Architecture: Core qualification: Compulsory

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

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

Course L1123: Wel	ding Technology
Тур	Lecture
Hrs/wk	3
СР	3
<b>Workload in Hours</b>	Independent Study Time 48, Study Time in Lecture 42
Lecturer	Prof. Claus Emmelmann, Prof. Karl-Ulrich Kainer
Language	
Cycle	
	- 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
Content	- 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
	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.
Literature	Dilthey, U.: Schweißtechnische Fertigungsverfahren, Bd. 2: Verhalten der Werkstoffe beim Schweißen, 3. Aufl., Berlin 2005.
	Dilthey, U.: Schweißtechnische Fertigungsverfahren, Bd. 3: Gestaltung und Festigkeit von Schweißkonstruktionen, 2. Aufl., Berlin 2002.

Courses				
Title		Тур	Hrs/wk	СР
Introduction to Control	Systems (L0654)	Lecture	2 Continu	4
ntroduction to Control	Systems (L0655)	Recitation (small)	Section 2	2
Module Responsible	Prof. Herbert Werner			
Admission Requirements	None			
Recommended Previous Knowledge	Representation of signals and systems in time and frequency domain, Laplace transform			
Educational Objectives	LATTOR FAVING NART CHECKDECTHING CTH	dents have reached t	he following learr	ning result
Professional Competence				
Knowledge	<ul> <li>Students can represent domain, and can in partice systems</li> <li>They can explain the dynamore properties in terms of frequency from it.</li> <li>They can explain the Nyoderived from it.</li> <li>They can explain the role control loops</li> <li>They can explain the way a frequency response</li> <li>They can explain issues and domain are implemented description.</li> </ul>	ular explain propertion mics of simple control lency response and re quist stability criterion of the phase margin a PID controller affect	ies of first and soll loops and interpoot locus on and the stabining and analysis and solve a control loop in	econd orderet dynan lity marg synthesis a terms of
Skills	<ul> <li>Students can transform models of linear dynamic systems from time frequency domain and vice versa</li> <li>They can simulate and assess the behavior of systems and control loops</li> <li>They can design PID controllers with the help of heuristic (Ziegler-Nichol tuning rules</li> <li>They can analyze and synthesize simple control loops with the help of rollocus and frequency response techniques</li> <li>They can calculate discrete-time approximations of controllers designed continuous-time and use it for digital implementation</li> <li>They can use standard software tools (Matlab Control Toolbox, Simulink) for carrying out these tasks</li> </ul>			
Personal Competence Social Competence	Students can work in small g		ve technical pro	oblems, a
Autonomy	Students can obtain information documentation, experiment guide  They can assess their knowledge	from provided sources) and use it when so	olving given probl	ems.

<b>Workload in Hours</b>	Independent Study Time 124, Study Time in Lecture 56		
Credit points			
Course achievement	None		
Examination	Written exam		
Examination duration and scale			
the Following	General Engineering Science (German program, 7 semester): Core qualification: Compulsory Bioprocess Engineering: Core qualification: Compulsory Computer Science: Specialisation Computational Mathematics: Elective Compulsory Data Science: Core qualification: Elective Compulsory Electrical Engineering: Core qualification: Compulsory Electrical Engineering: Core qualification: Compulsory Energy and Environmental Engineering: Core qualification: Compulsory General Engineering Science (English program, 7 semester): Specialisation Electrical Engineering: Compulsory General Engineering Science (English program, 7 semester): Specialisation Civil Engineering: Compulsory General Engineering Science (English program, 7 semester): Specialisation Bioprocess Engineering: Compulsory General Engineering Science (English program, 7 semester): Specialisation Energy and Enviromental Engineering: Compulsory General Engineering Science (English program, 7 semester): Specialisation Computer Science: Compulsory General Engineering Science (English program, 7 semester): Specialisation Mechanical Engineering, Focus Biomechanics: Compulsory General Engineering Science (English program, 7 semester): Specialisation Mechanical Engineering, Focus Energy Systems: Compulsory General Engineering Science (English program, 7 semester): Specialisation Mechanical Engineering, Focus Materials in Engineering: Compulsory General 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 Mechatronics: 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 (		

Course L0654: Intro	oduction to Control Systems
	Lecture
Hrs/wk	
СР	
Workload in Hours	Independent Study Time 92, Study Time in Lecture 28
	Prof. Herbert Werner
Language	DE
Cycle	WiSe
	<ul> <li>Linear systems, differential equations and transfer functions</li> <li>First and second order systems, poles and zeros, impulse and step response</li> <li>Stability</li> <li>Feedback systems</li> <li>Principle of feedback, open-loop versus closed-loop control</li> <li>Reference tracking and disturbance rejection</li> <li>Types of feedback, PID control</li> <li>System type and steady-state error, error constants</li> </ul>
Content	<ul> <li>Internal model principle</li> <li>Root locus techniques</li> <li>Root locus plots</li> <li>Root locus design of PID controllers</li> <li>Frequency response techniques</li> <li>Bode diagram</li> <li>Minimum and non-minimum phase systems</li> <li>Nyquist plot, Nyquist stability criterion, phase and gain margin</li> <li>Loop shaping, lead lag compensation</li> <li>Frequency response interpretation of PID control</li> </ul>
	<ul> <li>Root locus and frequency response of time delay systems</li> <li>Smith predictor</li> <li>Digital control</li> <li>Sampled-data systems, difference equations</li> <li>Tustin approximation, digital implementation of PID controllers</li> <li>Software tools</li> <li>Introduction to Matlab, Simulink, Control toolbox</li> <li>Computer-based exercises throughout the course</li> </ul>
Literature	<ul> <li>Werner, H., Lecture Notes "Introduction to Control Systems"</li> <li>G.F. Franklin, J.D. Powell and A. Emami-Naeini "Feedback Control of Dynamic Systems", Addison Wesley, Reading, MA, 2009</li> <li>K. Ogata "Modern Control Engineering", Fourth Edition, Prentice Hall, Upper Saddle River, NJ, 2010</li> <li>R.C. Dorf and R.H. Bishop, "Modern Control Systems", Addison Wesley, Reading, MA 2010</li> </ul>

Course L0655: Introduction 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	

	5: Computational Fluid Dyn			
Courses				
Title		Тур	Hrs/wk	CP
Computational Fluid D		Lecture Recitation	2 Section <sub>2</sub>	3
Computational Fluid D	ynamics I (L0419)	(large)	2	3
Module Responsible	Prof. Thomas Rung			
Admission Requirements	LNODE			
Recommended Previous Knowledge	Mathematical Methods for Engine     Fundamentals of Differential/inte		and series expansion	ons
Educational Objectives		have reached	the following learr	ning results
Professional Competence				
Knowledge	The students are able to list the basic r	numerics of pa	rtial differential eq	uations.
Skills	The students are able develop appropr for the governing partial differential algorithms in a structured way.			
Personal Competence Social Competence	The students can arrive at work results	in groups and	document them.	
	The students can independently analys	e approaches	to solving specific	problems.
Autonomy				
Workload in Hours	Independent Study Time 124, Study Tir	me in Lecture 5	56	
Credit points	6			
Course achievement	INONE			
Examination	Written exam			
Examination duration and scale	2h			
	General Engineering Science (German and Enviromental Engineering: Compul General Engineering Science (German Architecture: Compulsory General Engineering Science (Germ Mechanical Engineering, Focus Energy General Engineering Science (Germ Mechanical Engineering, Focus Energy	sory program, 7 s nan program, Systems: Elect nan program,	emester): Speciali 7 semester): S ive Compulsory 7 semester): S	sation Nava

	General Engineering Science (German program, 7 semester): Specialisation Energy and Enviromental Engineering: Elective Compulsory		
	General Engineering Science (German program, 7 semester): Specialisation		
Assignment for	Mechanical Engineering, Focus Theoretical Mechanical Engineering: Elective		
the Following	Compulsory		
Curricula	Energy Systems: Technical Complementary Course Core Studies: Elective		
	Compulsory		
	General Engineering Science (English program, 7 semester): Specialisation Energy		
	and Enviromental Engineering: Elective Compulsory		
	General Engineering Science (English program, 7 semester): Specialisation Energy		
	and Enviromental Engineering: Compulsory		
	General Engineering Science (English program, 7 semester): Specialisation		
	Mechanical Engineering, Focus Energy Systems: Elective Compulsory		
	General Engineering Science (English program, 7 semester): Specialisation Naval		
	Architecture: Compulsory		
	Mechanical Engineering: Specialisation Energy Systems: 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	
<b>Workload in Hours</b>	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	
<b>Workload in Hours</b>	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 M0640: Stochastics and Ship Dynamics				
Courses				
Title Ship Dynamics (L0352	)	Typ Lecture	Hrs/wk	<b>CP</b> 3
Ship Dynamics (L1620	)	Recitation Section (small)	<sup>n</sup> 1	1
Statistics and Stochast Engineering (L0364)	cic Processes in Naval Architecure and Ocean	Lecture	2	3
Module Responsible	Prof. Moustafa Abdel-Maksoud			
Admission Requirements	None			
Recommended Previous Knowledge	Linear algebra, analysis, complex is	numbers		
Educational Objectives	After taking part successfully, students h	ave reached the follo	wing learn	ing results
Professional Competence				
Knowledge	<ul> <li>The students are able to give an ove name application goals and they can des</li> <li>The students are able to give an ove name criteria in the rudder design.</li> <li>The students can name computation m and motions in waves.</li> </ul>	cribe the procedure or criew over varius ru	of the man	oeuvres. s. They car
Skills	<ul> <li>The students can come up with the discribe manoeuvres. The can use and lir</li> <li>The students are able to determine explain their physical meaning.</li> <li>The students can explain how a rudde effects which can occur.</li> <li>The students can mathematically described.</li> <li>The students can explain the mathematically described.</li> </ul>	nearise them.  hydrodynamic coefer works and they can be waves.	ficients ar n explain	nd they can
Personal Competence		in groups and docum	ont thom	
Social Competence	<ul><li>The students can arrive at work results</li><li>The students can discuss in groups and</li></ul>			
Autonomy	<ul> <li>The students can assess their own st further work steps on this basis.</li> </ul>	rengthes and weakr	nesses and	d the define
Workload in Hours	Independent Study Time 140, Study Time	e in Lecture 70		
Credit points	7			
Course achievement	None			

Examination	Written exam
Examination duration and scale	180 min
Assignment for the Following	General Engineering Science (German program, 7 semester): Specialisation Naval Architecture: Compulsory General Engineering Science (English program, 7 semester): Specialisation Naval Architecture: Compulsory Naval Architecture: Core qualification: Compulsory

Course L0352: Ship	Dynamics		
Тур	Lecture		
Hrs/wk	2		
СР	3		
<b>Workload in Hours</b>	Independent Study Time 62, Study Time in Lecture 28		
Lecturer	Prof. Moustafa Abdel-Maksoud		
Language			
Cycle			
	<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	
<b>Workload in Hours</b>	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: S	tatistics and Stochastic Processes in Naval Architecure and Ocean
Engineering	
Тур	Lecture
Hrs/wk	
СР	
	Independent Study Time 62, Study Time in Lecture 28
	Dr. Volker Müller
Language	
Cycle	WiSe
Content	<ul> <li>descriptive statistics, parameter, criteria for outliers</li> <li>sample, sample space, probability, probability space</li> <li>Bayes method, conditional probability, law of total probability</li> <li>Discrete and continuous random variables</li> <li>Probability distributions</li> <li>mixed and joint random variables and their distribution</li> <li>Characteristics of random variables (expectation, variance, skewness, kurtosis,)</li> <li>(central) limit theorem</li> <li>Stochastic processes</li> <li>Statistical description of seaway, harmonic analysis of seaway</li> <li>narrow-banded Gaussian process, seaway and its characteristics</li> <li>sea- and wind spectra</li> <li>transformation of spectra, transfer function</li> </ul>
Literature	V. Müller, Statistik und Stochastik in der Schiffs- und Meerestechnik, Vorlesungsskript, Institut für Fluiddynamik und Schiffstheorie, Technische Universität Hamburg-Harburg, 2014  W. Blendermann "Grundlagen der Wahrscheinlichkeitsrechnung", Vorlesungsskript, Arbeitsbereich Fluiddynamik und Schiffstheorie, Technische Universität Hamburg-Harburg, 2001  H. W. Coleman, W. G. Steele, Experimentation and Uncertainty Analysis for Engineers, 3 <sup>rd</sup> Edition, John Wiley & Sons, Inc., New York, NY, 2009  ITTC Recommended Procedures and Guidelines, In: Quality Systems Manual, International Towing Tank Conference (ITTC), 2011  F.M. Dekking, C. Kraaikamp, H.P. Lopuhaä, L.E. Meester, A Modern Introduction To Probability and Statistics, Springer, 2005  Springer Handbook of Engineering Statistics, H. Pham (Hrsg.), Springer, 2006  A. Klenke, Wahrscheinlichkeitstheorie, Springer, 2013

