

# **Module Manual**

Bachelor of Science (B.Sc.)

## **Mechanical Engineering**

Cohort: Winter Term 2021

Updated: 18th September 2021

# Table of Contents

Table of Contents	2
Program description	3
Core Qualification	5
Module M0725: Production Engineering	5
Module M0577: Non-technical Courses for Bachelors	8
Module M0889: Mechanics I (Statics)	10
Module M0850: Mathematics I	12
Module M0933: Fundamentals of Materials Science	15
Module M1006: Team Project MB	17
Module M1692: Computer Science for Engineers - Introduction and Overview	18
Module M0671: Technical Thermodynamics I	19
Module M0696: Mechanics II: Mechanics of Materials	21
Module M0594: Fundamentals of Mechanical Engineering Design	23
Module M0851: Mathematics II	25
Module M0597: Advanced Mechanical Engineering Design	28
Module M0598: Mechanical Engineering: Design	31
Module M0608: Basics of Electrical Engineering	34
Module M0688: Technical Thermodynamics II	36
Module M0853: Mathematics III	38
Module M0959: Mechanics III (Dynamics)	41
Module M0865: Fundamentals of Production and Quality Management	43
Module M0610: Electrical Machines and Actuators	45
Module M0680: Fluid Dynamics	47
Module M0934: Advanced Materials	49
Module M0960: Mechanics IV (Oscillations, Analytical Mechanics, Multibody Systems, Numerical Mechanics)	51
Module M0596: Advanced Mechanical Design Project	53
Module M0833: Introduction to Control Systems	55
Module M0956: Measurement Technology for Mechanical Engineers	58
Module M0829: Foundations of Management	61
Specialization Biomechanics	64
Module M1277: MED I: Introduction to Anatomy	64
Module M1278: MED I: Introduction to Radiology and Radiation Therapy	66
Module M1279: MED II: Introduction to Biochemistry and Molecular Biology	68
Module M1333: BIO I: Implants and Fracture Healing	69
Module M1280: MED II: Introduction to Physiology	71
Module M1332: BIO I: Experimental Methods in Biomechanics	72
Specialization Energy Systems	73
Module M0684: Heat Transfer	73
Module M1022: Reciprocating Machinery	75
Module M0655: Computational Fluid Dynamics I	78
Module M0662: Numerical Mathematics I	80
Module M0639: Gas and Steam Power Plants	82
Specialization Aircraft Systems Engineering	85
Module M1320: Simulation and Design of Mechatronic Systems	85
Module M0599: Integrated Product Development and Lightweight Design	87
Module M0767: Aeronautical Systems	89
Specialization Materials in Engineering Sciences	91
Module M1009: Material Science Laboratory	91
Module M1746: Materials Engineering: Materials Selection, Processing and Modelling	93
Module M1005: Enhanced Fundamentals of Materials Science	95
Specialization Mechatronics	99
Module M0854: Mathematics IV	99
Module M1320: Simulation and Design of Mechatronic Systems	102
Module M0777: Semiconductor Circuit Design	104
Specialization Product Development and Production	106
Module M0726: Production Technology	106
Module M1009: Material Science Laboratory	109
Module M0599: Integrated Product Development and Lightweight Design	111
Specialization Theoretical Mechanical Engineering	113
Module M0662: Numerical Mathematics I	113
Module M0684: Heat Transfer	115
Module M1573: Modeling, Simulation and Optimization (EN)	117
Module M0854: Mathematics IV	118
Thesis	121
Module M-001: Bachelor Thesis	121

---

---

## Program description

---

---

### Content

Today one can find mechanical engineering in practically all industrially made goods of everyday life like cars, electronic devices or tools. Mechanical engineering incorporates technologies and develops market ready products from basic developments. Accordingly the field of activity of mechanical engineers is wide: Planning and calculation of plants, devices and machines, selection and development of materials, design of mechanical devices taking into account economic manufacturing and planning of production plants are examples. Developments in micro system technology, mechatronics and microelectronics extended the field of work during the last years. In addition, subjects outside the field of technology become more and more important for engineers.

The aim of the mechanical engineering programs at TUHH (bachelor and master) is to successfully prepare young people for their career start in this wide and always varying field. Mechanical engineers work in industry, medium-sized companies, public facilities, colleges and engineer's offices. Their activities can include various areas like research, development, production, project management, distribution, marketing and quality assurance.

The variety of applications within this occupation demands a high degree of specialization. Consequently, the professional training of mechanical engineers must balance the wide range of knowledge to be acquired (to offer diverse applications in the future) and the profoundness of training (for up-to-date technical competences). In the course of the consecutive bachelor's and master's program in mechanical engineering at the TUHH, the wide range of knowledge is taught mostly during the bachelor's program while specific skills are developed during the master's program. In any case, a profound understanding of the basics as well as a proficiency in common methods are part of the education. The course of study leading to the "Bachelor of Science" degree in mechanical engineering is designed with this aspiration. The fundamentals necessary to solve tasks in mechanical engineering are taught. Additionally, skills in an area of focus are taught during the bachelor's degree course. The degree qualifies students to work professionally in typical fields of mechanical engineering:

- Product development and production (production technologies, materials, lightweight design),
- Aircraft systems engineering (aircraft systems, simulation product development),
- Energy systems (thermal power plants, piston engines),
- Mechatronics (simulation, semiconductor technology),
- Biomechanics (medicine, implants),
- Materials in engineering sciences (materials sciences, structural materials)

In reality, the transitions between the individual fields of mechanical engineering are blurred. The listed fields of application can be further pursued on in one of the master's programs in mechanical engineering.

In addition to the technical basics, an education in non-technical areas such as business administration, patent law, humanities as well as law and philosophy is pursued that fulfills the demands made on modern day engineers.

### Career prospects

The courses' graduates are able to work responsibly and proficiently as mechanical engineers. According to the laws of the states of the Federal Republic of Germany, they may use the professional title engineer. Possible employers are for example manufacturing companies in the mechanical engineering sector as well as engineering and planning offices. The degree allows for further studies in a masters' program, e.g. the consecutive programs corresponding to the areas of focus.

### Learning target

The education objective of this bachelor's program is to develop the skills to select and combine basic methods and techniques to carry out technical tasks in the field of mechanical engineering and more specifically in the chosen area of focus.

#### Knowledge

- The students are able to name and describe the mathematical and scientific fundamentals and methods of the engineering sciences.
- The students are able to explain the fundamentals and methods of mechanical engineering and to give a summary of their field of studies.
- The students are able to explain in detail the fundamentals, methods, and areas of application of the individual areas of mechanical engineering.
- The students are able to reflect the fundamentals and methods of mechanical engineering and to give a summary of the relevant social, ethical, ecological, and economical boundary conditions of their field of studies.
- Knowledge in the areas of focus:
  - Biomechanics: The students are able to describe different types of implants and large-scale equipment for diagnosis and therapy and to explain their workings.
  - Energy Systems: The students are able to explain technologies for the conversion, distribution, and use of energy.
  - Aircraft Systems Engineering: The Students are able to explain methods of systems engineering in relation to aircraft design and production.
  - Materials in Engineering Sciences: The students are able to explain characteristics of engineering materials, particularly of metals, ceramics, and structural materials.
  - Mechatronics: The students are able to explain mechatronic systems and their function from the perspectives of mechanical and electrical engineering.
  - Product Development and Production: The Students are able to explain all steps of the product development process.
  - Theoretical Mechanical Engineering: The students are able to describe the problems of mechanical engineering based on theoretical fundamentals.

#### Skills

- The students are able to apply their knowledge about mathematical and scientific fundamentals and methods of engineering to simple theoretical and practical problems and to develop solutions.
- The Students are able to map typical detailed theoretical as well as practical mechanical engineering problems (e.g. dimensioning of machine parts such as shafts and bearings, calculation of energy flows) to their knowledge of fundamentals. They are able to analyze these problems methodically and based on fundamentals and to find and implement appropriate solution methods. They are able to document the chosen solution method adequately in writing.
- The students are able to map practical, rather general mechanical engineering problems (e.g. design of devices) to sub-problems from their or other relevant fields, to analyze them methodically and based on fundamentals and to find and implement appropriate solution methods. They are able to present their solution to an audience in a clearly structured manner.
- The students are able to handle practical engineering problems from research independently by applying appropriate methods, to document their chosen approach and to present it in front of an expert audience.
- skills in the area of focus:
  - Biomechanics: The students are able to analyze medical equipment and implants by applying scientific methods
  - Energy Systems: The Students are able to analyze processes such as combustion systems or recuperators by applying scientific methods.
  - Aircraft System Engineering: The students are able to apply the standard methods of aircraft design and production.
  - Materials of Engineering Sciences: The students are able to apply methods of mechanical engineering to the design and analysis of engineering materials.

## Module Manual B.Sc. "Mechanical Engineering"

- Mechatronics: The students are able to analyze mechatronic systems and their functions under consideration of aspects of electrical and mechanical engineering.
- Product Development and Production: The students are able to apply standard methods to the design of production processes.
- Theoretical Mechanical Engineering: The students are able to simulate mechanical and energy systems.

### **Social competency**

- The students are able to present the approach and outcome of their work comprehensibly in writing as well as orally.
- The students are able to communicate with experts and laypersons about subject matters and problems of mechanical engineering. They are able to react appropriately to enquiries, complements, and comments.
- The students are able to work in groups. They are able to define, distribute, and integrate subtasks. They are able to reach agreements in terms of time and to interact socially.

### **Independence**

- The students are able to obtain necessary specialist information and to put it into the context of their knowledge.
- The students are able to assess their competences realistically and to compensate for shortcomings independently.
- The students are able to acquire knowledge and skills of topic areas and problems in a self-organized and self-motivated manner (lifelong learning in engineering).

### **Program structure**

The course of studies consists of the core qualification in the extent of 150 credit points, a specialization in the extent of 18 credit points and the final work intended in the sixth semester in the extent of 12 credit points.

Specializations are: Energy technology, airplane-system technology, materials in the engineer's sciences, mechatronics, product development and production, as well as theoretical mechanical engineering.

**Core Qualification**

Within this block "Kernqualifikation" of the Bachelor of Science program the students get the basics knowledge, basic professional skills and methods as a base for the further development of their competence up the ability to work qualified and responsible and to apply their skills on the job. Scientific principle-base education in mathematics and the basics of engineering science are the essential topics of this block. First field applications, basics in business administration and nontechnical complementary courses are an important complement to these fields.

<b>Module M0725: Production Engineering</b>			
<b>Courses</b>			
<b>Title</b>	<b>Typ</b>	<b>Hrs/wk</b>	<b>CP</b>
Production Engineering I (L0608)	Lecture	2	2
Production Engineering I (L0612)	Recitation Section (large)	1	1
Production Engineering II (L0610)	Lecture	2	2
Production Engineering II (L0611)	Recitation Section (large)	1	1
<b>Module Responsible</b>	Prof. Wolfgang Hintze		
<b>Admission Requirements</b>	None		
<b>Recommended Previous Knowledge</b>	no course assessments required internship recommended		
<b>Educational Objectives</b>	After taking part successfully, students have reached the following learning results		
<b>Professional Competence</b>			
<i>Knowledge</i>	Students are able to ... <ul style="list-style-type: none"> <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 and requirements for tools, workpiece and process.</li> <li>explain the essential models of manufacturing technology.</li> </ul>		
<i>Skills</i>	Students are able to... <ul style="list-style-type: none"> <li>select manufacturing processes in accordance with the requirements.</li> <li>design manufacturing processes for simple tasks to meet the required tolerances of the component to be produced.</li> <li>assess components in terms of their production-oriented construction.</li> </ul>		
<b>Personal Competence</b>			
<i>Social Competence</i>	Students are able to ... <ul style="list-style-type: none"> <li>develop solutions in a production environment with qualified personnel at technical level and represent decisions.</li> </ul>		
<i>Autonomy</i>	Students are able to .. <ul style="list-style-type: none"> <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		
<b>Credit points</b>	6		
<b>Course achievement</b>	None		
<b>Examination</b>	Written exam		
<b>Examination duration and scale</b>	120 min		
<b>Assignment for the Following Curricula</b>	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 Theoretical Mechanical Engineering: Elective Compulsory Green Technologies: Energy, Water, Climate: Specialisation Energy Technology: Elective Compulsory Logistics and Mobility: Specialisation Production Management and Processes: Compulsory Logistics and Mobility: Specialisation Engineering Science: Elective Compulsory Mechanical Engineering: Core Qualification: Compulsory Mechatronics: Core Qualification: Compulsory Engineering and Management - Major in Logistics and Mobility: Specialisation Production Management and Processes: Compulsory		

Course L0608: Production Engineering I	
<b>Typ</b>	Lecture
<b>Hrs/wk</b>	2
<b>CP</b>	2
<b>Workload in Hours</b>	Independent Study Time 32, Study Time in Lecture 28
<b>Lecturer</b>	Prof. Wolfgang Hintze
<b>Language</b>	DE
<b>Cycle</b>	WiSe
<b>Content</b>	<ul style="list-style-type: none"> <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>
<b>Literature</b>	<p>Dubbel, Heinrich (Grote, Karl-Heinrich.; Feldhusen, Jörg.; Dietz, Peter.; Ziegmann, Gerhard,;) Taschenbuch für den Maschinenbau : mit Tabellen. Berlin [u.a.] : Springer, 2007</p> <p>Fritz, Alfred Herbert: Fertigungstechnik : mit 62 Tabellen. Berlin [u.a.] : Springer, 2004</p> <p>Keferstein, Claus P (Dutschke, Wolfgang,;): Fertigungsmesstechnik : praxisorientierte Grundlagen, moderne Messverfahren. Wiesbaden : Teubner, 2008</p> <p>Mohr, Richard: Statistik für Ingenieure und Naturwissenschaftler : Grundlagen und Anwendung statistischer Verfahren. Renningen : expert-Verl, 2008</p> <p>Klocke, F., König, W.: Fertigungsverfahren Bd. 1 Drehen, Fäsen, Bohren. 8. Aufl., Springer (2008)</p> <p>Klocke, Fritz (König, Wilfried,;): Umformen. Berlin [u.a.] : Springer, 2006</p> <p>Paucksch, E.: Zerspantechnik, Vieweg-Verlag, 1996</p> <p>Tönshoff, H.K.; Denkena, B., Spanen. Grundlagen, Springer-Verlag (2004)</p>

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

Course L0610: Production Engineering II	
<b>Typ</b>	Lecture
<b>Hrs/wk</b>	2
<b>CP</b>	2
<b>Workload in Hours</b>	Independent Study Time 32, Study Time in Lecture 28
<b>Lecturer</b>	Prof. Wolfgang Hintze, Prof. Claus Emmelmann
<b>Language</b>	DE
<b>Cycle</b>	SoSe
<b>Content</b>	<ul style="list-style-type: none"> <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>
<b>Literature</b>	<p>Klocke, F., König, W.: Fertigungsverfahren Bd. 2 Schleifen, Honen, Läppen, 4. Aufl., Springer (2005)</p> <p>Klocke, F., König, W.: Fertigungsverfahren Bd. 3 Abtragen, Generieren und Lasermaterialbearbeitung. 4. Aufl., Springer (2007)</p> <p>Spur, Günter (Stöferle, Theodor,;): Urformen. München [u.a.] : Hanser, 1981</p> <p>Schatt, Werner (Wieters, Klaus-Peter,; Kieback, Bernd,;): Pulvermetallurgie : Technologien und Werkstoffe. Berlin [u.a.] : Springer, 2007</p>

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

Module M0577: Non-technical Courses for Bachelors	
<b>Module Responsible</b>	Dagmar Richter
<b>Admission Requirements</b>	None
<b>Recommended Previous Knowledge</b>	None
<b>Educational Objectives</b>	After taking part successfully, students have reached the following learning results
<b>Professional Competence</b> <i>Knowledge</i>	<p><b>The Non-technical Academic Programms (NTA)</b></p> <p>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 <b>teaching architecture</b>, in its <b>teaching and learning arrangements</b>, in <b>teaching areas</b> and by means of teaching offerings in which students can qualify by opting for <b>specific competences</b> and a <b>competence level</b> at the Bachelor’s or Master’s level. The teaching offerings are pooled in two different catalogues for nontechnical complementary courses.</p> <p><b>The Learning Architecture</b></p> <p>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.</p> <p>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”</p> <p>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.</p> <p><b>Teaching and Learning Arrangements</b></p> <p>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.</p> <p><b>Fields of Teaching</b></p> <p>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.</p> <p>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.</p> <p><b>The Competence Level</b></p> <p>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.</p> <p>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.</p> <p><b>Specialized Competence (Knowledge)</b></p> <p>Students can</p> <ul style="list-style-type: none"> <li>• locate selected specialized areas with the relevant non-technical mother discipline,</li> <li>• outline basic theories, categories, terminology, models, concepts or artistic techniques in the disciplines represented in the learning area,</li> <li>• different specialist disciplines relate to their own discipline and differentiate it as well as make connections,</li> <li>• sketch the basic outlines of how scientific disciplines, paradigms, models, instruments, methods and forms of representation in the specialized sciences are subject to individual and socio-cultural interpretation and historicity,</li> <li>• Can communicate in a foreign language in a manner appropriate to the subject.</li> </ul>
<b>Skills</b>	<p><b>Professional Competence (Skills)</b></p> <p>In selected sub-areas students can</p> <ul style="list-style-type: none"> <li>• apply basic methods of the said scientific disciplines,</li> <li>• auestion a specific technical phenomena, models, theories from the viewpoint of another, aforementioned specialist discipline,</li> <li>• to handle simple questions in aforementioned scientific disciplines in a sucessful manner,</li> <li>• justify their decisions on forms of organization and application in practical questions in contexts that go beyond the technical relationship to the subject.</li> </ul>
<b>Personal Competence</b> <i>Social Competence</i>	<p><b>Personal Competences (Social Skills)</b></p> <p>Students will be able</p> <ul style="list-style-type: none"> <li>• to learn to collaborate in different manner,</li> </ul>



<i>Autonomy</i>	<ul style="list-style-type: none"> <li>• to present and analyze problems in the abovementioned fields in a partner or group situation in a manner appropriate to the addressees,</li> <li>• to express themselves competently, in a culturally appropriate and gender-sensitive manner in the language of the country (as far as this study-focus would be chosen),</li> <li>• to explain nontechnical items to auditorium with technical background knowledge.</li> </ul> <p><b>Personal Competences (Self-reliance)</b></p> <p>Students are able in selected areas</p> <ul style="list-style-type: none"> <li>• to reflect on their own profession and professionalism in the context of real-life fields of application</li> <li>• to organize themselves and their own learning processes</li> <li>• to reflect and decide questions in front of a broad education background</li> <li>• to communicate a nontechnical item in a competent way in written form or verbally</li> <li>• to organize themselves as an entrepreneurial subject country (as far as this study-focus would be chosen)</li> </ul>
<b>Workload in Hours</b>	Depends on choice of courses
<b>Credit points</b>	6

<b>Courses</b>
<b>Information regarding lectures and courses can be found in the corresponding module handbook published separately.</b>

Module M0889: Mechanics I (Statics)			
Courses			
Title	Typ	Hrs/wk	CP
Mechanics I (Statics) (L1001)	Lecture	2	3
Mechanics I (Statics) (L1002)	Recitation Section (small)	2	2
Mechanics I (Statics) (L1003)	Recitation Section (large)	1	1
<b>Module Responsible</b>	Prof. Robert Seifried		
<b>Admission Requirements</b>	None		
<b>Recommended Previous Knowledge</b>	Solid school knowledge in mathematics and physics.		
<b>Educational Objectives</b>	After taking part successfully, students have reached the following learning results		
<b>Professional Competence</b>			
<i>Knowledge</i>	The students can <ul style="list-style-type: none"> <li>• describe the axiomatic procedure used in mechanical contexts;</li> <li>• explain important steps in model design;</li> <li>• present technical knowledge in stereostatics.</li> </ul>		
<i>Skills</i>	The students can <ul style="list-style-type: none"> <li>• explain the important elements of mathematical / mechanical analysis and model formation, and apply it to the context of their own problems;</li> <li>• apply basic statical methods to engineering problems;</li> <li>• estimate the reach and boundaries of statical methods and extend them to be applicable to wider problem sets.</li> </ul>		
<b>Personal Competence</b>			
<i>Social Competence</i>	The students can work in groups and support each other to overcome difficulties.		
<i>Autonomy</i>	Students are capable of determining their own strengths and weaknesses and to organize their time and learning based on those.		
<b>Workload in Hours</b>	Independent Study Time 110, Study Time in Lecture 70		
<b>Credit points</b>	6		
<b>Course achievement</b>	None		
<b>Examination</b>	Written exam		
<b>Examination duration and scale</b>	90 min		
<b>Assignment for the Following Curricula</b>	General Engineering Science (German program, 7 semester): Core Qualification: Compulsory Civil- and Environmental Engineering: Core Qualification: Compulsory Bioprocess Engineering: Core Qualification: Compulsory Data Science: Specialisation Mechanics: Compulsory Digital Mechanical Engineering: Core Qualification: Compulsory Electrical Engineering: Core Qualification: Elective Compulsory Green Technologies: Energy, Water, Climate: Core Qualification: Compulsory Computational Science and Engineering: Specialisation II. Mathematics & Engineering Science: Elective Compulsory Logistics and Mobility: Core Qualification: Compulsory Mechanical Engineering: Core Qualification: Compulsory Mechatronics: Core Qualification: Compulsory Orientation Studies: Core Qualification: Elective Compulsory Naval Architecture: Core Qualification: Compulsory Technomathematics: Core Qualification: Compulsory Process Engineering: Core Qualification: Compulsory Engineering and Management - Major in Logistics and Mobility: Core Qualification: Compulsory		

Course L1001: Mechanics I (Statics)	
<b>Typ</b>	Lecture
<b>Hrs/wk</b>	2
<b>CP</b>	3
<b>Workload in Hours</b>	Independent Study Time 62, Study Time in Lecture 28
<b>Lecturer</b>	Prof. Robert Seifried
<b>Language</b>	DE
<b>Cycle</b>	WiSe
<b>Content</b>	<ul style="list-style-type: none"> <li>• Tasks in Mechanics</li> <li>• Modelling and model elements</li> <li>• Vector calculus for forces and torques</li> <li>• Forces and equilibrium in space</li> <li>• Constraints and reactions, characterization of constraint systems</li> <li>• Planar and spatial truss structures</li> <li>• Internal forces and moments for beams and frames</li> <li>• Center of mass, volumn, area and line</li> <li>• Computation of center of mass by intergals, joint bodies</li> <li>• Friction (sliding and sticking)</li> <li>• Friction of ropes</li> </ul>
<b>Literature</b>	<b>K. Magnus, H.H. Müller-Slany: Grundlagen der Technischen Mechanik. 7. Auflage, Teubner (2009).</b> <b>D. Gross, W. Hauger, J. Schröder, W. Wall: Technische Mechanik 1. 11. Auflage, Springer (2011).</b>