Module M1109	9: Resistance and Propulsion	n			
Courses					
<b>Title</b> Resistance and Propuls Resistance and Propuls		Typ Lecture Recitation (large)	Section	Hrs/wk 2 2	<b>CP</b> 3
Module Responsible	Prof. Stefan Krüger	(iai ge)			
Admission Requirements					
Recommended Previous Knowledge		cs.			
	After taking part successfully, students h	ave reached	the follov	ving learn	ing results
Professional Competence					
Knowledge	The hydrodynamic basics that are relevant for resistance and propulsion of ships are discussed. The different resistance phenomena and their practical applications to hullform design as well as numerical and empirical prediction methods are subject of the course. Furthermore, environmental additional resistances are dealt with. The course includes model test techniques and their application to full scale ships. This hold also for propulsion and hullefficiency elements, mainly thrust deduction and wake. Main Focus is how hull forms can be optimized for minimum and sustainable fuel consumption. The following topics are dealt with:  - Stillwater/added resistance, Wave resistance, Minimization of wave resistance, numerical prediction methods, friction laws, laminar/turbulent flow separation, Hull form design for redcude flow separation, Appendage Design and resistance, Froude 's resistance law,form factor method, thrust deduction, wake, model scaling laws, resistance tests, free running propeller tests and propeller basics, propulsion tests, full scale speed power predictions, additional resistances (wind, steering, current, sea state), EEDI, speed trials, contractual matters concerning speed/power, bunker claims				
Skills	The student shall learn to design co consumption by applying numreical tec several progosis methods. Furtermore, t determine and minimize the required poor	chniques and the course wi	l to eval II enable	uate thes the stude	se hulls by ent to clearl
Personal Competence					
Social Competence	The student learns to prepare technical with his building suvervision team.	matters in su	ıch a wa <u>y</u>	y that he	can compte
Autonomy	The student learns to prepare technical with his building suvervision team.	matters in su	ıch a wa <u>y</u>	y that he	can compte
Workload in Hours	Independent Study Time 124, Study Time	e in Lecture 5	6		
Credit points	6				
Course achievement	None				
Examination	Written exam				
Examination duration and scale	180 min				

Assignment for	General Engineering Science (German program, 7 semester): Specialisation Naval Architecture: Compulsory
the rollowing	General Engineering Science (English program 7 semester): Specialisation Navall
Curricula	Architecture: Compulsory  Naval Architecture: Core qualification: Compulsory

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

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

Courses				
Title		Тур	Hrs/wk	СР
Ship Design (L1262)		Lecture Recitation	2 Section <sub>2</sub>	3
Ship Design (L1264)		(large)	2	3
Module Responsible	Prof. Stefan Krüger			
Admission Requirements	LNODE			
Recommended Previous Knowledge	Fluid Dynamics for Naval Arc     Posistance and Propulsion II		and Propulsion	
Educational Objectives	LATTOR TAKING NART CHECCOCCITIIIV CITING	ents have reached t	the following learn	ing results
Professional Competence				
	aerly design phase. Competitive discussed. Typical bulding contract The most important main parameter the competitiveness of a design. The main parameters on the total per process elements. In this lecture models or formulae. The student properly so that the relavent technical contracts are the student properly so that the relavent technical contracts are the student properly so that the relavent technical contracts are the student properly so that the relavent technical contracts are the student properly so that the relavent technical contracts are the student properly so that the relavent technical contracts are the student properly so that the relavent technical contracts are the student properly so that the relavent technical contracts are the student properly so that the relavent technical contracts are the student properly so that the relavent technical contracts are the student properly so that the relavent technical contracts are the student properly so that the relavent technical contracts are the student properly so that the relavent technical contracts are the student properly so that the relavent technical contracts are the student properly so that the relavent technical contracts are the student properly so that the relavent technical contracts are the student properly so the student properly	es and the related ers of a ship are intr ne lecture focusses formance of a ship the design chang shall further learn	technical risk are roduced and their on the influence of design and the ges are dealt with to model comp	introduced influence of of alternated consecutive n by simple
Knowledge	The lecture continues with an in project, from the initial design phointroduced to generate bulding spend of granularity during the different adressed:	ase to a building co ecfication relevant i	ontract. Further, r nformation at diffe	nethods are erent leven
	- Structure of a building specification of Light Ship Weight Components - Design of main section and hull for Design of aftbody lines and manor Design of main propulsion plant Design of subdivision - Determination of limiting GMreques Scantlings of most improtant structure Longitudinal strength - Outfitting Components - Relevant rules and regulations	nt and Deadweight rm evering devices • Curves		
Skills	The student is made familiar with to ships. The goal of the lecture is that design based on a vessel of confident within the Marine Environment. The determine the fundamantal technic fulfillment procedures of the control Ship Design" the relevant methods a ship design are treated.	t the student shall mparison fulfilling to lecture deals with al characteristics or cat values. Based	be able to carry or ypical contract ro the basic design f a ship design wit on the lecture "	ut a concep equirement methods t th respect t Principles
Personal Competence				
	The students learns to prepare tech	nnical matters in su	ch a way the he c	an persuad

Social Competence	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.
<b>Workload in Hours</b>	Independent Study Time 124, Study Time in Lecture 56
Credit points	6
Course achievement	None
Examination	Written exam
Examination duration and scale	180 min
the Following	General Engineering Science (German program, 7 semester): Specialisation Naval Architecture: Compulsory General Engineering Science (English program, 7 semester): Specialisation Naval Architecture: Compulsory Naval Architecture: Core qualification: Compulsory

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

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

Module M0829	9: Foundations of Managem	ent			
Courses					
Title		Тур		Hrs/wk	СР
Management Tutorial	(L0882)	Recitation (small)	Section	2	3
Introduction to Manage	ement (L0880)	Lecture		3	3
Module Responsible	Prof. Christoph Ihl				
Admission Requirements					
Knowledge	Basic Knowledge of Mathematics and Bu	ısiness			
Educational Objectives	LATTOR FAKING NART CHECKDECTHING CHINONTE	have reached	the follow	wing learn	ing results
Professional Competence					
Knowledge	<ul> <li>describe and explain basic busi and sourcing, supply chain mana management, information man marketing</li> <li>explain the relevance of plannin situations under multiple objective methods from mathematical Fina</li> <li>state basics from accounting and</li> </ul>	Economics are on name imported on name imported of and go treprneurial properties functions agement, organagement, in grand decisions and uncertance costing and second on the second of	and Organd In part defined Mana tant defined als in Marojects as promization in making ainty, are elected control or making are elected control or el	gement a initions from the management duction, pand human management duction, pand human management explain	o Marketing are able and the subom the field or curement and ess, esp. in some basimethods.
Skills Personal	systems	able to  tructure them structures of comaking under ement system of marketing from mather	appropriompanies multiplens and	an Entre iately s le objecti Business finance to	preneurshi ives, unde informatio predefine
Competence	Students are able to  work successfully in a team of stue to apply their knowledge from the		ı entrepr	eneurship	project an

Social Competence	<ul> <li>write a coherent report on the project</li> <li>to communicate appropriately and</li> <li>to cooperate respectfully with their fellow students.</li> </ul>
Autonomy	work in a team and to organize the team themselves     to write a report on their project.
<b>Workload in Hours</b>	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	several written exams during the semester
the Following	General Engineering Science (German program, 7 semester): Core qualification: Compulsory Civil- and Environmental Engineering: Specialisation Civil Engineering: Elective Compulsory Civil- and Environmental Engineering: Specialisation Water and Environments: Elective Compulsory Civil- and Environmental Engineering: Specialisation Water and Environments: Elective Compulsory Civil- and Environmental Engineering: Specialisation Traffic and Mobility: Elective Compulsory Bioprocess Engineering: Core qualification: Compulsory Bioprocess Engineering: Core qualification: Compulsory Data Science: Core qualification: Compulsory Data Science: Core qualification: Compulsory Electrical Engineering: Core qualification: Compulsory Energy and Environmental Engineering: Core qualification: Compulsory General Engineering Science (English program, 7 semester): Specialisation Electrical Engineering: Compulsory General Engineering Science (English program, 7 semester): Specialisation Civil Engineering: Compulsory General Engineering Science (English program, 7 semester): Specialisation Energy and Environmental Engineering: Compulsory General Engineering Science (English program, 7 semester): Specialisation Computer Science: Compulsory General Engineering Science (English program, 7 semester): Specialisation Computer Science: Compulsory General Engineering Science (English program, 7 semester): Specialisation Mechanical Engineering, Focus Biomechanics: Compulsory General Engineering Science (English program, 7 semester): Specialisation Mechanical Engineering, Focus Biomechanics: Compulsory General Engineering Science (English program, 7 semester): Specialisation Mechanical Engineering, Focus Materials in Engineering: Compulsory General Engineering Science (English program, 7 semester): Specialisation Mechanical Engineering, Focus Mechatronics: Compulsory General Engineering Science (English program, 7 semester): Specialisation Mechanical Engineering Science (English program, 7 semester): Specialisation Mechanical Engineering, Focus M

Mechatronics: Core qualification: Compulsory

Orientierungsstudium: Core qualification: Elective Compulsory

Naval Architecture: Core qualification: Compulsory Technomathematics: Core qualification: Compulsory Process Engineering: Core qualification: Compulsory

Course L0882: Man	agement Tutorial
Тур	Recitation Section (small)
Hrs/wk	2
СР	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Prof. Christoph Ihl, Katharina Roedelius, Tobias Vlcek
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 self-selected projects that focus on the elaboration of an innovative business idea from the point of view of an established company or a startup. Again, the business knowledge from the lecture should come to practical use. The group projects are guided by a mentor.
Literature	Relevante Literatur aus der korrespondierenden Vorlesung.

Course L0880: Intr	oduction to Management
Тур	Lecture
Hrs/wk	3
СР	3
Workload in Hours	Independent Study Time 48, Study Time in Lecture 42
Lecturer	Prof. Christoph Ihl, Prof. Thorsten Blecker, Prof. Christian Lüthje, Prof. Christian Ringle, Prof. Kathrin Fischer, Prof. Cornelius Herstatt, Prof. Wolfgang Kersten, Prof. Matthias Meyer, Prof. Thomas Wrona
Language	DE
Cycle	WiSe/SoSe
Content	<ul> <li>Introduction to Business and Management</li> <li>Important definitions from Management</li> <li>Important definitions from Management,</li> <li>Developing Objectives for Business, and their relation to important Business functions</li> <li>Business Functions: Functions of the Value Chain, e.g. Production and Procurement, Supply Chain Management, Innovation Management, Marketing and Sales Cross-sectional Functions, e.g. Organisation, Human Ressource Management, Supply Chain Management, Information Management</li> <li>Definitions as information, information systems, aspects of data security and strategic information systems</li> <li>Definition and Relevance of innovations, e.g. innovation opporunities, risks etc.</li> <li>Relevance of marketing, B2B vs. B2C-Marketing</li> <li>different techniques from the field of marketing (e.g. scenario technique), pricing strategies</li> <li>important organizational structures</li> <li>basics of human ressource management</li> <li>Introduction to Business Planning and the steps of a planning process</li> <li>Decision Analysis: Elements of decision problems and methods for solving decision problems</li> <li>Selected Planning Tasks, e.g. Investment and Financial Decisions</li> <li>Introduction to Accounting: Accounting, Balance-Sheets, Costing</li> <li>Relevance of Controlling and selected Controlling methods</li> <li>Important aspects of Entrepreneurship projects</li> </ul>
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.