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

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

Module M0850: Mathematics I	
<b>Courses</b>	
<b>Title</b>	<b>Typ</b> <b>Hrs/wk</b> <b>CP</b>
Analysis I (L1010)	Lecture 2 2
Analysis I (L1012)	Recitation Section (small) 1 1
Analysis I (L1013)	Recitation Section (large) 1 1
Linear Algebra I (L0912)	Lecture 2 2
Linear Algebra I (L0913)	Recitation Section (small) 1 1
Linear Algebra I (L0914)	Recitation Section (large) 1 1
<b>Module Responsible</b>	Prof. Anusch Taraz
<b>Admission Requirements</b>	None
<b>Recommended Previous Knowledge</b>	School mathematics
<b>Educational Objectives</b>	After taking part successfully, students have reached the following learning results
<b>Professional Competence</b>	<ul style="list-style-type: none"> <li>• Students can name the basic concepts in analysis and linear algebra. 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> <ul style="list-style-type: none"> <li>• Students can model problems in analysis and 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> <ul style="list-style-type: none"> <li>• Students are able to work together in teams. They are capable to use mathematics as a common language.</li> <li>• In doing so, they can communicate new concepts according to the needs of their cooperating partners. Moreover, they can design examples to check and deepen the understanding of their peers.</li> </ul> <ul style="list-style-type: none"> <li>• Students are capable of checking their understanding of complex concepts on their own. They can specify open questions precisely and know where to get help in solving them.</li> <li>• Students have developed sufficient persistence to be able to work for longer periods in a goal-oriented manner on hard problems.</li> </ul>
<i>Knowledge</i>	
<i>Skills</i>	
<b>Personal Competence</b>	
<i>Social Competence</i>	
<i>Autonomy</i>	
<b>Workload in Hours</b>	Independent Study Time 128, Study Time in Lecture 112
<b>Credit points</b>	8
<b>Course achievement</b>	None
<b>Examination</b>	Written exam
<b>Examination duration and scale</b>	60 min (Analysis I) + 60 min (Linear Algebra I)
<b>Assignment for the Following Curricula</b>	General Engineering Science (German program, 7 semester): Core Qualification: Compulsory Civil- and Environmental Engineering: Core Qualification: Compulsory Bioprocess Engineering: Core Qualification: Compulsory Digital Mechanical Engineering: Core Qualification: Compulsory Electrical Engineering: Core Qualification: Compulsory Green Technologies: Energy, Water, Climate: Core Qualification: Compulsory Computational Science and Engineering: Core Qualification: Compulsory Logistics and Mobility: Core Qualification: Compulsory Mechanical Engineering: Core Qualification: Compulsory Mechatronics: Core Qualification: Compulsory Orientation Studies: Core Qualification: Elective Compulsory Naval Architecture: Core Qualification: Compulsory Process Engineering: Core Qualification: Compulsory Engineering and Management - Major in Logistics and Mobility: Core Qualification: Compulsory

Course L1010: Analysis I	
<b>Typ</b>	Lecture
<b>Hrs/wk</b>	2
<b>CP</b>	2
<b>Workload in Hours</b>	Independent Study Time 32, Study Time in Lecture 28
<b>Lecturer</b>	Dozenten des Fachbereiches Mathematik der UHH
<b>Language</b>	DE
<b>Cycle</b>	WiSe
<b>Content</b>	Foundations of differential and integrational calculus of one variable <ul style="list-style-type: none"> <li>• statements, sets and functions</li> <li>• natural and real numbers</li> <li>• convergence of sequences and series</li> <li>• continuous and differentiable functions</li> <li>• mean value theorems</li> <li>• Taylor series</li> <li>• calculus</li> <li>• error analysis</li> <li>• fixpoint iteration</li> </ul>
<b>Literature</b>	<ul style="list-style-type: none"> <li>• <a href="http://www.math.uni-hamburg.de/teaching/export/tuhh/index.html">http://www.math.uni-hamburg.de/teaching/export/tuhh/index.html</a></li> </ul>

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

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

Course L0912: Linear Algebra I	
<b>Typ</b>	Lecture
<b>Hrs/wk</b>	2
<b>CP</b>	2
<b>Workload in Hours</b>	Independent Study Time 32, Study Time in Lecture 28
<b>Lecturer</b>	Prof. Anusch Taraz, Prof. Marko Lindner, Dr. Dennis Clemens
<b>Language</b>	DE
<b>Cycle</b>	WiSe
<b>Content</b>	<ul style="list-style-type: none"> <li>• vectors: intuition, rules, inner and cross product, lines and planes</li> <li>• systems of linear equations: Gauß elimination, matrix product, inverse matrices, transformations, block matrices, determinants</li> <li>• orthogonal projection in <math>\mathbb{R}^n</math>, Gram-Schmidt-Orthonormalization</li> </ul>
<b>Literature</b>	<ul style="list-style-type: none"> <li>• T. Arens u.a. : Mathematik, Spektrum Akademischer Verlag, Heidelberg 2009</li> <li>• W. Mackens, H. Voß: Mathematik I für Studierende der Ingenieurwissenschaften, HECO-Verlag, Alsdorf 1994</li> <li>• W. Mackens, H. Voß: Aufgaben und Lösungen zur Mathematik I für Studierende der Ingenieurwissenschaften, HECO-Verlag, Alsdorf 1994</li> <li>• G. Strang: Lineare Algebra, Springer-Verlag, 2003</li> <li>• G. und S. Teschl: Mathematik für Informatiker, Band 1, Springer-Verlag, 2013</li> </ul>

Course L0913: Linear Algebra I	
<b>Typ</b>	Recitation Section (small)
<b>Hrs/wk</b>	1
<b>CP</b>	1
<b>Workload in Hours</b>	Independent Study Time 16, Study Time in Lecture 14
<b>Lecturer</b>	Prof. Anusch Taraz, Prof. Marko Lindner, Dr. Dennis Clemens
<b>Language</b>	DE
<b>Cycle</b>	WiSe
<b>Content</b>	<ul style="list-style-type: none"> <li>vectors: intuition, rules, inner and cross product, lines and planes</li> <li>general vector spaces: subspaces, Euclidean vector spaces</li> <li>systems of linear equations: Gauß-elimination, matrix product, inverse matrices, transformations, LR-decomposition, block matrices, determinants</li> </ul>
<b>Literature</b>	<ul style="list-style-type: none"> <li>T. Arens u.a. : Mathematik, Spektrum Akademischer Verlag, Heidelberg 2009</li> <li>W. Mackens, H. Voß: Mathematik I für Studierende der Ingenieurwissenschaften, HECO-Verlag, Alsdorf 1994</li> <li>W. Mackens, H. Voß: Aufgaben und Lösungen zur Mathematik I für Studierende der Ingenieurwissenschaften, HECO-Verlag, Alsdorf 1994</li> </ul>

Course L0914: Linear Algebra I	
<b>Typ</b>	Recitation Section (large)
<b>Hrs/wk</b>	1
<b>CP</b>	1
<b>Workload in Hours</b>	Independent Study Time 16, Study Time in Lecture 14
<b>Lecturer</b>	Dr. Christian Seifert, Dr. Dennis Clemens
<b>Language</b>	DE
<b>Cycle</b>	WiSe
<b>Content</b>	See interlocking course
<b>Literature</b>	See interlocking course

Module M0933: Fundamentals of Materials Science				
Courses				
Title	Typ	Hrs/wk	CP	
Fundamentals of Materials 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	
<b>Module Responsible</b>	Prof. Jörg Weißmüller			
<b>Admission Requirements</b>	None			
<b>Recommended Previous Knowledge</b>	Highschool-level physics, chemistry und mathematics			
<b>Educational Objectives</b>	After taking part successfully, students have reached the following learning results			
<b>Professional Competence</b>				
<i>Knowledge</i>	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.			
<i>Skills</i>	The students are able to trace materials phenomena back to the underlying physical and chemical laws of nature. Materials phenomena here refers to mechanical properties such as strength, ductility, and stiffness, chemical properties such as corrosion resistance, and to phase transformations such as solidification, precipitation, or melting. The students can explain the relation between processing conditions and the materials microstructure, and they can account for the impact of microstructure on the material's behavior.			
<b>Personal Competence</b>				
<i>Social Competence</i>	-			
<i>Autonomy</i>	-			
<b>Workload in Hours</b>	Independent Study Time 96, Study Time in Lecture 84			
<b>Credit points</b>	6			
<b>Course achievement</b>	None			
<b>Examination</b>	Written exam			
<b>Examination duration and scale</b>	180 min			
<b>Assignment for the Following Curricula</b>	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 General Engineering Science (German program, 7 semester): Specialisation Energy and Environmental Engineering: Compulsory Data Science: Specialisation Materials Science: Compulsory Digital Mechanical Engineering: Core Qualification: Compulsory Energy and Environmental Engineering: Core Qualification: Compulsory Green Technologies: Energy, Water, Climate: Specialisation Energy Technology: Elective Compulsory Logistics and Mobility: Specialisation Engineering Science: Elective Compulsory Logistics and Mobility: Specialisation Production Management and Processes: Elective Compulsory Mechanical Engineering: Core Qualification: Compulsory Mechatronics: Core Qualification: Compulsory Naval Architecture: Core Qualification: Compulsory Technomathematics: Specialisation III. Engineering Science: Elective Compulsory Engineering and Management - Major in Logistics and Mobility: Specialisation Production Management and Processes: Elective Compulsory			

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

Course L0506: Fundamentals of Materials Science II (Advanced Ceramic Materials, Polymers and Composites)	
<b>Typ</b>	Lecture
<b>Hrs/wk</b>	2
<b>CP</b>	2
<b>Workload in Hours</b>	Independent Study Time 32, Study Time in Lecture 28
<b>Lecturer</b>	Prof. Bodo Fiedler, Prof. Gerold Schneider
<b>Language</b>	DE
<b>Cycle</b>	SoSe
<b>Content</b>	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
<b>Literature</b>	<p>Vorlesungsskript</p> <p>W.D. Callister: Materials Science and Engineering -An Introduction-5th ed., John Wiley &amp; Sons, Inc., New York, 2000, ISBN 0-471-32013-7</p>

Course L1095: Physical and Chemical Basics of Materials Science	
<b>Typ</b>	Lecture
<b>Hrs/wk</b>	2
<b>CP</b>	2
<b>Workload in Hours</b>	Independent Study Time 32, Study Time in Lecture 28
<b>Lecturer</b>	Prof. Stefan Müller
<b>Language</b>	DE
<b>Cycle</b>	WiSe
<b>Content</b>	<ul style="list-style-type: none"> <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 makroskopik Properties: Discussion of examples (metals, semiconductors, hybrid systems)</li> </ul>
<b>Literature</b>	<p>Für den <b>Elektromagnetismus</b>:</p> <ul style="list-style-type: none"> <li>• Bergmann-Schäfer: „Lehrbuch der Experimentalphysik“, Band 2: „Elektromagnetismus“, de Gruyter</li> </ul> <p>Für die <b>Atomphysik</b>:</p> <ul style="list-style-type: none"> <li>• Haken, Wolf: „Atom- und Quantenphysik“, Springer</li> </ul> <p>Für die <b>Materialphysik und Elastizität</b>:</p> <ul style="list-style-type: none"> <li>• Hornbogen, Warlimont: „Metallkunde“, Springer</li> </ul>



Module M1006: Team Project MB			
<b>Courses</b>			
<b>Title</b>		<b>Typ</b>	<b>Hrs/wk</b>
Team Project MB (L1236)		Project-/problem-based Learning	6
<b>Module Responsible</b>	Prof. Bodo Fiedler		
<b>Admission Requirements</b>	None		
<b>Recommended Previous Knowledge</b>	none		
<b>Educational Objectives</b>	After taking part successfully, students have reached the following learning results		
<b>Professional Competence</b>			
<i>Knowledge</i>	Students are able to give a summary of the technical details of projects in the area of civil engineering 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.		
<i>Skills</i>	The students can transfer their fundamental knowledge on civil engineering to the process of solving practical problems. They identify and overcome typical problems during the realization of projects in the context of civil engineering. Students are able to develop, compare, and choose conceptual solutions for non-standardized problems.		
<b>Personal Competence</b>			
<i>Social Competence</i>	Students are able to cooperate in small, mixed-subject groups in order to independently derive solutions to given problems in the context of civil engineering. They are able to effectively present and explain their results alone or in groups in front of a qualified audience. Students have the ability to develop alternative approaches to an civil engineering problem independently or in groups and discuss advantages as well as drawbacks.		
<i>Autonomy</i>	Students are capable of independently solving mechanical 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.		
<b>Workload in Hours</b>	Independent Study Time 96, Study Time in Lecture 84		
<b>Credit points</b>	6		
<b>Course achievement</b>	None		
<b>Examination</b>	Written elaboration		
<b>Examination duration and scale</b>	2 h at Milestones (in rooms of the institutes)		
<b>Assignment for the Following Curricula</b>	Mechanical Engineering: Core Qualification: Compulsory		

Course L1236: Team Project MB	
<b>Typ</b>	Project-/problem-based Learning
<b>Hrs/wk</b>	6
<b>CP</b>	6
<b>Workload in Hours</b>	Independent Study Time 96, Study Time in Lecture 84
<b>Lecturer</b>	Prof. Bodo Fiedler, Dozenten des SD M
<b>Language</b>	DE
<b>Cycle</b>	WiSe
<b>Content</b>	N/A
<b>Literature</b>	Unterlagen zur Organisation Unterlagen zu den Projekten bzw. Teilprojekten

Module M1692: Computer Science for Engineers - Introduction and Overview				
<b>Courses</b>				
<b>Title</b>		<b>Typ</b>	<b>Hrs/wk</b>	<b>CP</b>
Computer Science for Engineers - Introduction and Overview (L2685)		Lecture	3	3
Computer Science for Engineers - Introduction and Overview (L2686)		Recitation Section (small)	2	3
<b>Module Responsible</b>	Prof. Görschwin Fey			
<b>Admission Requirements</b>	None			
<b>Recommended Previous Knowledge</b>				
<b>Educational Objectives</b>	After taking part successfully, students have reached the following learning results			
<b>Professional Competence</b> <i>Knowledge</i> <i>Skills</i>				
<b>Personal Competence</b> <i>Social Competence</i> <i>Autonomy</i>				
<b>Workload in Hours</b>	Independent Study Time 110, Study Time in Lecture 70			
<b>Credit points</b>	6			
<b>Course achievement</b>	<b>Compulsory</b>	<b>Bonus</b>	<b>Form</b>	<b>Description</b>
	No	10 %	Attestation	Testate finden semesterbegleitend statt.
<b>Examination</b>	Written exam			
<b>Examination duration and scale</b>	90 min			
<b>Assignment for the Following Curricula</b>	General Engineering Science (German program, 7 semester): Core Qualification: Compulsory Electrical Engineering: Core Qualification: Compulsory Green Technologies: Energy, Water, Climate: Core Qualification: Compulsory Logistics and Mobility: Core Qualification: Compulsory Mechanical Engineering: Core Qualification: Compulsory Mechatronics: Core Qualification: Compulsory Orientation Studies: Core Qualification: Elective Compulsory Naval Architecture: Core Qualification: Compulsory Engineering and Management - Major in Logistics and Mobility: Core Qualification: Compulsory			

Course L2685: Computer Science for Engineers - Introduction and Overview	
<b>Typ</b>	Lecture
<b>Hrs/wk</b>	3
<b>CP</b>	3
<b>Workload in Hours</b>	Independent Study Time 48, Study Time in Lecture 42
<b>Lecturer</b>	Prof. Görschwin Fey
<b>Language</b>	DE/EN
<b>Cycle</b>	WiSe
<b>Content</b>	
<b>Literature</b>	<ul style="list-style-type: none"> <li>• Informatik                             <ul style="list-style-type: none"> <li>◦ Helmut Herold, Bruno Lurz, Jürgen Wohlrab, Matthias Hopf: Grundlagen der Informatik, 3. Auflage, 816 Seiten, Pearson Studium, 2017.</li> </ul> </li> <li>• C++                             <ul style="list-style-type: none"> <li>◦ Bjarne Stroustrup, Einführung in die Programmierung mit C++, 479 Seiten, Pearson Studium, 2010. --&gt; in der englischen Version bereits eine neuere Auflage!</li> <li>◦ Jürgen Wolf : Grundkurs C++: C++-Programmierung verständlich erklärt, Rheinwerk Computing, 3. Auflage, 2016.</li> </ul> </li> </ul>

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

Module M0671: Technical Thermodynamics I			
<b>Courses</b>			
<b>Title</b>	<b>Typ</b>	<b>Hrs/wk</b>	<b>CP</b>
Technical Thermodynamics I (L0437)	Lecture	2	4
Technical Thermodynamics I (L0439)	Recitation Section (large)	1	1
Technical Thermodynamics I (L0441)	Recitation Section (small)	1	1
<b>Module Responsible</b>	Prof. Dr. Arne Speerforck		
<b>Admission Requirements</b>	None		
<b>Recommended Previous Knowledge</b>	Elementary knowledge in Mathematics and Mechanics		
<b>Educational Objectives</b>	After taking part successfully, students have reached the following learning results		
<b>Professional Competence</b>			
<i>Knowledge</i>	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 energy. They are able to draw the Carnot cycle in a Thermodynamics related diagram. They know the physical difference between an ideal and a real gas and are able to use the related equations of state. They know the meaning of a fundamental state of equation and know the basics of two phase Thermodynamics.		
<i>Skills</i>	Students are able to calculate the internal energy, the enthalpy, the kinetic and the potential energy as well as work and heat for simple change of states and to use this calculations for the Carnot cycle. They are able to calculate state variables for an ideal and for a real gas from measured thermal state variables.		
<b>Personal Competence</b>			
<i>Social Competence</i>	The students are able to discuss in small groups and develop an approach.		
<i>Autonomy</i>	Students are able to define independently tasks, to get new knowledge from existing knowledge as well as to find ways to use the knowledge in practice.		
<b>Workload in Hours</b>	Independent Study Time 124, Study Time in Lecture 56		
<b>Credit points</b>	6		
<b>Course achievement</b>	None		
<b>Examination</b>	Written exam		
<b>Examination duration and scale</b>	90 min		
<b>Assignment for the Following Curricula</b>	General Engineering Science (German program, 7 semester): Core Qualification: Compulsory Bioprocess Engineering: Core Qualification: Compulsory Digital Mechanical Engineering: Core Qualification: Compulsory Green Technologies: Energy, Water, Climate: Core Qualification: Compulsory Logistics and Mobility: Specialisation Traffic Planning and Systems: Elective Compulsory Mechanical Engineering: Core Qualification: Compulsory Mechatronics: Core Qualification: Compulsory Orientation Studies: Core Qualification: Elective Compulsory Naval Architecture: Core Qualification: Compulsory Technomathematics: Specialisation III. Engineering Science: Elective Compulsory Process Engineering: Core Qualification: Compulsory Engineering and Management - Major in Logistics and Mobility: Specialisation Traffic Planning and Systems: Elective Compulsory		

Course L0437: Technical Thermodynamics I	
<b>Typ</b>	Lecture
<b>Hrs/wk</b>	2
<b>CP</b>	4
<b>Workload in Hours</b>	Independent Study Time 92, Study Time in Lecture 28
<b>Lecturer</b>	Prof. Dr. Arne Speerforck
<b>Language</b>	DE
<b>Cycle</b>	SoSe
<b>Content</b>	<ol style="list-style-type: none"> <li>1. Introduction</li> <li>2. Fundamental terms</li> <li>3. Thermal Equilibrium and temperature               <ol style="list-style-type: none"> <li>3.1 Thermal equation of state</li> </ol> </li> <li>4. First law               <ol style="list-style-type: none"> <li>4.1 Heat and work</li> <li>4.2 First law for closed systems</li> <li>4.3 First law for open systems</li> <li>4.4 Examples</li> </ol> </li> <li>5. Equations of state and changes of state               <ol style="list-style-type: none"> <li>5.1 Changes of state</li> <li>5.2 Cycle processes</li> </ol> </li> <li>6. Second law               <ol style="list-style-type: none"> <li>6.1 Carnot process</li> <li>6.2 Entropy</li> <li>6.3 Examples</li> <li>6.4 Exergy</li> </ol> </li> <li>7. Thermodynamic properties of pure fluids               <ol style="list-style-type: none"> <li>7.1 Fundamental equations of Thermodynamics</li> <li>7.2 Thermodynamic potentials</li> <li>7.3 Calorific state variables for arbitrary fluids</li> <li>7.4 state equations (van der Waals u.a.)</li> </ol> </li> </ol>
<b>Literature</b>	<ul style="list-style-type: none"> <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	
<b>Typ</b>	Recitation Section (large)
<b>Hrs/wk</b>	1
<b>CP</b>	1
<b>Workload in Hours</b>	Independent Study Time 16, Study Time in Lecture 14
<b>Lecturer</b>	Prof. Dr. Arne Speerforck
<b>Language</b>	DE
<b>Cycle</b>	SoSe
<b>Content</b>	See interlocking course
<b>Literature</b>	See interlocking course