## **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 M088 Engineering	6: Fundamentals of Proc	ess Enginee	ering and	Materia
Courses				
(L0829)	ess Engineering/Bioprocess Engineering	Typ  Lecture  Lecture	<b>Hrs/wk</b> 2 2	<b>CP</b> 1 2
	Prof. Michael Schlüter			
A dunicaiou	None			
Recommended Previous Knowledge	none			
Educational Objectives	After taking part successfully, student	s have reached the	e following learn	ing results
Professional Competence				
Knowledge	<ul> <li>After passing this module the students</li> <li>give an overview of the most engineering,</li> <li>explain some working methods</li> </ul>	important fields	on process and	·
	After passing this module the students	s should have the	ability to:	
Skills	<ul> <li>list and outline the most import</li> <li>name the most important wor fields of process engineering,</li> <li>read and prepare an engineerin</li> <li>explain the most important to treatment</li> <li>scheme typical chemical and be the aid of pointers.</li> </ul>	king approaches on the depth of	or methods of t vastewater and	exhaust a
Personal				
	[716]			

Competence	
	The students are able to
Social Competence	<ul> <li>work out results in groups and document them,</li> <li>provide appropriate feedback and handle feedback on their own performance constructively.</li> </ul>
Autonomy	The students are able to estimate their progress of learning by themselves and to deliberate their lack of knowledge in Process Engineering and Bioprocess Engineering.
Workload in Hours	Independent Study Time 34, Study Time in Lecture 56
Credit points	3
	CompulsorBonus Form Description
achievement	No 5 % Written elaboration
	No 5 % Written elaboration Written exam
	Written exam

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				
	Introduction into the different research fields of the subject Process Engineering and Bioprocess Engineering.				
Literature	s. StudIP				

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

Module M0730	D: Computer Engineering						
Courses							
<b>Title</b> Computer Engineering Computer Engineering		Typ Lecture Recitation (small)	Hrs/wk 3 Section 1	<b>CP</b> 4 2			
Module	Prof. Heiko Falk	(Siliali)					
Responsible Admission Requirements							
Recommended Previous Knowledge	Basic knowledge in electrical engineerin	g					
Educational Objectives	After taking part successfully, students have reached the following learning results						
Professional Competence							
Knowledge	<ul> <li>This module deals with the foundations of the functionality of computing systems. It covers the layers from the assembly-level programming down to gates. The module includes the following topics:         <ul> <li>Introduction</li> <li>Combinational logic: Gates, Boolean algebra, Boolean functions, hardware synthesis, combinational networks</li> <li>Sequential logic: Flip-flops, automata, systematic hardware design</li> <li>Technological foundations</li> <li>Computer arithmetic: Integer addition, subtraction, multiplication and division</li> <li>Basics of computer architecture: Programming models, MIPS single-cycle architecture, pipelining</li> <li>Memories: Memory hierarchies, SRAM, DRAM, caches</li> <li>Input/output: I/O from the perspective of the CPU, principles of passing data, point-to-point connections, busses</li> </ul> </li> </ul>						
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 a 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 has on the hardware-centric abstraction layers from the assembly language down to gates. This way, they will be enabled to evaluate the impact that these low abstraction levels have on an entire system's performance and to propose feasible options.						
Personal Competence							
Social Competence	Students are able to solve similar probles results accordingly.	lems alone or	in a group and t	o present the			
Autonomy	Students are able to acquire new knowledge from specific literature and to associate this knowledge with other classes.						
	Independent Study Time 124, Study Time	ne in Lecture 5	66				
Credit points	lo						

	Compulsor <b>B</b> onus	Form		D	escription	
achievement	Yes 10 %	Excercise	S			
Examination	Written exam					
Examination duration and scale	90 minutes, contents of	f course an	nd labs			
Assignment for the Following	General Engineering Computer Science: Com General Engineering Bioprocess Engineering General Engineering General Engineering General Engineering Electrical Engineering Electrical Engineering General Engineering Mechanical Engineering General Engineering Sengineering: Compulso Computer Science: Core Data Science: Core qua Electrical Engineering Sengineering: Compulso General Engineering General Engineering General Engineering Mechanical Engineering	Science ( Inpulsory Scienc	German  German	program, gram, 7 ser program, ram, 7 ser program, s: Compuls program, ems Engine program, ems: Comp program, elopment a program, ems: Comp program, ems: Compuls program, es: Compuls program, es: Compuls program, ems: Compuls	7 semester): emester): Specia 7 semester): 7 semester): mester): Specia nester): Specia 7 semester): sory 7 semester): sory 7 semester): g Sciences: Cor 7 semester): lengineering: C 7 semester): lengineering: C 7 semester): lengineering: C 7 semester): soulsory 7 semester): semester): Specialis emester): Specialis	Specialisation Specialisation Specialisation Specialisation Ilisation Energy Isation Process Specialisation Specialisation Specialisation Specialisation ompulsory Specialisation Compulsory Specialisation Compulsory Specialisation Compulsory Specialisation Compulsory Specialisation Cialisation Civil Specialisation Cialisation Civil Specialisation
	General Engineering Mechanical Engineering General Engineering Mechanical Engineering General Engineering Mechanical Engineering	Science ( g, Focus Air Science ( g, Focus Ma Science ( g, Focus Ma Science (	(English processed (English paterials in leading (English paterials) (English paterials) (English paterials)	orogram, ems Engind orogram, Engineerin orogram, s: Compuls orogram,	7 semester): eering: Compul 7 semester): g Sciences: Cor 7 semester): sory 7 semester):	sory Specialisati npulsory Specialisati Specialisati

General Engineering Science (English program, 7 semester): Specialisation Mechanical Engineering, Focus Theoretical Mechanical Engineering: Compulsory General Engineering Science (English program, 7 semester): Specialisation Naval Architecture: Compulsory General Engineering Science (English program, 7 semester): Specialisation Process Engineering: Compulsory General Engineering Science (English program, 7 semester): Specialisation Biomedical Engineering: Compulsory Computational Science and Engineering: Core qualification: Compulsory Mechatronics: Core qualification: Compulsory Technomathematics: Specialisation II. Informatics: Elective Compulsory

Course L0321: Com	puter 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: Com	Course L0324: Computer Engineering		
Тур	Recitation Section (small)		
Hrs/wk	1		
СР	2		
<b>Workload in Hours</b>	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 M0938	3: Bioprocess Engineering -	Fundamentals		
Courses				
Title		Typ	Hrs/wk	СР
	g - Fundamentals (L0841)	<b>Typ</b> Lecture	2	3
Bioprocess Engineering	g- Fundamentals (L0842)	Recitation Section (large)	<sup>1</sup> 2	1
Bioprocess Engineering	g - Fundamental Practical Course (L0843)	Practical Course	2	2
Module Responsible	Prof. Andreas Liese			
Admission Requirements	None			
Knowledge	none, module "organic chemistry", modu		•	
Educational Objectives	After taking part successfully, students h	nave reached the follo	wing learn	ing results
Professional Competence				
Knowledge	Students are able to describe the basic concepts of bioprocess engineering. They are able to classify different types of kinetics for enzymes and microorganisms, as well as to differentiate different types of inhibition. The parameters of stoichiometry and rheology can be named and mass transport processes in bioreactors can be explained. The students are capable to explain fundamental bioprocess management, sterilization technology and downstream processing in detail.			
Skills	<ul> <li>After successful completion of this module, students should be able to</li> <li>describe different kinetic approaches for growth and substrate-uptake and to calculate the corresponding parameters</li> <li>predict qualitatively the influence of energy generation, regeneration redox equivalents and growth inhibition on the fermentation process</li> <li>analyze bioprocesses on basis of stoichiometry and to set up / solv metabolic flux equations</li> <li>distinguish between scale-up criteria for different bioreactors and bioprocesses (anaerobic, aerobic as well as microaerobic) to compare the as well as to apply them to current biotechnical problem</li> <li>propose solutions to complicated biotechnological problems and to deduct the corresponding models</li> <li>to explore new knowledge resources and to apply the newly gained contents identify scientific problems with concrete industrial use and to formulate solutions.</li> <li>to document and discuss their procedures as well as results in a scientific manner</li> </ul>			
Personal Competence Social Competence	After completion of this module partic questions in small teams to enhance opinions and increase their capacity fenvironments.	the ability to take or teamwork in engi	position to neering a	o their ow nd scientifi
Autonomy	After completion of this module participants will be able to solve a technical problem in a team independently by organizing their workflow and to present their results in a plenum.			
Workload in Hours	Independent Study Time 96, Study Time	in Lecture 84		

Credit points	6		
Course	Compulsor <b>B</b> onus	Form	Description
achievement	Yes 5 %	Subject theoretical practical work	and
Examination	Written exam		
Examination duration and scale	90 min		
the Following	Engineering: Compulsor General Engineering Bioprocess Engineering Bioprocess Engineering General Engineering Bioprocess Engineering General Engineering General Engineering Compulsor Biomedical Engineering Compulsory Biomedical Engineering Compulsory Biomedical Engineering Elective Compulsory Biomedical Engineering Elective Compulsory Technomathematics: Sp	Science (German pro : Compulsory : Core qualification: Cor Science (English pro : Compulsory :ience (English program ry :: Specialisation Artificia g: Specialisation Impl g: Specialisation Medic g: Specialisation Manag	gram, 7 semester): Specialisation  1, 7 semester): Specialisation Process  21 Organs and Regenerative Medicine:  22 ants and Endoprostheses: Elective  23 Technology and Control Theory:  24 jement and Business Administration:  25 ering Science: Elective Compulsory

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

Course L0842: Bioprocess Engineering- Fundamentals		
Тур	Recitation Section (large)	
Hrs/wk	2	
СР	1	
<b>Workload in Hours</b>	Independent Study Time 2, Study Time in Lecture 28	
Lecturer	Prof. Andreas Liese, Prof. An-Ping Zeng	
Language		
Cycle	SoSe	
	1. Introduction (Prof. Liese, Prof. Zeng)	
	2. Enzymatic kinetics (Prof. Liese)	
	3. Stoichiometry I + II (Prof. Liese)	
	4. Microbial Kinetics I+II (Prof. Zeng)	
Content	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: Biop	process Engineering - Fundamental Practical Course
Тур	Practical Course
Hrs/wk	2
СР	2
<b>Workload in Hours</b>	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Prof. Andreas Liese, Prof. An-Ping Zeng
Language	DE
Cycle	SoSe
Content	In this course fermentation and downstream technologies on the example of the production of an enzyme by means of a recombinant microorganism is learned. Detailed characterization and simulation of enzyme kinetics as well as application of the enzyme in a bioreactor is carried out.  The students document their experiments and results in a protocol.
Literature	Skript

Courses				
<b>Title</b> Fundamentals of Fluid	Mechanics (L0091)	<b>Typ</b> Lecture	Hrs/wk	<b>CP</b> 4
Fluid Mechanics for Pro	ocess Engineering (L0092)	Recitation (large)	Section 2	2
Module Responsible	Prof. Michael Schlüter			
Admission Requirements	None			
Recommended Previous Knowledge	<ul> <li>Mathematics I+II+III</li> <li>Technical Mechanics I+II</li> <li>Technical Thermodynamics I-</li> <li>Working with force balances</li> <li>Simplification and solving of Integration</li> </ul>		equations	
Educational Objectives	After taking part successfully, stude	nts have reached	the following lea	rning results
Professional Competence	Students are able to:			
Knowledge	explain the difference between a give an overview for difference.	rent applications ing Continuity- and N	of the Reynold	•
Skills	<ul> <li>The students are able to</li> <li>describe and model incompresion reduce the governing equal archive quantitative solutions</li> <li>notice the dependency between use the learned basics for free engineering</li> </ul>	tions of fluid me se.g. by integration en theory and te	echanics by simpon chnical application	ns
Personal Competence				
Social Competence	<ul> <li>are capable to gather in publications and relate that in able to work together on sub to present their results ef exercises)</li> <li>are able to work out solutions orally and to present</li> </ul>	nformation to the ject related tasks fectively in Engl ns for exercises	context of the led in small groups. ish (e.g. during	cture and They are ab small grou
Autonomy	<ul> <li>The students are able to</li> <li>search further literature for this literature,</li> <li>work on their exercises by the with the feedback.</li> </ul>	•	·	_

Credit points	6		
Course achievement	CompulsorBonus Yes 5 %	<b>Form</b> Midterm	Description
Examination	Written exam		
Examination duration and scale	3 hours		
Assignment for the Following Curricula	Engineering: Compu General Engineerin Bioprocess Engineer General Engineering and Enviromental Er Bioprocess Engineer Energy and Environr General Engineerin Bioprocess Engineer General Engineering and Enviromental Er General Engineering Engineering: Compu	Isory	ion: Compulsory : Core qualification: Compulsory sh program, 7 semester): Specialisation program, 7 semester): Specialisation Energy sory program, 7 semester): Specialisation Process Engineering Science: Elective Compulsory

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

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

Module M0544	4: Phase Equilibria Ther	modynamics		
Courses				
Title Phase Equilibria Therm	-	<b>Typ</b> Lecture Recitation	Hrs/wk 2 Section 1	<b>CP</b> 2
Phase Equilibria Therm Phase Equilibria Therm	-	(small) Recitation (large)	Section 1	2
Module Responsible	Prof. Irina Smirnova			
Admission Requirements	None			
Recommended Previous Knowledge		Thermodynamics I a	and II	
Educational Obiectives	After taking part successfully, stud	lents have reached	the following learn	ing results
Professional Competence				
Knowledge	<ul> <li>Starting from the very basics of thermodynamics, the students learn the mathematical tools to describe thermodynamic equilibria.</li> <li>They learn how state variables are influenced by the mixing of compound and learn concepts to quantitatively describe these properties.</li> <li>Moreover, the students learn how phase equilibria can be described mathematically and which phenomena may occur if different phases (vapor liquid, solid) coexist in equilibrium. Furthermore the fundamentals of reaction equilibria are taught.</li> <li>For different phase equilibria, several examples relevant for different kinds of processes are shown and the necessary knowledge for plotting and interpreting the equilibria are taught.</li> </ul>			
Skills	<ul> <li>Applying their knowledge, equation for the determina simplify these equations me</li> <li>The students know models the system in the equilibrium athematical relations.</li> <li>For specific applications, physico-chemical properties literature sources.</li> <li>Beside pure compound properties of mixtures.</li> <li>The students know how to know how to interpret the o</li> <li>Based on their knowledge, concepts that are the basis chemical engineering.</li> </ul>	ation of the equiliberation of the equiliberation of the equiliberation which can be used um state and they at they are able to so of compounds as perties the students of visualize phase eccurring phenomenthe students are above the students are above the students are above the students.	to determine the pare able to solve to self-reliantly find well as model para are capable of dequilibria graphical a.	now how to properties of the resulting of necessary arameters is escribing the fundamental
Personal Competence				