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

Module M0696: Mechanics II: Mechanics of Materials				
<b>Courses</b>				
<b>Title</b>		<b>Typ</b>	<b>Hrs/wk</b>	<b>CP</b>
Mechanics II (L0493)		Lecture	2	2
Mechanics II (L0494)		Recitation Section (small)	2	2
Mechanics II (L1691)		Recitation Section (large)	2	2
<b>Module Responsible</b>	Prof. Christian Cyron			
<b>Admission Requirements</b>	None			
<b>Recommended Previous Knowledge</b>	Mechanics I			
<b>Educational Objectives</b>	After taking part successfully, students have reached the following learning results			
<b>Professional Competence</b>	<p><i>Knowledge</i> Having accomplished this module, the students know and understand the basic concepts of continuum mechanics and elastostatics, in particular stress, strain, constitutive laws, stretching, bending, torsion, failure analysis, energy methods and stability of structures.</p> <p><i>Skills</i> Having accomplished this module, the students are able to</p> <ul style="list-style-type: none"> <li>- apply the fundamental concepts of mathematical and mechanical modeling and analysis to problems of their choice</li> <li>- apply the basic methods of elastostatics to problems of engineering, in particular in the design of mechanical structures</li> <li>- to educate themselves about more advanced aspects of elastostatics</li> </ul>			
<b>Personal Competence</b>	<p><i>Social Competence</i></p> <ul style="list-style-type: none"> <li>-</li> </ul> <p><i>Autonomy</i></p> <ul style="list-style-type: none"> <li>-</li> </ul>			
<b>Workload in Hours</b>	Independent Study Time 96, Study Time in Lecture 84			
<b>Credit points</b>	6			
<b>Course achievement</b>	None			
<b>Examination</b>	Written exam			
<b>Examination duration and scale</b>	90 min			
<b>Assignment for the Following Curricula</b>	General Engineering Science (German program, 7 semester): Core Qualification: Compulsory Civil- and Environmental Engineering: Core Qualification: Compulsory Bioprocess Engineering: Core Qualification: Compulsory Data Science: Specialisation Mechanics: Compulsory Digital Mechanical Engineering: Core Qualification: Compulsory Electrical Engineering: Core Qualification: Elective Compulsory Green Technologies: Energy, Water, Climate: Core Qualification: Compulsory Logistics and Mobility: Core Qualification: Compulsory Mechanical Engineering: Core Qualification: Compulsory Mechatronics: Core Qualification: Compulsory Orientation Studies: Core Qualification: Elective Compulsory Naval Architecture: Core Qualification: Compulsory Technomathematics: Specialisation III. Engineering Science: Elective Compulsory Process Engineering: Core Qualification: Compulsory Engineering and Management - Major in Logistics and Mobility: Core Qualification: Compulsory			
Course L0493: Mechanics II				
<b>Typ</b>	Lecture			
<b>Hrs/wk</b>	2			
<b>CP</b>	2			
<b>Workload in Hours</b>	Independent Study Time 32, Study Time in Lecture 28			
<b>Lecturer</b>	Prof. Christian Cyron			
<b>Language</b>	DE			
<b>Cycle</b>	SoSe			
<b>Content</b>	stresses and strains Hooke's law tension and compression torsion bending stability buckling energy methods			
<b>Literature</b>	<ul style="list-style-type: none"> <li>• Gross, D., Hauger, W., Schröder, J., Wall, W.A.: Technische Mechanik 1, Springer</li> <li>• Gross, D., Hauger, W., Schröder, J., Wall, W.A.: Technische Mechanik 2 Elastostatik, Springer</li> </ul>			

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

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

Module M0594: Fundamentals of Mechanical Engineering Design			
<b>Courses</b>			
<b>Title</b>		<b>Typ</b>	<b>Hrs/wk</b> <b>CP</b>
Fundamentals of Mechanical Engineering Design (L0258)		Lecture	2                  3
Fundamentals of Mechanical Engineering Design (L0259)		Recitation Section (large)	2                  3
<b>Module Responsible</b>	Prof. Dieter Krause		
<b>Admission Requirements</b>	None		
<b>Recommended Previous Knowledge</b>	<ul style="list-style-type: none"> <li>• Basic knowledge about mechanics and production engineering</li> <li>• Internship (Stage I Practical)</li> </ul>		
<b>Educational Objectives</b>	After taking part successfully, students have reached the following learning results		
<b>Professional Competence</b>	<p><i>Knowledge</i> After passing the module, students are able to:</p> <ul style="list-style-type: none"> <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> <p><i>Skills</i> After passing the module, students are able to:</p> <ul style="list-style-type: none"> <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> <p><b>Personal Competence</b></p> <p><i>Social Competence</i></p> <ul style="list-style-type: none"> <li>• Students are able to discuss technical information in the lecture supported by activating methods.</li> </ul> <p><i>Autonomy</i></p> <ul style="list-style-type: none"> <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 124, Study Time in Lecture 56		
<b>Credit points</b>	6		
<b>Course achievement</b>	None		
<b>Examination</b>	Written exam		
<b>Examination duration and scale</b>	120		
<b>Assignment for the Following Curricula</b>	General Engineering Science (German program, 7 semester): Core Qualification: Compulsory Digital Mechanical Engineering: Core Qualification: Compulsory Green Technologies: Energy, Water, Climate: Specialisation Energy Technology: Elective Compulsory Logistics and Mobility: Core Qualification: Compulsory Mechanical Engineering: Core Qualification: Compulsory Mechatronics: Core Qualification: Compulsory Orientation Studies: Core Qualification: Elective Compulsory Naval Architecture: Core Qualification: Compulsory Technomathematics: Specialisation III. Engineering Science: Elective Compulsory		

<b>Course L0258: Fundamentals of Mechanical Engineering Design</b>	
<b>Typ</b>	Lecture
<b>Hrs/wk</b>	2
<b>CP</b>	3
<b>Workload in Hours</b>	Independent Study Time 62, Study Time in Lecture 28
<b>Lecturer</b>	Prof. Dieter Krause, Prof. Josef Schlattmann, Prof. Otto von Estorff, Prof. Sören Ehlers
<b>Language</b>	DE
<b>Cycle</b>	SoSe
<b>Content</b>	<p><b>Lecture</b></p> <ul style="list-style-type: none"> <li>• Introduction to design</li> <li>• Introduction to the following machine elements                             <ul style="list-style-type: none"> <li>◦ Screws</li> <li>◦ Shaft-hub joints</li> <li>◦ Rolling contact bearings</li> <li>◦ Welding / adhesive / solder joints</li> <li>◦ Springs</li> <li>◦ Axes &amp; shafts</li> </ul> </li> <li>• Presentation of technical objects (technical drawing)</li> </ul> <p><b>Exercise</b></p> <ul style="list-style-type: none"> <li>• Calculation methods for dimensioning the following machine elements:                             <ul style="list-style-type: none"> <li>◦ Screws</li> <li>◦ Shaft-hub joints</li> <li>◦ Rolling contact bearings</li> <li>◦ Welding / adhesive / solder joints</li> <li>◦ Springs</li> <li>◦ Axis &amp; shafts</li> </ul> </li> </ul>
<b>Literature</b>	<ul style="list-style-type: none"> <li>• Dubbel, Taschenbuch für den Maschinenbau; Grote, K.-H., 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>

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



Module M0851: Mathematics II	
<b>Courses</b>	
<b>Title</b>	<b>Typ</b> <b>Hrs/wk</b> <b>CP</b>
Analysis II (L1025)	Lecture 2 2
Analysis II (L1026)	Recitation Section (large) 1 1
Analysis II (L1027)	Recitation Section (small) 1 1
Linear Algebra II (L0915)	Lecture 2 2
Linear Algebra II (L0916)	Recitation Section (small) 1 1
Linear Algebra II (L0917)	Recitation Section (large) 1 1
<b>Module Responsible</b>	Prof. Anusch Taraz
<b>Admission Requirements</b>	None
<b>Recommended Previous Knowledge</b>	Mathematics I
<b>Educational Objectives</b>	After taking part successfully, students have reached the following learning results
<b>Professional Competence</b>	<ul style="list-style-type: none"> <li>• Students can name further concepts in analysis and linear algebra. 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> <ul style="list-style-type: none"> <li>• Students can model problems in analysis and 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> <ul style="list-style-type: none"> <li>• Students are able to work together in teams. They are capable to use mathematics as a common language.</li> <li>• In doing so, they can communicate new concepts according to the needs of their cooperating partners. Moreover, they can design examples to check and deepen the understanding of their peers.</li> </ul> <ul style="list-style-type: none"> <li>• Students are capable of checking their understanding of complex concepts on their own. They can specify open questions precisely and know where to get help in solving them.</li> <li>• Students have developed sufficient persistence to be able to work for longer periods in a goal-oriented manner on hard problems.</li> </ul>
<i>Knowledge</i>	
<i>Skills</i>	
<b>Personal Competence</b>	
<i>Social Competence</i>	
<i>Autonomy</i>	
<b>Workload in Hours</b>	Independent Study Time 128, Study Time in Lecture 112
<b>Credit points</b>	8
<b>Course achievement</b>	None
<b>Examination</b>	Written exam
<b>Examination duration and scale</b>	60 min (Analysis II) + 60 min (Linear Algebra II)
<b>Assignment for the Following Curricula</b>	General Engineering Science (German program, 7 semester): Core Qualification: Compulsory Civil- and Environmental Engineering: Core Qualification: Compulsory Bioprocess Engineering: Core Qualification: Compulsory Digital Mechanical Engineering: Core Qualification: Compulsory Electrical Engineering: Core Qualification: Compulsory Green Technologies: Energy, Water, Climate: Core Qualification: Compulsory Computational Science and Engineering: Core Qualification: Compulsory Logistics and Mobility: Core Qualification: Compulsory Mechanical Engineering: Core Qualification: Compulsory Mechatronics: Core Qualification: Compulsory Orientation Studies: Core Qualification: Elective Compulsory Naval Architecture: Core Qualification: Compulsory Process Engineering: Core Qualification: Compulsory Engineering and Management - Major in Logistics and Mobility: Core Qualification: Compulsory

Course L1025: Analysis II	
<b>Typ</b>	Lecture
<b>Hrs/wk</b>	2
<b>CP</b>	2
<b>Workload in Hours</b>	Independent Study Time 32, Study Time in Lecture 28
<b>Lecturer</b>	Dozenten des Fachbereiches Mathematik der UHH
<b>Language</b>	DE
<b>Cycle</b>	SoSe
<b>Content</b>	<ul style="list-style-type: none"> <li>• power series and elementary functions</li> <li>• interpolation</li> <li>• integration (proper integrals, fundamental theorem, integration rules, improper integrals, parameter dependent integrals)</li> <li>• applications of integration (volume and surface of bodies of revolution, lines and arc length, line integrals)</li> <li>• numerical quadrature</li> <li>• periodic functions</li> </ul>
<b>Literature</b>	<ul style="list-style-type: none"> <li>• <a href="http://www.math.uni-hamburg.de/teaching/export/tuhh/index.html">http://www.math.uni-hamburg.de/teaching/export/tuhh/index.html</a></li> </ul>

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

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

Course L0915: Linear Algebra II	
<b>Typ</b>	Lecture
<b>Hrs/wk</b>	2
<b>CP</b>	2
<b>Workload in Hours</b>	Independent Study Time 32, Study Time in Lecture 28
<b>Lecturer</b>	Prof. Anusch Taraz, Prof. Marko Lindner, Dr. Dennis Clemens
<b>Language</b>	DE
<b>Cycle</b>	SoSe
<b>Content</b>	<ul style="list-style-type: none"> <li>• general vector spaces: subspaces, Euclidean vector spaces</li> <li>• linear mappings: basis transformation, orthogonal projection, orthogonal matrices, householder matrices</li> <li>• linear regression: normal equations, linear discrete approximation</li> <li>• eigenvalues: diagonalising matrices, normal matrices, symmetric and Hermite matrices</li> <li>• system of linear differential equations</li> <li>• matrix factorizations: LR-decomposition, QR-decomposition, Schur decomposition, Jordan normal form, singular value decomposition</li> </ul>
<b>Literature</b>	<ul style="list-style-type: none"> <li>• T. Arens u.a. : Mathematik, Spektrum Akademischer Verlag, Heidelberg 2009</li> <li>• W. Mackens, H. Voß: Mathematik I für Studierende der Ingenieurwissenschaften, HECO-Verlag, Alsdorf 1994</li> <li>• W. Mackens, H. Voß: Aufgaben und Lösungen zur Mathematik I für Studierende der Ingenieurwissenschaften, HECO-Verlag, Alsdorf 1994</li> <li>• G. Strang: Lineare Algebra, Springer-Verlag, 2003</li> <li>• G. und S. Teschl: Mathematik für Informatiker, Band 1, Springer-Verlag, 2013</li> </ul>