Social Competence	The students are able to work in small groups, to solve the corresponding problems and to present them oraly to the tutors and other students
Autonomy	<ul> <li>The students are able to find necessary information self-reliantly in literature sources and to judge their quality.</li> <li>During the semester the students are able to check their learning progress continuously in exercises. Based on this knowledge the students can adept their learning process.</li> </ul>
<b>Workload in Hours</b>	Independent Study Time 124, Study Time in Lecture 56
Credit points	6
Course achievement	None
Examination	Written exam
Examination duration and scale	120 minutes; theoretical questions and calculations
Assignment for the Following Curricula	General Engineering Science (German program, 7 semester): Specialisation Process Engineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Bioprocess Engineering: Compulsory Bioprocess Engineering: Core qualification: Compulsory General Engineering Science (English program, 7 semester): Specialisation Bioprocess Engineering: Compulsory General Engineering Science (English program, 7 semester): Specialisation Process Engineering: Compulsory Process Engineering: Core qualification: Compulsory

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

Course L0140: Phas	se Equilibria Thermodynamics
Тур	Recitation Section (small)
Hrs/wk	1
СР	2
<b>Workload in Hours</b>	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> <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: Pha	se Equilibria Thermodynamics
Тур	Recitation Section (large)
Hrs/wk	1
СР	2
<b>Workload in Hours</b>	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 M0618	3: Renewables and Energy	Systems					
Courses							
<b>Title</b> Power Industry (L0316 Energy Systems and E Renewable Energy (L0 Renewable Energy (L1	nergy Industry (L0315) 313)	Typ Lecture Lecture Lecture Recitation (small)	Hrs/wk 1 2 2 Section 1	CP 1 2 2			
Module Responsible	Prof. Martin Kaltschmitt						
Admission Requirements	None						
Recommended Previous Knowledge							
Educational Objectives	After taking part successfully, students	have reached t	he following learn	ing results			
Professional Competence							
Knowledge	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.						
Skills	Students are able to apply methodological demand or energy production for variethey can evaluate energy systems tectand design them under certain given necessary subject-specific calculation reproblem.  The students are able to explain of processing from the field of renewable the right context.	ous types of e chnically, envir- conditions. The ules, also for no questions and	nergy systems. Fonmentally and eerefore, they can ot standardized so possible approa	urthermore, economically choose the plutions of a ches to its			
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	e in Lecture 84					
Credit points							
Course achievement	None						
Examination	Written exam						

Examination duration and scale	3 hours written exam
Assignment for the Following Curricula	Compulsory

Course L0316: Pow	er Industry
Тур	Lecture
Hrs/wk	1
СР	1
<b>Workload in Hours</b>	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> <li>Cost and efficiency calculation</li> </ul> </li> </ul>
Literature	Folien der Vorlesung

Course L0315: Energy Systems and Energy Industry				
Тур	Lecture			
Hrs/wk	2			
СР	2			
<b>Workload in Hours</b>	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: Ren	ewable Energy
Тур	Lecture
Hrs/wk	2
СР	2
<b>Workload in Hours</b>	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: Ren	ewable Energy
Тур	Recitation Section (small)
Hrs/wk	1
СР	1
<b>Workload in Hours</b>	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>

	2: Signals and Systems						
Courses							
Title	10422)	Тур	Hrs/wl				
Signals and Systems (I		Lecture Recitation	Section 2	4			
Signals and Systems (I	L0433)	(small)	2	2			
Module Responsible	Prof. Gerhard Bauch						
Admission Requirements	None						
•	Mathematics 1-3						
Previous	The modul is an introduction to the theory of signals and systems. Good knowledge in maths as covered by the moduls Mathematik 1-3 is expected. Further experience with spectral transformations (Fourier series, Fourier transform, Laplace transform) is useful but not required.						
Educational Objectives	After taking part successfully, studen	ts have reached th	ne following lea	rning results			
Professional Competence							
·	The students are able to classify and describe signals and linear time-invariant (LTI) systems using methods of signal and system theory. They are able to apply the fundamental transformations of continuous-time and discrete-time signals and systems. They can describe and analyse deterministic signals and systems mathematically in both time and image domain. In particular, they understand the effects in time domain and image domain which are caused by the transition of a continuous-time signal to a discrete-time signal.						
Skills	The students are able to describe and analyse deterministic signals and linear time invariant systems using methods of signal and system theory. They can analyse and design basic systems regarding important properties such as magnitude and phase response, stability, linearity etc They can assess the impact of LTI systems on the signal properties in time and frequency domain.						
Personal Competence							
•	! The students can jointly solve specific	problems.					
·	The students can jointly solve specific problems.  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 tutorial problems, software tools, clicker system.						
Workload in Hours	Independent Study Time 110, Study	Time in Lecture 70					
Credit points	6						
Course achievement	INONE						
	J Written exam						
Examination duration and scale							
	General Engineering Science (Germ Compulsory Computer Science: Core qualification Data Science: Core qualification: Com Electrical Engineering: Core qualificat General Engineering Science (English Engineering: Compulsory General Engineering Science (English Bioprocess Engineering: Compulsory	Compulsory pulsory ion: Compulsory program, 7 seme	ster): Specialis	ation Electric			

		Engineering r Science: Cor		(English	program,	7	semester):	Specialisation	
	•			(English	program,	7	semester):	Specialisation	
		General Engineering Science (English program, 7 semester): Specialisation Mechanical Engineering, Focus Biomechanics: Compulsory							
Assignment for	General	Engineering	Science	(English	program,	7	semester):	Specialisation	
the Following									
Curricula								Specialisation	
	Mechanic	cal Engineerin	g, Focus A	ircraft Sys	stems Engir	ieei	ing: Compuls	sory	
	General	Engineering	Science	(English	program,	7	semester):	Specialisation	
	Mechanic	cal Engineerin	g, Focus M	1aterials ir	n Engineerir	ng S	ciences: Con	npulsory	
	General	Engineering	Science	(English	program,	7	semester):	Specialisation	
		cal Engineerin							
	General	Engineering	Science	(English	program,	7	semester):	Specialisation	
	Mechanical Engineering, Focus Theoretical Mechanical Engineering: Compulsory								
	General Engineering Science (English program, 7 semester): Specialisation Process								
	Engineer	Engineering: Compulsory							
	General	Engineering	Science	(English	program,	7	semester):	Specialisation	
	Biomedical Engineering: Compulsory								
	Computational Science and Engineering: Core qualification: Compulsory								
	Mechatronics: Core qualification: Compulsory								
	Technom	athematics: S	pecialisat	ion III. Eng	ineering Sc	ien	ce: Elective (	Compulsory	

Course L0432: Sign	nals and Systems					
	Lecture					
Hrs/wk						
СР						
	Independent Study Time 78, Study Time in Lecture 42					
	Prof. Gerhard Bauch					
Language						
Cycle						
Сусіе	3036					
	Introduction to signal and system theory					
	a. Cianala					
	<ul><li>Signals</li><li>Classification of signals</li></ul>					
	■ Continuous-time and discrete-time signals					
	<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</li> </ul>					
	equations, respectively					
	Basic properties of signals and operations on signals					
	<ul><li>Elementary signals</li><li>Distributions (Generalized Functions)</li></ul>					
	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 inverses.					
	<ul> <li>Time-invariance</li> <li>Description of LTI systems by impulse response and frequency</li> </ul>					
	response					
	Convolution					
	<ul> <li>Convolution and correlation</li> </ul>					
	Properties of LTI-systems					
	Causal systems					
	Stable systems					
	Memoryless systems     Fourier Series and Fourier Transform					
	<ul> <li>Fourier Series and Fourier Transform</li> <li>Fourier transform of continuous-time signals, discrete-time signals,</li> </ul>					
l	- Fourier transform of continuous-time signals, discrete-time signals,					

periodic signals, non-periodic signals • Properties of the Fourier transform • Fourier transform of some basic signals Parseval's theorem Analysis of LTI-systems and signals in the frequency domain Frequency response, magnitude response and phase response Transmission factor, attenuation, gain Frequency-flat and frequency-selective LTI-systems Bandwidth definitions o Basic types of systems (filters), lowpass, highpass, bandpass, bandstop systems Phase delay and group delay Linear-phase systems Distortion-free systems Content • Spectrum analysis with limited observation window: Leakage effect Laplace Transform Relation of Fourier transform and Laplace transform Properties of the Laplace transform Laplace transform of some basic signals Analysis of LTI-systems in the s-domain Transfer function of LTI-systems • Relation of Laplace transform, magnitude response and phase response Analysis of LTI-systems using pole-zero plots Allpass filters Minimum-phase, maximum-phase and mixed phase filters Stable systems Sampling Sampling theorem · Reconstruction of continuous-time signals in frequency domain and time domain Oversampling Aliasing Sampling with pulses of finite duration, sample and hold Decimation and interpolation Discrete-Time Fourier Transform (DTFT) Relation of Fourier transform and DTFT Properties of the DTFT Discrete Fourier Transform (DFT) Relation of DTFT and DFT Cyclic properties of the DFT DFT matrix Zero padding Cyclic convolution Fast Fourier Transform (FFT) • Application of the DFT: Orthogonal Frequency Division Multiplex (OFDM) Z-Transform Relation of Laplace transform, DTFT, and z-transform Properties of the z-transform Z-transform of some basic discrete-time signals Discrete-time systems, digital filters FIR and IIR filters Z-transform of digital filters • Analysis of discrete-time systems using pole-zero plots in the z-domain Stability Allpass filters • Minimum-phase, maximum-phase and mixed-phase filters Linear phase filters • T. Frey , M. Bossert , Signal- und Systemtheorie, B.G. Teubner Verlag 2004 K. Kammeyer, K. Kroschel, Digitale Signalverarbeitung, Teubner Verlag.

## Literature

- B. Girod ,R. Rabensteiner , A. Stenger , Einführung in die Systemtheorie, B.G. Teubner, Stuttgart, 1997
- J.R. Ohm, H.D. Lüke , Signalübertragung, Springer-Verlag 8. Auflage, 2002
- S. Haykin, B. van Veen: Signals and systems. Wiley.
- Oppenheim, A.S. Willsky: Signals and Systems. Pearson.
- Oppenheim, R. W. Schafer: Discrete-time signal processing. Pearson.

Course L0433: Signals and Systems		
Тур	Recitation Section (small)	
Hrs/wk	2	
СР	2	
<b>Workload in Hours</b>	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 M0892	2: Chemical Reaction Engine	ering				
Courses						
Courses		T	Hara familia	CD		
<b>Title</b> Chemical Reaction Engineering (Fundamentals) (L0204)		<b>Typ</b> Lecture	Hrs/wk 2	<b>CP</b> 2		
Chemical Reaction Engineering (Fundamentals) (L0244)		Recitation Section (large)	<sup>1</sup> 2	2		
Experimental Course C	Chemical Engineering (Fundamentals) (L0221)	_	2	2		
Module Responsible	Prof. Raimund Horn					
Admission Requirements	None					
Recommended Previous Knowledge	Contents of the previous modules math thermodynamics I+II as well as computa			y, technica		
Educational Objectives	After taking part successfully, students h	ave reached the follo	wing learn	ing results		
Professional Competence						
Knowledge	They are able to point out differences processes. The students have a strong al isothermal ideal reactors and to describe	The students are able to explain basic concepts of chemical reaction engineering. They are able to point out differences between thermodynamical and kinetical processes. The students have a strong ability to outline parts of isothermal and non-isothermal ideal reactors and to describe their properties.				
Skills	<ul><li>apply different computational meth isothermal ideal reactors,</li><li>determine and compute stable operation</li></ul>	- determine and compute stable operation points for these reactors , - conduct experiments on a lab-scale pilot plants and document these according to				
Personal Competence						
Social Competence	After successful completition of the lab-conganize themselfes in small groups engineering. The students can discuss the other and with their teachers.	to solve issues i	n chemic	al reaction		
Autonomy	The students are able to obtain relevance autonomously. Students can prepare and conduct experiments.			ssess thei ely to plan		
	Independent Study Time 96, Study Time	in Lecture 84				
Credit points						
Course achievement	Yes None Form Subject theore practical work	<b>Descript</b> etical and	ion			
Examination	Written exam					
Examination duration and scale						
Assignment for the Following	General Engineering Science (German pr Engineering: Compulsory General Engineering Science (Germa Bioprocess Engineering: Compulsory Bioprocess Engineering: Core qualificatio Bioprocess Engineering: Core qualificatio	n program, 7 sem n: Compulsory				

Curricula	General	Engineering	Science	(English	program,	7	semester):	Specialisation
	Bioprocess Engineering: Compulsory							
	General Engineering Science (English program, 7 semester): Specialisation Proce					sation Process		
	Engineering: Compulsory							
	Process Engineering: Core qualification: Compulsory							
	Process E	Engineering: C	ore qualif	ication: Co	mpulsory			

Course L0204: Che	mical Reaction Engineering (Fundamentals)
Тур	Lecture
Hrs/wk	2
СР	2
<b>Workload in Hours</b>	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)
Content	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,
1	ı

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)

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

## Literature

- $\hbox{H. S. Fogler, Essentials of Chemical Reaction Engineering, Prentice Hall} \\$
- 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 L0244: Chemical Reaction Engineering (Fundamentals)		
Тур	Recitation Section (large)	
Hrs/wk	2	
СР	2	
<b>Workload in Hours</b>	Independent Study Time 32, Study Time in Lecture 28	
Lecturer	Prof. Raimund Horn, Dr. Oliver Korup	

## Language DE Cycle WiSe

Fundamentals of chemical reaction engineering, definitions, calculation of species concentrations (reactor, reaction mixture, reactants, products, inerts and solvents, reaction volume, Reaktor volume, chemical reaction, mass, moles, mole fraction, volume, density, molar concentration, mass-concentration, molality, partial pressure, hydrodynamic residence time, space time, extent of reaction, reactor throughput, reactor load, conversion, selectivity, yield, concentration calculations in stationary and flowing multicomponent-mixtures)

Stoichiometry and stoichiometric calculations (simple reactions, complex reactions, key reactions, key species, matrix of stoichiometric coefficients, linear dependent and independent reactions, element-species-matrix, row reduced form of a matrix, rank of a matrix, Gauss Jordan elimination, relation between stoichiometry and kinetics, calculating the extent of reaction from mole number changes in complex reactions)

Thermodynamics (What is thermodynamics?, importance of thermodynamics in chemical reaction engineering, zeroth law of thermodynamics, temperature scales, temperature measurements in praxis, first law of thermodynamics, internal energy, enthalpy, calorimeter, heat of reaction, standard heat of formation, Hess law, heat capacity, Kirchhoff law, standard heat of reaction, pressure dependence of the heat of reaction, second law of thermodynamics, reversible and irreversible processes, entropy, Clausius inequality, free energy, Gibbs Energy, chemical potential, chemical equilibrium, activity, van't Hoff law, calculation of chemical equilibrium, principle of Le Chatelier and Braun, equilibrium calculations in multiple reaction systems, Lagrange Multipliers)

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

Content

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)
	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
Literature	H. S. Fogler, Elements of Chemical Reaction Engineering, Prentice Hall B
Literature	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: Exp	erimental Course Chemical Engineering (Fundamentals)
Тур	Practical Course
Hrs/wk	2
СР	2
<b>Workload in Hours</b>	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Prof. Raimund Horn, Dr. Achim Bartsch
Language	DE/EN
Cycle	SoSe
	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.
	Levenspiel, O.: Chemical reaction engineering; John Wiley & Sons, New York, 3. Ed., 1999 VTM 309(LB)
	Praktikumsskript
Literature	Skript Chemische Verfahrenstechnik 1 (F.Keil)
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<b>Title</b> Practical Exercise Envi Environmental Techno	ronmental Technology (L1387) logie (L0326)	<b>Typ</b> Practical Course Lecture	<b>Hrs/wk</b> 1 2	<b>CP</b> 1 2			
Module Responsible	I Prof. Martin Kairschmitt						
Admission Requirements	None						
Recommended Previous Knowledge	Fundamentals of inorganic/organ	ic chemistry and biology					
Educational Objectives		udents have reached the fo	ollowing learn	ing results			
Professional Competence							
Knowledge	With the completion of this modul the students obtain profound knowledge of environmental technology. They are able to describe the behaviour of chemicals in the environment. Students can give an overview of scientific disciplines involved. They can explain terms and allocate them to related methods.						
Skills	Students are able to propose appropriate management and mitigation measures for environmental problems. They are able to determine geochemical parameters and to assess the potential of pollutants to migrate and transform. The students are able to work out well founded opinions on how Environmental Technology contributes to sustainable development, and they can present and defend these opinons in front of and against the group.						
Personal Competence		ss the various technical a	nd scientific	tasks ho			
Social Competence	subject-specific and multidisciplir to the task as a group as wimplementation.	nary. They are able to deve	lop different	approache			
Autonomy		Students can independently exploit sources about of the subject, acquire the particular knowledge and tranfer it to new problems.					
Mandalaadin Harres	Independent Study Time 48, Stud	dy Time in Lecture 42		Independent Study Time 48, Study Time in Lecture 42			
workioad in Hours	13						
Credit points	<u>                                     </u>						
Credit points	CompulsorPonus Form	Descr	iption				
	CompulsorBonus Form	theoretical and	iption				
Credit points Course achievement	CompulsorBonus Form  Ves None Subject	theoretical and	iption				
Credit points Course achievement	CompulsorBonus Yes None Subject practical Written exam  1 hour	theoretical and	iption				

Bioprocess Engineering: Elective Compulsory
General Engineering Science (English program, 7 semester): Specialisation Energy
and Enviromental Engineering: Compulsory
General Engineering Science (English program, 7 semester): Specialisation Process
Engineering: Elective Compulsory
Process Engineering: Core qualification: Elective Compulsory

Course L1387: Prac	ctical 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
Language	DE
Cycle	SoSe
Content	The experiment demonstrates the effect of ionic strength on the binding of dissolved zinc and phosphate by soil surfaces. From the results it can be inferred that the potential of soil surfaces is modified by the application of salt. This has consequences for the retention of nutrients and pollutants. The experiment is carried out with iron oxide rich soil material.  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	F. Scheffer und P. Schachtschabel (2002): "Lehrbuch der Bodenkunde" TUB Signatur AGG-308  W.E.H. Blum (2007): "Bodenkunde in Stichworten" TUB Signatur AGG-317  C. A. J. Appelo; D. Postma (2005): "Geochemistry, groundwater and pollution"  TUB Signatur GWC-515

Course L0326: Envi	ironmental Technologie
Тур	Lecture
Hrs/wk	
СР	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Prof. Martin Kaltschmitt, Dozenten des SD V
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)

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Courses				
Title	L Customes (LOCE 4)	Тур	Hrs/wk	CP
Introduction to Control		Lecture Recitation	2 Section <sub>2</sub>	4
Introduction to Control	l Systems (L0655)	(small)	2	2
Module Responsible				
Admission Requirements	110000			
Recommended Previous Knowledge		ms in time and	l frequency doma	ain, Laplac
Educational Objectives	LATTER TAKING NART CHCCECCTHIN/ CTHOENI	s have reached	the following learr	ing results
Professional Competence				
Knowledge	<ul> <li>Students can represent dyna domain, and can in particular systems</li> <li>They can explain the dynamics properties in terms of frequence.</li> <li>They can explain the Nyquist derived from it.</li> <li>They can explain the role of the control loops</li> <li>They can explain the way a PID frequency response</li> <li>They can explain issues arising domain are implemented digital</li> </ul>	explain propert of simple control y response and restability criteri he phase margin controller affect	ies of first and solloops and interproof locus on and the stabiling in analysis and its a control loop in	econd orderet dynami lity margin synthesis of terms of it
Skills	<ul> <li>Students can transform mode frequency domain and vice ver</li> <li>They can simulate and assess to they can design PID controlled tuning rules</li> <li>They can analyze and synthes locus and frequency response to the continuous time and use it for the can use standard softway carrying out these tasks</li> </ul>	sa the behavior of single simple contractions the simple contractions the confidence in the simple contractions the simple con	ystems and controllers tation	ol loops gler-Nichols help of roo designed i
Personal Competence	Students can work in small group	s to jointly so	lve technical pro	oblems, an
Social Competence  Autonomy	experimentally validate their controlled students can obtain information fro documentation, experiment guides) a They can assess their knowledge in	er designs m provided sou nd use it when s	rces (lecture not olving given probl	es, softwar ems.

<b>Workload in Hours</b>	Independent Study Time 124, Study Time in Lecture 56			
Credit points				
Course achievement	None			
Examination	Written exam			
Examination duration and scale	120 min			
the Following	General Engineering Science (German program, 7 semester): Core qualification: Compulsory Bioprocess Engineering: Core qualification: Compulsory Computer Science: Specialisation Computational Mathematics: Elective Compulsory Data Science: Core qualification: Elective Compulsory Electrical Engineering: Core qualification: Compulsory Energy and Environmental Engineering: Core qualification: Compulsory General Engineering Science (English program, 7 semester): Specialisation Electrical Engineering: Compulsory General Engineering Science (English program, 7 semester): Specialisation Civil Engineering: Compulsory General Engineering Science (English program, 7 semester): Specialisation Bioprocess Engineering: Compulsory General Engineering Science (English program, 7 semester): Specialisation Energy and Enviromental Engineering: Compulsory General Engineering Science (English program, 7 semester): Specialisation Computer Science: Compulsory General Engineering Science (English program, 7 semester): Specialisation Computer Science: Compulsory General Engineering Science (English program, 7 semester): Specialisation Mechanical Engineering, Focus Biomechanics: Compulsory General Engineering Science (English program, 7 semester): Specialisation Mechanical Engineering, Focus Energy Systems: Compulsory General Engineering Science (English program, 7 semester): Specialisation Mechanical Engineering, Focus Materials in 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 Mechatronics: Compulsory General Engineering Science (English program, 7 semester): Specialisation Mechanical Engineering, Focus Product Development and Production: Compulsory General Engineering Science (Engl			

Course L0654: Introduction to Control Systems				
Тур	Lecture			
Hrs/wk				
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	
<b>Workload in Hours</b>	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	

Courses					
Title		.70)	Тур	Hrs/wk	СР
Practical Course Measurement Technology (L2270) Measurement Technology (L2268)			Practical Course Lecture	2 2	2
	of Measurement Techno	ology (L2269)	Lecture	2	2
Module Responsible	Prof. Michael Schlüter				
Admission Requirements	None				
	Technical interest, logical skills, integral- and differential calculus, basic physica concepts such as temperature, mass, velocity, etc				
Educational Objectives	After taking part successfully, students have reached the following learning results				
Professional Competence					
	Physical basics: kine bodies, energy and remperature and hear	nomentum, elec			
Knowledge	Metrology: SI units, measurement and measurement uncertainty, basics of sensor technology, physical principles, temperature measurement, pressure measurement, level measurement, flow measurement. Usage of Matlab scripts.				
	Practical course: Pres measurement, conc measurements of chromatography	entration meas		ss transfer,	isition, flow capacitive calculation
Skills	Literature research, categorisation of thematical topics, analysis of an experimentatest stand, preparation of test protocol, first programming with Matlab, use crelevant laboratory measurement technology, preparation of a test protoco execution of calculations.				
Personal Competence					
Social Competence	Arrangement and division of work in practical training and learning groups assessment of own level of knowledge, work on the experimental stand in groups				
Autonomy	Time management of the workload, independent development of the thematic basics, personal responsibility for the provision of protective equipment and work clothing, practice of presentation in front of a group, active participation in the lectures, formulation of enquiries/detailed questions by using clicker.				
Workload in Hours	Independent Study Tir	me 96, Study Tin	ne in Lecture 84		
Credit points					
Course achievement	CompulsorBonus Yes 5 %	Form Attestation	Testat		für
			Messt	echnikpraktikı	ım
	Written exam				
Examination duration and					

	General Engineering Science (German program, 7 semester): Specialisation Process
A :	Engineering: Compulsory
the Following	General Engineering Science (German program, 7 semester): Specialisation Process Engineering: Compulsory Bioprocess Engineering: Core qualification: Compulsory General Engineering Science (English program, 7 semester): Specialisation Process Engineering: Compulsory
Commission	General Engineering Science (English program, 7 semester): Specialisation Process
Curricula	Engineering: Compulsory
	Orientierungsstudium: Core qualification: Elective Compulsory
	Process Engineering: Core qualification: Compulsory

Course L2270: Practical Course Measurement Technology		
Тур	Practical Course	
Hrs/wk	2	
СР	2	
<b>Workload in Hours</b>	Independent Study Time 32, Study Time in Lecture 28	
Lecturer	Prof. Michael Schlüter	
Language	<b>je</b> 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	<ul> <li>Hug, H.: Instrumentelle Analytik. Theorie und Praxis. Verlag Europa-Lehrmittel, Haan-Gruiten, 2015.</li> <li>Kamke, W.: Der Umgang mit experimentellen Daten, insbesondere Fehleranalyse, im physikalischen Anfänger-Praktikum. Eine elementare Einführung. W. Kamke, Kirchzarten [Keltenring 197], 2010.</li> <li>Strohrmann, G.: Messtechnik im Chemiebetrieb. Einführung in das Messen verfahrenstechnischer Größen. Oldenbourg, München, 2004.</li> </ul>	