Course L0916: Linear Algebra II	
<b>Typ</b>	Recitation Section (small)
<b>Hrs/wk</b>	1
<b>CP</b>	1
<b>Workload in Hours</b>	Independent Study Time 16, Study Time in Lecture 14
<b>Lecturer</b>	Prof. Anusch Taraz, Prof. Marko Lindner, Dr. Dennis Clemens
<b>Language</b>	DE
<b>Cycle</b>	SoSe
<b>Content</b>	<ul style="list-style-type: none"> <li>• linear mappings: basis transformation, orthogonal projection, orthogonal matrices, householder matrices</li> <li>• linear regression: QR-decomposition, normal equations, linear discrete approximation</li> <li>• eigenvalues: diagonalising matrices, normal matrices, symmetric and Hermite matrices, Jordan normal form, singular value decomposition</li> <li>• system of linear differential equations</li> </ul>
<b>Literature</b>	<ul style="list-style-type: none"> <li>• W. Mackens, H. Voß: Mathematik I für Studierende der Ingenieurwissenschaften, HECO-Verlag, Alsdorf 1994</li> <li>• W. Mackens, H. Voß: Aufgaben und Lösungen zur Mathematik I für Studierende der Ingenieurwissenschaften, HECO-Verlag, Alsdorf 1994</li> </ul>

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

Module M0597: Advanced Mechanical Engineering Design			
<b>Courses</b>			
<b>Title</b>	<b>Typ</b>	<b>Hrs/wk</b>	<b>CP</b>
Advanced Mechanical Engineering Design II (L0264)	Lecture	2	2
Advanced Mechanical Engineering Design II (L0265)	Recitation Section (large)	2	1
Advanced Mechanical Engineering Design I (L0262)	Lecture	2	2
Advanced Mechanical Engineering Design I (L0263)	Recitation Section (large)	2	1
<b>Module Responsible</b>	Prof. Dieter Krause		
<b>Admission Requirements</b>	None		
<b>Recommended Previous Knowledge</b>	<ul style="list-style-type: none"> <li>• Fundamentals of Mechanical Engineering Design</li> <li>• Mechanics</li> <li>• Fundamentals of Materials Science</li> <li>• Production Engineering</li> </ul>		
<b>Educational Objectives</b>	After taking part successfully, students have reached the following learning results		
<b>Professional Competence</b>	<p><i>Knowledge</i> After passing the module, students are able to:</p> <ul style="list-style-type: none"> <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> <p><i>Skills</i> After passing the module, students are able to:</p> <ul style="list-style-type: none"> <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>		
<b>Personal Competence</b>	<p><i>Social Competence</i></p> <ul style="list-style-type: none"> <li>• Students are able to discuss technical information in the lecture supported by activating methods.</li> </ul> <p><i>Autonomy</i></p> <ul style="list-style-type: none"> <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		
<b>Credit points</b>	6		
<b>Course achievement</b>	None		
<b>Examination</b>	Written exam		
<b>Examination duration and scale</b>	120		
<b>Assignment for the Following Curricula</b>	General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Energy Systems: Compulsory Energy and Environmental Engineering: Core Qualification: 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: Compulsory General Engineering Science (English program, 7 semester): Specialisation Mechanical Engineering, Focus Energy Systems: Compulsory Mechanical Engineering: Core Qualification: Compulsory Naval Architecture: Core Qualification: Compulsory		

Course L0264: Advanced Mechanical Engineering Design II	
<b>Typ</b>	Lecture
<b>Hrs/wk</b>	2
<b>CP</b>	2
<b>Workload in Hours</b>	Independent Study Time 32, Study Time in Lecture 28
<b>Lecturer</b>	Prof. Dieter Krause, Prof. Otto von Estorff
<b>Language</b>	DE
<b>Cycle</b>	SoSe
<b>Content</b>	<p><b>Advanced Mechanical Engineering Design I &amp; II</b></p> <p><b>Lecture</b></p> <ul style="list-style-type: none"> <li>• Fundamentals of the following machine elements:                             <ul style="list-style-type: none"> <li>◦ Linear rolling bearings</li> <li>◦ Axes &amp; shafts</li> <li>◦ Seals</li> <li>◦ Clutches &amp; brakes</li> <li>◦ Belt &amp; chain drives</li> <li>◦ Gear drives</li> <li>◦ Epicyclic gears</li> <li>◦ Crank drives</li> <li>◦ Sliding bearings</li> </ul> </li> <li>• Elements of fluidics</li> </ul> <p><b>Exercise</b></p> <ul style="list-style-type: none"> <li>• Calculation methods of the following machine elements:                             <ul style="list-style-type: none"> <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> </ul>
<b>Literature</b>	<ul style="list-style-type: none"> <li>• Dubbel, Taschenbuch für den Maschinenbau; Grote, K.-H., 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> <p>Sowie weitere Bücher zu speziellen Themen</p>

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

Course L0262: Advanced Mechanical Engineering Design I	
<b>Typ</b>	Lecture
<b>Hrs/wk</b>	2
<b>CP</b>	2
<b>Workload in Hours</b>	Independent Study Time 32, Study Time in Lecture 28
<b>Lecturer</b>	Prof. Dieter Krause, Prof. Otto von Estorff
<b>Language</b>	DE
<b>Cycle</b>	WiSe
<b>Content</b>	<p><b>Advanced Mechanical Engineering Design I &amp; II</b></p> <p><b>Lecture</b></p> <ul style="list-style-type: none"> <li>• Fundamentals of the following machine elements:                             <ul style="list-style-type: none"> <li>◦ Linear rolling bearings</li> <li>◦ Axes &amp; shafts</li> <li>◦ Seals</li> <li>◦ Clutches &amp; brakes</li> <li>◦ Belt &amp; chain drives</li> <li>◦ Gear drives</li> <li>◦ Epicyclic gears</li> <li>◦ Crank drives</li> <li>◦ Sliding bearings</li> </ul> </li> <li>• Elements of fluidics</li> </ul> <p><b>Exercise</b></p> <ul style="list-style-type: none"> <li>• Calculation methods of the following machine elements:                             <ul style="list-style-type: none"> <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> </ul>
<b>Literature</b>	<ul style="list-style-type: none"> <li>• Dubbel, Taschenbuch für den Maschinenbau; Grote, K.-H., 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> <p>Sowie weitere Bücher zu speziellen Themen</p>

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

Module M0598: Mechanical Engineering: Design				
<b>Courses</b>				
<b>Title</b>		<b>Typ</b>	<b>Hrs/wk</b>	<b>CP</b>
Embodiment Design and 3D-CAD (L0268)		Lecture	2	1
Mechanical Design Project I (L0695)		Project-/problem-based Learning	3	2
Mechanical Design Project II (L0592)		Project-/problem-based Learning	3	2
Team Project Design Methodology (L0267)		Project-/problem-based Learning	2	1
<b>Module Responsible</b>	Prof. Dieter Krause			
<b>Admission Requirements</b>	None			
<b>Recommended Previous Knowledge</b>	<ul style="list-style-type: none"> <li>• Fundamentals of Mechanical Engineering Design</li> <li>• Mechanics</li> <li>• Fundamentals of Materials Science</li> <li>• Production Engineering</li> </ul>			
<b>Educational Objectives</b>	After taking part successfully, students have reached the following learning results			
<b>Professional Competence</b>	<p><i>Knowledge</i> After passing the module, students are able to:</p> <ul style="list-style-type: none"> <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> <p><i>Skills</i> After passing the module, students are able to:</p> <ul style="list-style-type: none"> <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 systematically and solution-oriented,</li> <li>• apply creativity techniques in teams.</li> </ul> <p><b>Personal Competence</b></p> <p><i>Social Competence</i> After passing the module, students are able to:</p> <ul style="list-style-type: none"> <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> <p><i>Autonomy</i> Students are able</p> <ul style="list-style-type: none"> <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>			
<b>Workload in Hours</b>	Independent Study Time 40, Study Time in Lecture 140			
<b>Credit points</b>	6			
<b>Course achievement</b>	<b>Compulsory</b>	<b>Bonus</b>	<b>Form</b>	<b>Description</b>
	Yes	None	Written elaboration	3D-CAD-Praktikum
	Yes	None	Written elaboration	Teamprojekt Konstruktionsmethodik
	Yes	None	Written elaboration	Konstruktionsprojekt 1
	Yes	None	Written elaboration	Konstruktionsprojekt 2
<b>Examination</b>	Written exam			
<b>Examination duration and scale</b>	180			
<b>Assignment for the Following Curricula</b>	General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Biomedical Engineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Biomedical Engineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Energy and Environmental Engineering: Compulsory Digital Mechanical Engineering: Core Qualification: Compulsory Energy and Environmental Engineering: Core Qualification: Compulsory Engineering Science: Core Qualification: Compulsory General Engineering Science (English program, 7 semester): Specialisation Biomedical Engineering: Compulsory Green Technologies: Energy, Water, Climate: Specialisation Energy Technology: Elective Compulsory Mechanical Engineering: Core Qualification: Compulsory Mechatronics: Core Qualification: Compulsory Naval Architecture: Core Qualification: Compulsory			

Course L0268: Embodiment Design and 3D-CAD	
<b>Typ</b>	Lecture
<b>Hrs/wk</b>	2
<b>CP</b>	1
<b>Workload in Hours</b>	Independent Study Time 2, Study Time in Lecture 28
<b>Lecturer</b>	Prof. Dieter Krause
<b>Language</b>	DE
<b>Cycle</b>	WiSe
<b>Content</b>	<ul style="list-style-type: none"> <li>• Basics of 3D CAD technology</li> <li>• Practical course to apply a 3D CAD system                             <ul style="list-style-type: none"> <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>
<b>Literature</b>	<ul style="list-style-type: none"> <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, K.-H., 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., Vošiek, J., Springer Vieweg, aktuelle Auflage.</li> </ul>

Course L0695: Mechanical Design Project I	
<b>Typ</b>	Project-/problem-based Learning
<b>Hrs/wk</b>	3
<b>CP</b>	2
<b>Workload in Hours</b>	Independent Study Time 18, Study Time in Lecture 42
<b>Lecturer</b>	Prof. Thorsten Schüppstuhl
<b>Language</b>	DE
<b>Cycle</b>	WiSe
<b>Content</b>	<ul style="list-style-type: none"> <li>• Create a technical documentation of an existing mechanical model</li> <li>• Consolidation of the following aspects of technical drawings:                             <ul style="list-style-type: none"> <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>
<b>Literature</b>	<ol style="list-style-type: none"> <li>1. Hoischen, H.; Hesser, W.: Technisches Zeichnen. Grundlagen, Normen, Beispiele, darstellende Geometrie, 33. Auflage. Berlin 2011.</li> <li>2. Labisch, S.; Weber, C.: Technisches Zeichnen. Selbstständig lernen und effektiv üben, 4. Auflage. Wiesbaden 2008.</li> <li>3. Fischer, U.: Tabellenbuch Metall, 43. Auflage. Haan-Gruiten 2005.</li> </ol>



Course L0592: Mechanical Design Project II	
<b>Typ</b>	Project-/problem-based Learning
<b>Hrs/wk</b>	3
<b>CP</b>	2
<b>Workload in Hours</b>	Independent Study Time 18, Study Time in Lecture 42
<b>Lecturer</b>	Prof. Wolfgang Hintze
<b>Language</b>	DE
<b>Cycle</b>	SoSe
<b>Content</b>	<ul style="list-style-type: none"> <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>
<b>Literature</b>	<p><b>Dubbel, Taschenbuch für Maschinenbau</b>, Beitz, W., Küttner, K.-H., Springer-Verlag.</p> <p>Maschinenelemente, Band I - III, Niemann, G., Springer-Verlag.</p> <p><b>Maschinen- und Konstruktionselemente</b>, Steinhilper, W., Röper, R., Springer-Verlag.</p> <p>Einführung in die DIN-Normen, Klein, M., Teubner-Verlag.</p> <p>Konstruktionslehre, Pahl, G., Beitz, W., Springer-Verlag.</p>

Course L0267: Team Project Design Methodology	
<b>Typ</b>	Project-/problem-based Learning
<b>Hrs/wk</b>	2
<b>CP</b>	1
<b>Workload in Hours</b>	Independent Study Time 2, Study Time in Lecture 28
<b>Lecturer</b>	Prof. Dieter Krause
<b>Language</b>	DE
<b>Cycle</b>	SoSe
<b>Content</b>	<ul style="list-style-type: none"> <li>• Introduction to engineering designing methodology</li> <li>• Team Project Design Methodology                             <ul style="list-style-type: none"> <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>
<b>Literature</b>	<ul style="list-style-type: none"> <li>• Dubbel, Taschenbuch für den Maschinenbau; Grote, K.-H., 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 M0608: Basics of Electrical Engineering			
<b>Courses</b>			
<b>Title</b>	<b>Typ</b>	<b>Hrs/wk</b>	<b>CP</b>
Basics of Electrical Engineering (L0290)	Lecture	3	4
Basics of Electrical Engineering (L0292)	Recitation Section (small)	2	2
<b>Module Responsible</b>	Prof. Thorsten Kern		
<b>Admission Requirements</b>	None		
<b>Recommended Previous Knowledge</b>	Basics of mathematics		
<b>Educational Objectives</b>	After taking part successfully, students have reached the following learning results		
<b>Professional Competence</b>			
<i>Knowledge</i>	Students can to draw and explain circuit diagrams for electric and electronic circuits with a small number of components. They can describe the basic function of electric and electronic components and can present the corresponding equations. They can demonstrate the use of the standard methods for calculations.		
<i>Skills</i>	Students are able to analyse electric and electronic circuits with few components and to calculate selected quantities in the circuits. They apply the usual methods of the electrical engineering for this.		
<b>Personal Competence</b>			
<i>Social Competence</i>	none		
<i>Autonomy</i>	Students are able independently to analyse electric and electronic circuits and to calculate selected quantities in the circuits.		
<b>Workload in Hours</b>	Independent Study Time 110, Study Time in Lecture 70		
<b>Credit points</b>	6		
<b>Course achievement</b>	None		
<b>Examination</b>	Written exam		
<b>Examination duration and scale</b>	135 minutes		
<b>Assignment for the Following Curricula</b>	Bioprocess Engineering: Core Qualification: Compulsory Digital Mechanical Engineering: Core Qualification: Compulsory Energy and Environmental Engineering: Core Qualification: Compulsory Green Technologies: Energy, Water, Climate: Core Qualification: Compulsory Logistics and Mobility: Core Qualification: Compulsory Logistics and Mobility: Specialisation Production Management and Processes: Elective Compulsory Logistics and Mobility: Specialisation Traffic Planning and Systems: Elective Compulsory Mechanical Engineering: Core Qualification: Compulsory Orientation Studies: Core Qualification: Elective Compulsory Naval Architecture: Core Qualification: Compulsory Process Engineering: Core Qualification: Compulsory Engineering and Management - Major in Logistics and Mobility: Specialisation Production Management and Processes: Elective Compulsory Engineering and Management - Major in Logistics and Mobility: Specialisation Traffic Planning and Systems: Elective Compulsory		

Course L0290: Basics of Electrical Engineering	
<b>Typ</b>	Lecture
<b>Hrs/wk</b>	3
<b>CP</b>	4
<b>Workload in Hours</b>	Independent Study Time 78, Study Time in Lecture 42
<b>Lecturer</b>	Prof. Thorsten Kern
<b>Language</b>	DE
<b>Cycle</b>	WiSe
<b>Content</b>	DC networks: Current, voltage, power, Kirchhoff's laws, equivalent sources, network analysis  AC: Characteristics, RMS, complex representation, phasor diagrams, power Three phase AC: Characteristics, star-delta-connection, power, transformer  Electronics: Principle, operating behaviour and application of electronic devices as diode, Zener-diode, thyristor, transistor operational amplifier
<b>Literature</b>	Alexander von Weiss, Manfred Krause: "Allgemeine Elektrotechnik"; Vieweg-Verlag, Signatur der Bibliothek der TUHH: ETB 309 Ralf Kories, Heinz Schmitt - Walter: "Taschenbuch der Elektrotechnik"; Verlag Harri Deutsch; Signatur der Bibliothek der TUHH: ETB 122 "Grundlagen der Elektrotechnik" - andere Autoren

<b>Course L0292: Basics of Electrical Engineering</b>	
<b>Typ</b>	Recitation Section (small)
<b>Hrs/wk</b>	2
<b>CP</b>	2
<b>Workload in Hours</b>	Independent Study Time 32, Study Time in Lecture 28
<b>Lecturer</b>	Prof. Thorsten Kern, Weitere Mitarbeiter
<b>Language</b>	DE
<b>Cycle</b>	WiSe
<b>Content</b>	<p>Exercices to the analysis of circuits and the calculation of electrical quantities th the topics:</p> <p>DC networks: Current, voltage, power, Kirchhoff's laws, equivalent sources, network analysis</p> <p>AC: Characteristics, RMS, complexe representation, phasor diagrams, power</p> <p>Three phase AC: Characterisitics, star-delta- connection, power, transformer</p> <p>Elektronics: Principle, operating behaviour and application of electronic devises as diode, Zener-diode, thyristor, transistor operational amplifier</p>
<b>Literature</b>	<p>Alexander von Weiss, Manfred Krause: "Allgemeine Elektrotechnik"; Vieweg-Verlag, Signatur der Bibliothek der TUHH: ETB 309</p> <p>Ralf Kories, Heinz Schmitt - Walter: "Taschenbuch der Elektrotechnik"; Verlag Harri Deutsch; Signatur der Bibliothek der TUHH: ETB 122</p> <p>"Grundlagen der Elektrotechnik" - andere Autoren</p>

Module M0688: Technical Thermodynamics II			
<b>Courses</b>			
<b>Title</b>	<b>Typ</b>	<b>Hrs/wk</b>	<b>CP</b>
Technical Thermodynamics II (L0449)	Lecture	2	4
Technical Thermodynamics II (L0450)	Recitation Section (large)	1	1
Technical Thermodynamics II (L0451)	Recitation Section (small)	1	1
<b>Module Responsible</b>	Prof. Dr. Arne Speerforck		
<b>Admission Requirements</b>	None		
<b>Recommended Previous Knowledge</b>	Elementary knowledge in Mathematics, Mechanics and Technical Thermodynamics I		
<b>Educational Objectives</b>	After taking part successfully, students have reached the following learning results		
<b>Professional Competence</b>	<p><i>Knowledge</i> Students are familiar with different cycle processes like Joule, Otto, Diesel, Stirling, Seiliger and Clausius-Rankine. They are able to derive energetic and exergetic efficiencies and know the influence different factors. They know the difference between anti clockwise and clockwise cycles (heat-power cycle, cooling cycle). They have increased knowledge of steam cycles and are able to draw the different cycles in Thermodynamics related diagrams. They know the laws of gas mixtures, especially of humid air processes and are able to perform simple combustion calculations. They are provided with basic knowledge in gas dynamics and know the definition of the speed of sound and know about a Laval nozzle.</p> <p><i>Skills</i> Students are able to use thermodynamic laws for the design of technical processes. Especially they are able to formulate energy, exergy- and entropy balances and by this to optimise technical processes. They are able to perform simple safety calculations in regard to an outflowing gas from a tank. They are able to transform a verbal formulated message into an abstract formal procedure.</p> <p><b>Personal Competence</b></p> <p><i>Social Competence</i> The students are able to discuss in small groups and develop an approach.</p> <p><i>Autonomy</i> Students are able to define independently tasks, to get new knowledge from existing knowledge as well as to find ways to use the knowledge in practice.</p>		
<b>Workload in Hours</b>	Independent Study Time 124, Study Time in Lecture 56		
<b>Credit points</b>	6		
<b>Course achievement</b>	None		
<b>Examination</b>	Written exam		
<b>Examination duration and scale</b>	90 min		
<b>Assignment for the Following Curricula</b>	General Engineering Science (German program, 7 semester): Core Qualification: Compulsory Bioprocess Engineering: Core Qualification: Compulsory Energy and Environmental Engineering: Core Qualification: Compulsory Energy Systems: Technical Complementary Course Core Studies: Elective Compulsory Engineering Science: Specialisation Mechanical Engineering: Elective Compulsory General Engineering Science (English program, 7 semester): Specialisation Mechanical Engineering: Elective Compulsory Green Technologies: Energy, Water, Climate: Core Qualification: Compulsory Mechanical Engineering: Core Qualification: Compulsory Mechatronics: Core Qualification: Compulsory Technomathematics: Specialisation III. Engineering Science: Elective Compulsory Process Engineering: Core Qualification: Compulsory		

Course L0449: Technical Thermodynamics II	
<b>Typ</b>	Lecture
<b>Hrs/wk</b>	2
<b>CP</b>	4
<b>Workload in Hours</b>	Independent Study Time 92, Study Time in Lecture 28
<b>Lecturer</b>	Prof. Dr. Arne Speerforck
<b>Language</b>	DE
<b>Cycle</b>	WiSe
<b>Content</b>	8. Cycle processes 7. Gas - vapor - mixtures 10. Open systems with constant flow rates 11. Combustion processes 12. Special fields of Thermodynamics
<b>Literature</b>	<ul style="list-style-type: none"> <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	
<b>Typ</b>	Recitation Section (large)
<b>Hrs/wk</b>	1
<b>CP</b>	1
<b>Workload in Hours</b>	Independent Study Time 16, Study Time in Lecture 14
<b>Lecturer</b>	Prof. Dr. Arne Speerforck
<b>Language</b>	DE
<b>Cycle</b>	WiSe
<b>Content</b>	See interlocking course
<b>Literature</b>	See interlocking course