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

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

	6: Thermal Separation				
Courses					
Title	((0110)	Тур		Hrs/wk	СР
Γhermal Separation Pr Γhermal Separation Pr		Lecture Recitation	Section	2	2
•		(small) Recitation	Section	2	_
Thermal Separation Pr		(large)		_	1
Separation Processes (		Practical Cour	se	1	1
Responsible Admission					
Requirements	INODE				
Recommended Previous Knowledge		Thermodynamics III			
	After taking part successfully	students have reached t	the follov	ving learn	ing results
Professional Competence					
Knowledge	<ul> <li>The students can distiprocesses such as distill</li> <li>The students develop during a separation process, the possibilitie systems</li> <li>They have good knowled and devices</li> </ul>	ation, extraction, and ac an understanding for ocess, the estimation is of energy saving, an	dsorptior the cou of the e d the se	rse of co energy de election o	oncentrati emand of f separati
Skills	Using the gained know boundary for a given se and material balances The students can use separation process and They can select and degiven case based on the the students are capa properties from appropr They can calculate contient the students are able experimental lab work. The students are able to of the experimental wor. The students are capable of other lectures and use it tog lectures such as thermodyname.	different graphical meddefine the amount of the sign a basic type of the advantages and disadvable to obtain indeperiate sources (diagrams and discontinuous and discontinuous the to prove their the discuss the theoretical k with the teachers in collinking their gained knether for the solution	thods for eoretical ermal septimental sept	he associon the destages reparation professional median controllers and the median controllers and the median controllers are set on the media	signing of equired process ed mater the content lems. Oth
Personal Competence					
	The students can work t	echnical assignments in	small gr	oups and	present

	combined results in the tutorial
Social Competence	<ul> <li>The students are able to carry out practical lab work in small groups and organize a functional division of labor between them. They are able to discuss their results and to document them scientifically in a report.</li> </ul>
Autonomy	<ul> <li>The students are capable to obtain the needed information from suitable sources by themselves and assess their quality</li> <li>The students can proof the state of their knowledge with exam resembling assignments and in this way control their learning process</li> </ul>
Workload in Hours	Independent Study Time 96, Study Time in Lecture 84
Credit points	6
Course achievement	None
Examination	Written exam
Examination duration and scale	120 minutes; theoretical questions and calculations
the Following	General Engineering Science (German program, 7 semester): Specialisation Process Engineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Bioprocess Engineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Energy and Environmental Engineering: Compulsory Bioprocess Engineering: Core qualification: Compulsory Energy and Environmental Engineering: Core qualification: Compulsory General Engineering Science (English program, 7 semester): Specialisation Bioprocess Engineering: Compulsory General Engineering Science (English program, 7 semester): Specialisation Energy and Environmental Engineering: Compulsory General Engineering Science (English program, 7 semester): Specialisation Process Engineering: Compulsory Process Engineering: Core qualification: Compulsory

Course L0118: The	rmal Separation Processes
Тур	Lecture
Hrs/wk	2
СР	2
<b>Workload in Hours</b>	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.  <ul> <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> </li> </ul>

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

Course L0141: The	rmal Separation Processes
Тур	Recitation Section (large)
Hrs/wk	1
СР	1
<b>Workload in Hours</b>	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: Sep	aration Processes
Тур	Practical Course
Hrs/wk	1
СР	1
<b>Workload in Hours</b>	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
	<ul> <li>Extractive and azeotrope distillation, water vapor 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>

Title  Typ  Hrs/wk  CP  Heat and Mass Transfer (L0101)  Heat and Mass Transfer (L0102)  Rectation  Rectiation  Rectiation  Rectation  Section 1  2   Module  Responsible  Admission  Requirements  Recommended  Previous  Knowledge  Educational  Objectives  Professional  Competence   The students are capable of explaining qualitative and determin quantitative heat transfer in procedural apparatus (e. g. heat exchang chemical reactors).  They are capable of distinguish and characterize different kinds of he transfer mechanisms namely heat conduction, heat transfer and ther readiation.  The students have the ability to explain the physical basis for mass transin detail and to describe mass transfer qualitative and quantitative by us suitable mass transfer theories.  They are able to depict the analogy between heat- and mass transfer and describe complex linked processes in detail.  * The students are able to set reasonable system boundaries for a given transport problem by using the gained knowledge and to balance corresponding energy and mass flow, respectively.  They are capable to solve specific heat transfer problems (e.g. heat chemical reactors, temperature alteration in fluids) and to calculate corresponding heat flows.  Using dimensionless quantities, the students can execute scaling up technical processes or apparatus.  They are able to distinguish between diffusion, convective mass transing mass transfer. They can use this knowledge for the description a design of apparatus (e.g. extraction column, rectification column).  In this context, the students are capable to choose and design fundamer types of heat and mass exchanger for a specific application considering transmers. They can use this knowledge for the description and mass transfer. They can use this knowledge for the description and mass transfer. They can use this knowledge for the description and mass transfer. They can use this	Module M053	3: Heat and Mass Transfer			
Heat and Mass Transfer (L0101)  Heat and Mass Transfer (L0102)  Recitation Section 1 2 (small)  Recommended Previous Knowledge  Educational Objectives  Professional Competence  **The students have the ability to explain the physical basis for mass transfer and describe complex linked processes in detail.  **Knowledge**  **Knowledge**  **The students have the ability to explain the physical basis for mass transfer and describe complex linked processes in detail.  **They are capable to set reasonable system boundaries for a gix transport problem by using the gained knowledge and to balance corresponding energy and mass flow. **Energy transfer problems (e.g. heat chemical reactors).  **They are able to depict the analogy between heat- and mass transfer and describe complex linked processes in detail.  **They are capable to solve specific heat transfer problems (e.g. heat chemical reactors, temperature alteration in fluids) and to calculate corresponding heat flows.  **Using dimensionless quantities, the students can execute scaling up technical processes or apparatus.  **They are able to depict new apparatus (e.g. extraction column, convective mass transfer and design of apparatus (e.g. extraction column, rectification column).  **In this context, the students are capable to choose and design fundamer types of heat and mass exchanger for a specific application considering the advantages and disadvantages, respectively.  **In addition, they can calculate both, steady-state and non-steady-st	Courses				
Module Responsible   Admission   None	Heat and Mass Transfe	er (L0102)	Lecture Recitation (small) Recitation	2 Section <sub>1</sub>	2
Admission Requirements Recommended Previous Knowledge  Educational Objectives Professional Competence  • The students are capable of explaining qualitative and determin quantitative heat transfer in procedural apparatus (e. g. heat exchang chemical reactors).  • They are capable of distinguish and characterize different kinds of he transfer mechanisms namely heat conduction, heat transfer and there radiation.  **Knowledge**  Knowledge**  **Knowledge**  **The students have the ability to explain the physical basis for mass transined in detail and to describe mass transfer qualitative and quantitative by us suitable mass transfer theories.  • They are able to depict the analogy between heat- and mass transfer and describe complex linked processes in detail.  • The students are able to set reasonable system boundaries for a given transport problem by using the gained knowledge and to balance corresponding energy and mass flow, respectively.  • They are capable to solve specific heat transfer problems (e.g. head chemical reactors, temperature alteration in fluids) and to calculate corresponding heat flows.  • Using dimensionless quantities, the students can execute scaling up technical processes or apparatus.  * They are able to distinguish between diffusion, convective mass transit and mass transfer. They can use this knowledge for the description and design of apparatus (e.g. extraction column, rectification column).  • In this context, the students are capable to choose and design fundamer types of heat and mass exchanger for a specific application considering the advantages and disadvantages, respectively.  • In addition, they can calculate both, steady-state and non-steady-st	Module	Prof. Irina Smirnova	(idige)		
Recommended Previous Knowledge: Technical Thermodynamics  Educational Objectives  Professional Competence  • The students are capable of explaining qualitative and determin quantitative heat transfer in procedural apparatus (e. g. heat exchange chemical reactors).  • They are capable of distinguish and characterize different kinds of hear transfer mechanisms namely heat conduction, heat transfer and there radiation.  • The students have the ability to explain the physical basis for mass transfer in detail and to describe mass transfer qualitative and quantitative by us suitable mass transfer theories.  • They are able to depict the analogy between heat- and mass transfer and describe complex linked processes in detail.  • They are capable to solve specific heat transfer problems (e.g. hear chemical reactors, temperature alteration in fluids) and to calculate chemical reactors, temperature alteration in fluids) and to calculate chemical processes or apparatus.  • They are able to distinguish between diffusion, convective mass transit and mass transfer. They can use this knowledge for the description and design of apparatus (e.g. extraction column, rectification column).  • In this context, the students are capable to choose and design fundamer types of heat and mass exchanger for a specific application considering the advantages and disadvantages, respectively.	Admission				
Professional Competence  • The students are capable of explaining qualitative and determin quantitative heat transfer in procedural apparatus (e. g. heat exchang chemical reactors).  • They are capable of distinguish and characterize different kinds of his transfer mechanisms namely heat conduction, heat transfer and there radiation.  • The students have the ability to explain the physical basis for mass transfer in detail and to describe mass transfer qualitative and quantitative by us suitable mass transfer theories.  • They are able to depict the analogy between heat- and mass transfer and describe complex linked processes in detail.  • They are capable to solve specific heat transfer problems (e.g. heat chemical reactors, temperature alteration in fluids) and to calculate corresponding heat flows.  • Using dimensionless quantities, the students can execute scaling up technical processes or apparatus.  • They are able to distinguish between diffusion, convective mass transit and mass transfer. They can use this knowledge for the description a design of apparatus (e.g. extraction column, rectification column).  • In this context, the students are capable to choose and design fundamer types of heat and mass exchanger for a specific application considering the advantages and disadvantages, respectively.  • In addition, they can calculate both, steady-state and non-steady-st	Recommended Previous	Basic knowledge: Technical Thermody	namics		
<ul> <li>The students are capable of explaining qualitative and determin quantitative heat transfer in procedural apparatus (e. g. heat exchange chemical reactors).</li> <li>They are capable of distinguish and characterize different kinds of heat transfer mechanisms namely heat conduction, heat transfer and there radiation.</li> <li>The students have the ability to explain the physical basis for mass transin detail and to describe mass transfer qualitative and quantitative by us suitable mass transfer theories.</li> <li>They are able to depict the analogy between heat- and mass transfer and describe complex linked processes in detail.</li> <li>They are apable to solve specific heat transfer problems (e.g. heat chemical reactors, temperature alteration in fluids) and to calculate corresponding heat flows.</li> <li>Using dimensionless quantities, the students can execute scaling up technical processes or apparatus.</li> <li>They are able to distinguish between diffusion, convective mass transit and mass transfer. They can use this knowledge for the description a design of apparatus (e.g. extraction column, rectification column).</li> <li>In this context, the students are capable to choose and design fundamer types of heat and mass exchanger for a specific application considering the advantages and disadvantages, respectively.</li> <li>In addition, they can calculate both, steady-state and non-steady-st</li> </ul>		After taking part successfully, student	s have reached	the following learr	ning results
quantitative heat transfer in procedural apparatus (e. g. heat exchange chemical reactors).  • They are capable of distinguish and characterize different kinds of he transfer mechanisms namely heat conduction, heat transfer and there radiation.  • The students have the ability to explain the physical basis for mass transin detail and to describe mass transfer qualitative and quantitative by us suitable mass transfer theories.  • They are able to depict the analogy between heat- and mass transfer and describe complex linked processes in detail.  • They are apable to solve specific heat transfer problems (e.g. heat chemical reactors, temperature alteration in fluids) and to calculate corresponding heat flows.  • Using dimensionless quantities, the students can execute scaling up technical processes or apparatus.  • They are able to distinguish between diffusion, convective mass transit and mass transfer. They can use this knowledge for the description a design of apparatus (e.g. extraction column, rectification column).  • In this context, the students are capable to choose and design fundamer types of heat and mass exchanger for a specific application considering the advantages and disadvantages, respectively.  • In addition, they can calculate both, steady-state and non-steady-st					
transport problem by using the gained knowledge and to balance corresponding energy and mass flow, respectively.  They are capable to solve specific heat transfer problems (e.g. head chemical reactors, temperature alteration in fluids) and to calculate corresponding heat flows.  Using dimensionless quantities, the students can execute scaling up technical processes or apparatus.  They are able to distinguish between diffusion, convective mass transit and mass transfer. They can use this knowledge for the description a design of apparatus (e.g. extraction column, rectification column).  In this context, the students are capable to choose and design fundament types of heat and mass exchanger for a specific application considering the advantages and disadvantages, respectively.  In addition, they can calculate both, steady-state and non-steady-st	Knowledge	quantitative heat transfer in perchemical reactors).  They are capable of distinguing transfer mechanisms namely radiation.  The students have the ability the in detail and to describe mass suitable mass transfer theories.  They are able to depict the analysis.	orocedural apposh and characted heat conduction of explain the particular depth of transfer quality alogy between	aratus (e. g. heat sterize different ki on, heat transfer shysical basis for mative and quantitat	exchanger nds of head and therma nass transfer tive by using
<ul> <li>processes in procedural apparatus.</li> <li>The students are capable to connect their knowledge obtained in to course with knowlegde of other courses (In particular the course thermodynamics, fluid mechanics and chemical process engineering) to so concrete technical problems.</li> </ul>	Skills	transport problem by using corresponding energy and mass.  They are capable to solve so chemical reactors, temperature corresponding heat flows.  Using dimensionless quantities technical processes or apparature.  They are able to distinguish to and mass transfer. They can design of apparatus (e.g. extractional extra types of heat and mass exchant advantages and disadvantages.  In addition, they can calculate processes in procedural appara.  The students are capable to course with knowlegde of thermodynamics, fluid mechants.	the gained kn s flow, respective pecific heat tree alteration in s, the student is. The student is. The student is is in the student is is in the student is	owledge and to vely.  ansfer problems (  fluids) and to constant of the constant of the design of th	balance the decade deca

Personal Competence			
Social Competence	<ul> <li>The students are capable to work on subject-specific challenges in teams and to present the results orally in a reasonable manner to tutors and other students.</li> </ul>		
Autonomy	<ul> <li>The students are able to find and evaluate necessary information from suitable sources</li> <li>They are able to prove their level of knowledge during the course with accompanying procedure continuously (clicker-system, exam-like assignments) and on this basis they can control their learning processes.</li> </ul>		
<b>Workload in Hours</b>	Independent Study Time 124, Study Time in Lecture 56		
Credit points	6		
Course achievement	None		
Examination	Nritten exam		
Examination duration and scale	120 minutes; theoretical questions and calculations		
Assignment for the Following Curricula	General Engineering Science (German program, 7 semester): Specialisation Process Engineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Bioprocess Engineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Energy and Environmental Engineering: Compulsory Bioprocess Engineering: Core qualification: Compulsory Energy and Environmental Engineering: Core qualification: Compulsory General Engineering Science (English program, 7 semester): Specialisation Bioprocess Engineering: Compulsory General Engineering Science (English program, 7 semester): Specialisation Energy and Environmental Engineering: Compulsory General Engineering Science (English program, 7 semester): Specialisation Process Engineering: Compulsory Technomathematics: Specialisation III. Engineering Science: Elective Compulsory Process Engineering: Core qualification: Compulsory		

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

Course L0102: Heat and Mass Transfer	
Тур	Recitation Section (small)
Hrs/wk	1
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	

Courses				
Title		Тур	Hrs/wk	
Informatics for Process	-	Lecture Recitation	2 Section <sub>2</sub>	2
Informatics for Process	-	(small)	2	2
Numeric and Matlab (L		Practical Cour	rse 2	2
Module Responsible	Dr. Marcus Venzke			
Admission Requirements	None			
Recommended Previous Knowledge	Basic knowledge in using MS Wind	ows.		
Educational Objectives	After taking part successfully, stud	dents have reached	the following lear	ning results
Professional Competence		and object-oriented	concepts.	
Knowledge				
Skills	Students are capable of object-or Java and of solving mathematic questions.	estions by using Ma	tlab.	
Personal Competence Social Competence	Students are able to work out solu	tions together in sm	all groups.	
Autonomy	l Students are able to assess acquir	ed skills by applying	it in practice.	
Workload in Hours	Independent Study Time 96, Study	/ Time in Lecture 84		
Credit points	6			
Course achievement	None			
Examination	Written exam			
Examination duration and scale	90 min			
the Following	General Engineering Science (Ger and Enviromental Engineering: Ele General Engineering Science (Ger Engineering: Elective Compulsory Bioprocess Engineering: Core qual Energy and Environmental Engine General Engineering Science (Eng	ective Compulsory man program, 7 sen ification: Compulsor ering: Core qualifica	nester): Specialis y tion: Compulsory	ation Proce

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

Process Engineering: Core qualification: Compulsory

Course L0836: Info	rmatics for Process Engineers		
Тур	Lecture		
Hrs/wk	4		
СР	2		
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28		
Lecturer	Dr. Marcus Venzke		
Language	DE		
Cycle	SoSe		
Content	<ul> <li>Introduction to object-oriented modelling and programming exemplified with Java</li> <li>Objects, classes</li> <li>Methods, properties</li> <li>Inheritance</li> <li>Basics of the language Java</li> <li>Sample application: Simulation of an electricity network</li> <li>2D graphics</li> <li>Events and Controls</li> </ul>		
Literature	Campione, Mary; Walrath, Kathy: The Java Tutorial - A practical guide for programmers. Addison-Wesley, Reading, Massachusets, 1998. Bibliothek: TII 978  Krüger, Guido; Hansen, Heiko: Handbuch der Java-Programmierung. 3. Auflage Addison-Wesley, 2002. http://www.javabuch.de/  Krüger, Guido: Go to Java 2. Addison-Wesley Verlag, Bonn, 1999. Bibliothek: TII 717  Cowell, John: Essential Java 2 fast. Springer Verlag, London, 1999. Bibliothek: TII 942  Java SE 7 Documentation http://docs.oracle.com/javase/7/docs/  Java Platform, Standard Edition 7 API Specification http://docs.oracle.com/javase/7/docs/api/		

Course L0837: Info	rmatics for Process Engineers		
Тур	Recitation Section (small)		
Hrs/wk			
СР	2		
	Independent Study Time 32, Study Time in Lecture 28		
Lecturer	Dr. Marcus Venzke		
Language			
Cycle	SoSe		
	In the lab, the content from the lecture is practiced and deepened with practical assignments. Every week one or two programming tasks are assigned. These are solved by the students on computers independently, coached by a tutor.		
Literature	Campione, Mary; Walrath, Kathy: The Java Tutorial - A practical guide for programmers. Addison-Wesley, Reading, Massachusets, 1998. Bibliothek: TII 978  Krüger, Guido; Hansen, Heiko: Handbuch der Java-Programmierung. 3. Auflage Addison-Wesley, 2002. http://www.javabuch.de/  Krüger, Guido: Go to Java 2. Addison-Wesley Verlag, Bonn, 1999. Bibliothek: TII 717  Cowell, John: Essential Java 2 fast. Springer Verlag, London, 1999. Bibliothek: TII 942  Java SE 7 Documentation http://docs.oracle.com/javase/7/docs/  Java Platform, Standard Edition 7 API Specification http://docs.oracle.com/javase/7/docs/api/		

Course L0125: Nun	neric and Matlab
Тур	Practical Course
Hrs/wk	2
СР	2
<b>Workload in Hours</b>	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Prof. Siegfried Rump, Weitere Mitarbeiter
Language	DE
Cycle	SoSe
Content	<ol> <li>Programming in Matlab</li> <li>Numerical methods for systems of nonlinear equations</li> <li>Basics in computer arithmetic</li> <li>Linear and nonlinear optimization</li> <li>Condition of problems and algorithms</li> <li>Verified numerical results with INTLAB</li> </ol>
Literature	Literatur (Software-Teil):  1. Moler, C., Numerical Computing with MATLAB, SIAM, 2004 2. The Math Works, Inc., MATLAB: The Language of Technical Computing, 2007 3. Rump, S. M., INTLAB: Interval Labority, http://www.ti3.tu-harburg.de 4. Highham, D. J.; Highham, N. J., MATLAB Guide, SIAM, 2005

Module M0670	0: Particle Tecl	hnology and S	olids Proce	ss Engine	ering
Courses					
<b>Title</b> Particle Technology I (	L0434)		<b>Typ</b> Lecture	Hrs/wk	<b>CP</b> 3
Particle Technology I (	L0435)		Recitation Se (small)	ection 1	1
Particle Technology I (	L0440)		Practical Course	2	2
Module Responsible	Prof. Stefan Heinrich				
Admission Requirements					
Recommended Previous Knowledge	keine				
	After taking part suc	cessfully, students h	ave reached the	following learn	ing results
Professional Competence					
Knowledge	<ul> <li>After successful completion of the module students are able to</li> <li>name and explain processes and unit-operations of solids process engineering,</li> <li>characterize particles, particle distributions and to discuss their bulk properties</li> </ul>				
Skills	<ul> <li>Students are able to</li> <li>choose and design apparatuses and processes for solids processing according to the desired solids properties of the product</li> <li>asses solids with respect to their behavior in solids processing steps</li> <li>document their work scientifically.</li> </ul>				
Personal Competence					
Social Competence	Scientific personal ar	nd to develop solution	ns for technical-s	cientific issues	in a group.
Autonomy	Students are able independently.	to analyze and se	olve questions	regarding sol	id particles
	Independent Study T	ime 110, Study Time	e in Lecture 70		
Credit points	! 				
Course achievement		<b>Form</b> Written elaborati	sechs	c <b>ription</b> s Berichte (p ericht) à 5-10 (	
Examination	Written exam				
Examination duration and scale					
Assignment for	General Engineering Engineering: Compul General Engineering Bioprocess Engineering General Engineering and Enviromental En Bioprocess Engineeri	lsory g Science (Germar ing: Compulsory Science (German pr gineering: Compulso	n program, 7 ogram, 7 semes ry	semester): S <sub>l</sub>	pecialisation

the Following	Energy and Environmental Engineering: Core qualification: Compulsory		
Curricula	General Engineering Science (English program, 7 semester): Specialisation		
	Bioprocess Engineering: Compulsory		
	General Engineering Science (English program, 7 semester): Specialisation Energy		
	and Enviromental Engineering: Compulsory		
	General Engineering Science (English program, 7 semester): Specialisation Process		
	Engineering: Compulsory		
	Process Engineering: Core qualification: Compulsory		

Course L0434: Part	ticle Technology I
Тур	Lecture
Hrs/wk	2
СР	3
<b>Workload in Hours</b>	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Prof. Stefan Heinrich
Language	DE
Cycle	SoSe
Content	<ul> <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	
<b>Workload in Hours</b>	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: Part	ticle Technology I
Тур	Practical Course
Hrs/wk	2
СР	2
<b>Workload in Hours</b>	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	9: Process and P	lant Engine	ering I		
Courses					
Title			Тур	Hrs/wk	СР
Process and Plant Engi	ineering I (L0095)		Lecture	2	2
Process and Plant Engi	ineering I (L0096)		Recitation (large)	Section 1	2
Process and Plant Engi	ineering I (L1214)		Recitation (small)	Section 1	2
Module Responsible	Prof. Mirko Skiborowski				
Admission Requirements	None				
Recommended	unit operation of therma	al an dmechanica	separation p	orocesses	
Previous Knowledge	I chamical reactor aingin	eering			
Educational Objectives	After taking part succes	ssfully, students h	ave reached	the following learr	ning results
Professional					
Competence	l Istudents can:				
		olohal halance egi	ations of che	amical processes	
	classify and formulate blobal balance equations of chemical processes				
Knowledge	specify linear component equations of complex chemical processes				
	explain linear regression and data reconcilliation problems				
	explain pfd-diagrams				
	students are capable of				
	- formulation of mass and energy balance equations and estimation of product streams				
Skills	- estimation of component streams of chemical plants using linear component balance models				
	- solution of data reconcilliation tasks				
	- conduction of process synthesis				
	- economic evaluation of processes and the estimation of production costs				
Personal	 				
Competence					
Social Competence					
Autonomy					
	Independent Study Time	e 124, Study Time	in Lecture 5	56	
Credit points	i				
Course achievement		Form Subject theore practical work		Description	
Examination	Written exam				
Examination duration and scale	120 Min. lectures notes	and books			
	General Engineering Sc	ience (German pr	ogram, 7 ser	nester): Specialisa	tion Process

	Engineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Bioprocess Engineering: Compulsory
	General Engineering Science (German program, 7 semester): Specialisation Energy
Assignment for	and Enviromental Engineering: Elective Compulsory
	Bioprocess Engineering: Core qualification: Compulsory
Curricula	General Engineering Science (English program, 7 semester): Specialisation
	Bioprocess Engineering: Compulsory
	General Engineering Science (English program, 7 semester): Specialisation Energy
	and Enviromental Engineering: Elective Compulsory
	General Engineering Science (English program, 7 semester): Specialisation Process
	Engineering: Compulsory
	Process Engineering: Core qualification: Compulsory

Course L0095: Process and Plant Engineering I		
Тур	Lecture	
Hrs/wk	2	
СР	2	
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28	
Lecturer	Prof. Mirko Skiborowski	
Language	DE	
Cycle	SoSe	
Content	1. Introduction Structure and operation of production plants Operational business process Technical process design Motivation and targets of process development Life cycle of production plants 2. Engineering methods and tools Mass and energy balances Strategies of process synthesis Graphical representation of processes Multidimensional regression Data reconciliation and data validation 3. Process Synthesis Decision levels Experimental process development Reactor synthesis Synthesis of 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	
	S.D. Barnicki, J.R. Fair, Ind. End. Chem., 29(1990), S. 421, Ind. End. Chem., 31(1992), S. 1679	
	H. Becker, S. Godorr, H. Kreis, Chemical Engineering, January 2001, S. 68-74	
	Behr, W. Ebbers, N. Wiese, ChemIngTech. 72(2000)Nr. 10, S.1157	
	E. Blass, Entwicklung verfahrenstechnischer Prozesse, Springer-Verlag, 2. Auflage 1997	
	M. H. Bauer, J. Stichlmair, ChemIngTech., 68(1996), Nr. 8, 911-916	
	R. Dittmeyer, W. Keim, G. Kreysa, A. Oberholz, Chemische Technik. Prozesse und	

## Produkte,

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- J.M. Douglas, Conceptual Design of Chemical Processes, Mc Graw-Hill, NY, 1988
- G. Fieg, Inz. Chem. Proc., 5(1979), S.15-19
- G. Fieg, G. Wozny, L. Jeromin, Chem. Eng. Technol. 17(1994),5, 301-306
- G. Fieg, Heat and Mass Transfer 32(1996), S. 205-213
- G. Fieg, Chem. Eng. Processing, Vol. 41/2(2001), S. 123-133
- U.H. Felcht, Chemie eine reife Industrie oder weiterhin Innovationsmotor, Universitätsbuchhandlung Blazek und Bergamann, Frankfurt, 2000

## Literature

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
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Course L0096: Process and Plant Engineering I		
Тур	Recitation Section (large)	
Hrs/wk	1	
СР	2	
<b>Workload in Hours</b>	Independent Study Time 46, Study Time in Lecture 14	
Lecturer	Prof. Mirko Skiborowski, Dr. Thomas Waluga	
Language	DE	
Cycle	SoSe	
Content	See interlocking course	
Literature	See interlocking course	

Course L1214: Process and Plant Engineering I		
Тур	Recitation Section (small)	
Hrs/wk	1	
СР	2	
<b>Workload in Hours</b>	Independent Study Time 46, Study Time in Lecture 14	
Lecturer	Prof. Mirko Skiborowski, Dr. Thomas Waluga	
Language	DE	
Cycle	SoSe	
Content	See interlocking course	
Literature	See interlocking course	

Module M0829	9: Foundations of Managen	nent		
Courses				
<b>Title</b> Management Tutorial (L0882)		Typ Recitation (small)	Hrs/wk Section 2	<b>CP</b> 3
Introduction to Manage		Lecture	3	3
	<u> </u>			
Admission Requirements	110000			
Recommended Previous Knowledge	Basic Knowledge of Mathematics and B	usiness		
Educational Objectives	LATTOR FAKING NART CHECKDECTHING CTHOONTE	have reached	the following learn	ing results
Professional Competence				
Knowledge	After taking this module, students knareas in Business and Management, fi and Innovation, and also to Investmento  • explain the differences between disciplines in Management and of Management • explain the most important aspet the most important aspects of erection of the describe and explain basic bus and sourcing, supply chain management, information management, information management, information management, information management, information management, situations under multiple objection methods from mathematical Final state basics from accounting and	rom Planning at and Controlling Economics and to name imported imported in the street of and go interprine functions agement, organ anagement, in the street of and decisions and uncertaince	and Organisation to ng. In particular the nd Management a rtant definitions from als in Management rojects is as production, production, production and human innovation management making in Busing tainty, and explain	ney are able and the sub- om the field at and name or ocurement and ressource ement and ness, esp. in a some basic
Skills	Students are able to analyse busine (organization, objectives, strategies e project in a team. In particular, they are  analyse Management goals and analyse organisational and staff apply methods for decision uncertainty and under risk  analyse production and procur systems  analyse and apply basic methods select and apply basic method problems  apply basic methods from according the problems	etc.) and to case able to structure them structures of case making under the system of marketing sof	arry out an Entre appropriately ompanies r multiple object ms and Business matical finance to	epreneurship lives, under information o predefined
Personal Competence	Students are able to  work successfully in a team of st			
	to apply their knowledge from th  17771	ne lecture to ar	ı entrepreneurship	project and

Social Competence	<ul> <li>write a coherent report on the project</li> <li>to communicate appropriately and</li> <li>to cooperate respectfully with their fellow students.</li> </ul>
Autonomy	work in a team and to organize the team themselves     to write a report on their project.
<b>Workload in Hours</b>	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	several written exams during the semester
the Following	General Engineering Science (German program, 7 semester): Core qualification: Compulsory Civil- and Environmental Engineering: Specialisation Civil Engineering: Elective Compulsory Civil- and Environmental Engineering: Specialisation Water and Environments: Elective Compulsory Civil- and Environmental Engineering: Specialisation Water and Environments: Elective Compulsory Civil- and Environmental Engineering: Specialisation Traffic and Mobility: Elective Compulsory Bioprocess Engineering: Core qualification: Compulsory Bioprocess Engineering: Core qualification: Compulsory Computer Science: Core qualification: Compulsory Data Science: Core qualification: Compulsory Electrical Engineering: Core qualification: Compulsory Energy and Environmental Engineering: Core qualification: Compulsory General Engineering Science (English program, 7 semester): Specialisation Electrical Engineering: Compulsory General Engineering Science (English program, 7 semester): Specialisation Civil Engineering: Compulsory General Engineering Science (English program, 7 semester): Specialisation Engory General Engineering Science (English program, 7 semester): Specialisation Energy and Environmental Engineering: Compulsory General Engineering Science (English program, 7 semester): Specialisation Computer Science: Compulsory General Engineering Science (English program, 7 semester): Specialisation Mechanical Engineering, Focus Biomechanics: Compulsory General Engineering Science (English program, 7 semester): Specialisation Mechanical Engineering, Focus Biomechanics: Compulsory General Engineering Science (English program, 7 semester): Specialisation Mechanical Engineering, Focus Materials in Engineering: Compulsory General Engineering Science (English program, 7 semester): Specialisation Mechanical Engineering, Focus Mechatronics: Compulsory General Engineering Science (English program, 7 semester): Specialisation Mechanical Engineering, Focus Mechatronics: Compulsory General Engineering Science (English program, 7 semester): Specialisati

Mechatronics: Core qualification: Compulsory

Orientierungsstudium: Core qualification: Elective Compulsory

Naval Architecture: Core qualification: Compulsory Technomathematics: Core qualification: Compulsory Process Engineering: Core qualification: Compulsory

Course L0882: Management Tutorial			
Тур	Recitation Section (small)		
Hrs/wk	2		
СР	3		
<b>Workload in Hours</b>	Independent Study Time 62, Study Time in Lecture 28		
Lecturer	Prof. Christoph Ihl, Katharina Roedelius, Tobias Vlcek		
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 self-selected projects that focus on the elaboration of an innovative business idea from the point of view of an established company or a startup. Again, the business knowledge from the lecture should come to practical use. The group projects are guided by a mentor.		
Literature	Relevante Literatur aus der korrespondierenden Vorlesung.		

Course L0880: Introduction to Management			
	Lecture		
Hrs/wk			
СР			
Workload in Hours	Independent Study Time 48, Study Time in Lecture 42		
	Prof. Christoph Ihl, Prof. Thorsten Blecker, Prof. Christian Lüthje, Prof. Christian Ringle, Prof. Kathrin Fischer, Prof. Cornelius Herstatt, Prof. Wolfgang Kersten, Prof. Matthias Meyer, Prof. Thomas Wrona		
Language	DE		
Cycle	WiSe/SoSe		
Content	<ul> <li>Introduction to Business and Management, Business versus Economics, relevant areas in Business and Management</li> <li>Important definitions from Management,</li> <li>Developing Objectives for Business, and their relation to important Business functions</li> <li>Business Functions: Functions of the Value Chain, e.g. Production and Procurement, Supply Chain Management, Innovation Management, Marketing and Sales 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. Au 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 Rechnungslegur 7. Aufl., Stuttgart 2008.  Schweitzer, M.: Planung und Steuerung, in: Bea/Friedl/Schweitzer: Allgemei 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. Auflag Stuttgart 2006.		

Module M1274	4: Environmental Techno	logy		
Courses				
Title Environmental Assessr		<b>Typ</b> Lecture Recitation	Hrs/wk 2 Section 1	<b>CP</b> 2
Environmental Assessr	ment (L1054)	(small)	1	1
responsible.				
Admission Requirements				
Recommended Previous Knowledge	Fundamentals of inorganic/organic of	chemistry and biolo	gy	
Educational Objectives	After taking part successfully, stude	nts have reached t	he following learr	ing results
Professional				
Competence		lo the students	outing in death to	noviladas -4
Knowledge	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 a well as uncertainties and difficulties with their measurement.			
Skills	The students are able to select a silvariety of assessment methods. The managing and mitigating environmediable to carry out Life Cycle Impact software programs OpenLCA and the students have the competence publications on environmental impact.	hereby they can dental problems in Assessments indeceeded atabase Ecolovers to critically judgets.	evelop suitable s a business conte pendently and ca ent. After finishin	solutions for xt. They are an apply the g the course
Personal Competence				
Social Competence	The students are able to discuss the various technical and scientific tasks, bot subject-specific and multidisciplinary. They are able to develop jointly different solutions and to discuss their theoretical or practical implementation. Due to the selected lecture topics, the students receive insights into the multi-layered issues of the environment protection and the concept of sustainability. Their sensitivity and consciousness towards these subjects are raised and which helps to raise their awareness of their future social responsibilities in their role as engineers.		tly different Due to the red issues of nsitivity and o raise their	
Autonomy	The students learn to research, process and present a scientific topic independently. They are able to carry out independent scientific work. They can solve an environmental problem in a business context and are able to judge results of other publications.			
Workload in Hours	Independent Study Time 48, Study	Time in Lecture 42		
Credit points	<u> </u>			
Course achievement	None			
Examination	Written exam			
Examination				

duration and scale	1 hour written exam
the Following	General Engineering Science (German program, 7 semester): Specialisation Energy and Enviromental Engineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Bioprocess Engineering: Elective Compulsory General Engineering Science (German program, 7 semester): Specialisation Process Engineering: Elective Compulsory Bioprocess Engineering: Core qualification: Elective Compulsory Energy and Environmental Engineering: Core qualification: Compulsory General Engineering Science (English program, 7 semester): Specialisation Bioprocess Engineering: Elective Compulsory General Engineering Science (English program, 7 semester): Specialisation Energy and Enviromental Engineering: Compulsory General Engineering Science (English program, 7 semester): Specialisation Process Engineering: Elective Compulsory Process Engineering: Core qualification: Elective Compulsory

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

Course L1054: Environmental Assessment		
Тур	Recitation Section (small)	
Hrs/wk	1	
СР	1	
<b>Workload in Hours</b>	Independent Study Time 16, Study Time in Lecture 14	
Lecturer	Prof. Martin Kaltschmitt	
Language	DE	
Cycle	SoSe	
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	

## **Thesis**

Module M-001	: Bachelor Thesis
Courses	
Title	Typ Hrs/wk CP
Module Responsible	Professoren der TUHH
Admission Requirements	<ul> <li>According to General Regulations §21 (1):</li> <li>At least 126 ECTS credit points have to be achieved in study programme. The examinations board decides on exceptions.</li> </ul>
Recommended Previous Knowledge	
Educational Objectives	After taking part successfully, students have reached the following learning results
Professional Competence	
Knowledge	<ul> <li>The students can select, outline and, if need be, critically discuss the most important scientific fundamentals of their course of study (facts, theories, and methods).</li> <li>On the basis of their fundamental knowledge of their subject the students are capable in relation to a specific issue of opening up and establishing links with extended specialized expertise.</li> <li>The students are able to outline the state of research on a selected issue in their subject area.</li> </ul>
Skills	<ul> <li>The students can make targeted use of the basic knowledge of their subject that they have acquired in their studies to solve subject-related problems.</li> <li>With the aid of the methods they have learnt during their studies the students can analyze problems, make decisions on technical issues, and develop solutions.</li> <li>The students can take up a critical position on the findings of their own research work from a specialized perspective.</li> </ul>
Personal Competence	
Social Competence	<ul> <li>Both in writing and orally the students can outline a scientific issue for an expert audience accurately, understandably and in a structured way.</li> <li>The students can deal with issues in an expert discussion and answer them in a manner that is appropriate to the addressees. In doing so they can uphold their own assessments and viewpoints convincingly.</li> </ul>
Autonomy	<ul> <li>The students are capable of structuring an extensive work process in terms of time and of dealing with an issue within a specified time frame.</li> <li>The students are able to identify, open up, and connect knowledge and material necessary for working on a scientific problem.</li> <li>The students can apply the essential techniques of scientific work to research of their own.</li> </ul>

<b>Workload in Hours</b>	Independent Study Time 360, Study Time in Lecture 0
Credit points	12
Course achievement	None
Examination	Thesis
Examination duration and scale	According to General Regulations
the Following	General Engineering Science (German program, 7 semester): Thesis: Compulsory Civil- and Environmental Engineering: Thesis: Compulsory Bioprocess Engineering: Thesis: Compulsory Computer Science: Thesis: Compulsory Data Science: Thesis: Compulsory Digital Mechanical Engineering: Thesis: Compulsory Electrical Engineering: Thesis: Compulsory Energy and Environmental Engineering: Thesis: Compulsory Engineering Science: Thesis: Compulsory General Engineering Science (English program, 7 semester): Thesis: Compulsory Computational Science and Engineering: Thesis: Compulsory Logistics and Mobility: Thesis: Compulsory Mechanical Engineering: Thesis: Compulsory Mechatronics: Thesis: Compulsory Naval Architecture: Thesis: Compulsory Technomathematics: Thesis: Compulsory Teilstudiengang Lehramt Elektrotechnik-Informationstechnik: Thesis: Compulsory Teilstudiengang Lehramt Metalltechnik: Thesis: Compulsory Process Engineering: Thesis: Compulsory