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

Module M0853: Mathematics III				
Courses				
Title	Typ	Hrs/wk	CP	
Analysis III (L1028)	Lecture	2	2	
Analysis III (L1029)	Recitation Section (small)	1	1	
Analysis III (L1030)	Recitation Section (large)	1	1	
Differential Equations 1 (Ordinary Differential Equations) (L1031)	Lecture	2	2	
Differential Equations 1 (Ordinary Differential Equations) (L1032)	Recitation Section (small)	1	1	
Differential Equations 1 (Ordinary Differential Equations) (L1033)	Recitation Section (large)	1	1	
<b>Module Responsible</b>	Prof. Anusch Taraz			
<b>Admission Requirements</b>	None			
<b>Recommended Previous Knowledge</b>	Mathematics I + II			
<b>Educational Objectives</b>	After taking part successfully, students have reached the following learning results			
<b>Professional Competence</b>				
<i>Knowledge</i>	<ul style="list-style-type: none"> <li>Students can name the basic concepts in the area of analysis and differential equations. 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>			
<i>Skills</i>	<ul style="list-style-type: none"> <li>Students can model problems in the area of analysis and differential equations 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>			
<b>Personal Competence</b>				
<i>Social Competence</i>	<ul style="list-style-type: none"> <li>Students are able to work together in teams. They are capable to use mathematics as a common language.</li> <li>In doing so, they can communicate new concepts according to the needs of their cooperating partners. Moreover, they can design examples to check and deepen the understanding of their peers.</li> </ul>			
<i>Autonomy</i>	<ul style="list-style-type: none"> <li>Students are capable of checking their understanding of complex concepts on their own. They can specify open questions precisely and know where to get help in solving them.</li> <li>Students have developed sufficient persistence to be able to work for longer periods in a goal-oriented manner on hard problems.</li> </ul>			
<b>Workload in Hours</b>	Independent Study Time 128, Study Time in Lecture 112			
<b>Credit points</b>	8			
<b>Course achievement</b>	None			
<b>Examination</b>	Written exam			
<b>Examination duration and scale</b>	60 min (Analysis III) + 60 min (Differential Equations 1)			
<b>Assignment for the Following Curricula</b>	General Engineering Science (German program, 7 semester): Core Qualification: Compulsory Civil- and Environmental Engineering: Core Qualification: Compulsory Bioprocess Engineering: Core Qualification: Compulsory Digital Mechanical Engineering: Core Qualification: Compulsory Electrical Engineering: Core Qualification: Compulsory Energy and Environmental Engineering: Core Qualification: Compulsory Green Technologies: Energy, Water, Climate: Core Qualification: Compulsory Computational Science and Engineering: Core Qualification: Compulsory Logistics and Mobility: Specialisation Traffic Planning and Systems: Elective Compulsory Logistics and Mobility: Specialisation Production Management and Processes: Elective Compulsory Logistics and Mobility: Specialisation Information Technology: Compulsory Mechanical Engineering: Core Qualification: Compulsory Mechatronics: Core Qualification: Compulsory Naval Architecture: Core Qualification: Compulsory Process Engineering: Core Qualification: Compulsory Engineering and Management - Major in Logistics and Mobility: Specialisation Traffic Planning and Systems: Elective Compulsory Engineering and Management - Major in Logistics and Mobility: Specialisation Production Management and Processes: Elective Compulsory Engineering and Management - Major in Logistics and Mobility: Specialisation Information Technology: Compulsory			

Course L1028: Analysis III	
<b>Typ</b>	Lecture
<b>Hrs/wk</b>	2
<b>CP</b>	2
<b>Workload in Hours</b>	Independent Study Time 32, Study Time in Lecture 28
<b>Lecturer</b>	Dozenten des Fachbereiches Mathematik der UHH
<b>Language</b>	DE
<b>Cycle</b>	WiSe
<b>Content</b>	Main features of differential and integrational calculus of several variables <ul style="list-style-type: none"> <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>
<b>Literature</b>	<ul style="list-style-type: none"> <li>• <a href="http://www.math.uni-hamburg.de/teaching/export/tuhh/index.html">http://www.math.uni-hamburg.de/teaching/export/tuhh/index.html</a></li> </ul>

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

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

Course L1031: Differential Equations 1 (Ordinary Differential Equations)	
<b>Typ</b>	Lecture
<b>Hrs/wk</b>	2
<b>CP</b>	2
<b>Workload in Hours</b>	Independent Study Time 32, Study Time in Lecture 28
<b>Lecturer</b>	Dozenten des Fachbereiches Mathematik der UHH
<b>Language</b>	DE
<b>Cycle</b>	WiSe
<b>Content</b>	Main features of the theory and numerical treatment of ordinary differential equations <ul style="list-style-type: none"> <li>• Introduction and elementary methods</li> <li>• Existence and uniqueness of initial value problems</li> <li>• Linear differential equations</li> <li>• Stability and qualitative behaviour of the solution</li> <li>• Boundary value problems and basic concepts of calculus of variations</li> <li>• Eigenvalue problems</li> <li>• Numerical methods for the integration of initial and boundary value problems</li> <li>• Classification of partial differential equations</li> </ul>
<b>Literature</b>	<ul style="list-style-type: none"> <li>• <a href="http://www.math.uni-hamburg.de/teaching/export/tuhh/index.html">http://www.math.uni-hamburg.de/teaching/export/tuhh/index.html</a></li> </ul>

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

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



Module M0959: Mechanics III (Dynamics)	
<b>Courses</b>	
<b>Title</b>	<b>Typ</b> <b>Hrs/wk</b> <b>CP</b>
Mechanics III (Dynamics) (L1134)	Lecture 3 3
Mechanics III (Dynamics) (L1135)	Recitation Section (small) 2 2
Mechanics III (Dynamics) (L1136)	Recitation Section (large) 1 1
<b>Module Responsible</b>	Prof. Robert Seifried
<b>Admission Requirements</b>	None
<b>Recommended Previous Knowledge</b>	Mathematics I, II, Mechanics I (Statics)
<b>Educational Objectives</b>	After taking part successfully, students have reached the following learning results
<b>Professional Competence</b>	
<i>Knowledge</i>	The students can <ul style="list-style-type: none"> <li>describe the axiomatic procedure used in mechanical contexts;</li> <li>explain important steps in model design;</li> <li>present technical knowledge in stereostatics.</li> </ul>
<i>Skills</i>	The students can <ul style="list-style-type: none"> <li>explain the important elements of mathematical / mechanical analysis and model formation, and apply it to the context of their own problems;</li> <li>apply basic hydrostatical, kinematic and kinetic methods to engineering problems;</li> <li>estimate the reach and boundaries of statical methods and extend them to be applicable to wider problem sets.</li> </ul>
<b>Personal Competence</b>	
<i>Social Competence</i>	The students can work in groups and support each other to overcome difficulties.
<i>Autonomy</i>	Students are capable of determining their own strengths and weaknesses and to organize their time and learning based on those.
<b>Workload in Hours</b>	Independent Study Time 96, Study Time in Lecture 84
<b>Credit points</b>	6
<b>Course achievement</b>	None
<b>Examination</b>	Written exam
<b>Examination duration and scale</b>	120 min
<b>Assignment for the Following Curricula</b>	General Engineering Science (German program, 7 semester): Core Qualification: Compulsory Data Science: Core Qualification: Elective Compulsory Digital Mechanical Engineering: Core Qualification: Compulsory Energy and Environmental Engineering: Core Qualification: Elective Compulsory Green Technologies: Energy, Water, Climate: Specialisation Energy Technology: Elective Compulsory Mechanical Engineering: Core Qualification: Compulsory Mechatronics: Core Qualification: Compulsory Naval Architecture: Core Qualification: Compulsory Technomathematics: Specialisation III. Engineering Science: Elective Compulsory

Course L1134: Mechanics III (Dynamics)	
<b>Typ</b>	Lecture
<b>Hrs/wk</b>	3
<b>CP</b>	3
<b>Workload in Hours</b>	Independent Study Time 48, Study Time in Lecture 42
<b>Lecturer</b>	Prof. Robert Seifried
<b>Language</b>	DE
<b>Cycle</b>	WiSe
<b>Content</b>	Kinematics <ul style="list-style-type: none"> <li>Kinematics of points and relative motion</li> <li>Planar and spatial motion of point systems and rigid bodies</li> </ul> Dynamics <ul style="list-style-type: none"> <li>Terms</li> <li>Fundamental equations</li> <li>Motion of the rigid body in 3D-space</li> <li>Dynamics of gyroscopes, rotors</li> <li>Relative kinetics</li> <li>Systems with non-constant mass</li> </ul> Vibrations <ul style="list-style-type: none"> <li></li> </ul>
<b>Literature</b>	K. Magnus, H.H. Müller-Slany: Grundlagen der Technischen Mechanik. 7. Auflage, Teubner (2009). D. Gross, W. Hauger, J. Schröder, W. Wall: Technische Mechanik 3 und 4. 11. Auflage, Springer (2011).

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

<b>Course L1136: Mechanics III (Dynamics)</b>	
<b>Typ</b>	Recitation Section (large)
<b>Hrs/wk</b>	1
<b>CP</b>	1
<b>Workload in Hours</b>	Independent Study Time 16, Study Time in Lecture 14
<b>Lecturer</b>	Prof. Robert Seifried
<b>Language</b>	DE
<b>Cycle</b>	WiSe
<b>Content</b>	See interlocking course
<b>Literature</b>	See interlocking course

Module M0865: Fundamentals of Production and Quality Management			
<b>Courses</b>			
<b>Title</b>		<b>Typ</b>	<b>Hrs/wk</b>
Production Process Organization (L0925)		Lecture	2
Quality Management (L0926)		Lecture	2
			<b>CP</b>
			3
<b>Module Responsible</b>	Prof. Hermann Lödding		
<b>Admission Requirements</b>	None		
<b>Recommended Previous Knowledge</b>	None		
<b>Educational Objectives</b>	After taking part successfully, students have reached the following learning results		
<b>Professional Competence</b>			
<i>Knowledge</i>	Students are able to explain the contents of the lecture of the module.		
<i>Skills</i>	Students are able to apply the methods and models in the module to industrial problems.		
<b>Personal Competence</b>			
<i>Social Competence</i>	-		
<i>Autonomy</i>	-		
<b>Workload in Hours</b>	Independent Study Time 124, Study Time in Lecture 56		
<b>Credit points</b>	6		
<b>Course achievement</b>	None		
<b>Examination</b>	Written exam		
<b>Examination duration and scale</b>	180 Minuten		
<b>Assignment for the Following Curricula</b>	General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Aircraft Systems Engineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Product Development and Production: Compulsory Engineering Science: Core Qualification: Compulsory General Engineering Science (English program, 7 semester): Specialisation Mechanical Engineering: Elective Compulsory General Engineering Science (English program, 7 semester): Core Qualification: Compulsory Logistics and Mobility: Specialisation Production Management and Processes: Compulsory Logistics and Mobility: Specialisation Engineering Science: Elective Compulsory Mechanical Engineering: Core Qualification: Elective Compulsory Engineering and Management - Major in Logistics and Mobility: Specialisation Production Management and Processes: Compulsory		
Course L0925: Production Process Organization			
<b>Typ</b>	Lecture		
<b>Hrs/wk</b>	2		
<b>CP</b>	3		
<b>Workload in Hours</b>	Independent Study Time 62, Study Time in Lecture 28		
<b>Lecturer</b>	Prof. Hermann Lödding		
<b>Language</b>	EN		
<b>Cycle</b>	SoSe		
<b>Content</b>	(A) Introduction (B) Product planning (C) Process planning (D) Procurement (E) Manufacturing (F) Production planning and control (PPC) (G) Distribution (H) Cooperation		
<b>Literature</b>	Wiendahl, H.-P.: Betriebsorganisation für Ingenieure Vorlesungsskript		

<b>Course L0926: Quality Management</b>	
<b>Typ</b>	Lecture
<b>Hrs/wk</b>	2
<b>CP</b>	3
<b>Workload in Hours</b>	Independent Study Time 62, Study Time in Lecture 28
<b>Lecturer</b>	Prof. Hermann Lödding
<b>Language</b>	EN
<b>Cycle</b>	SoSe
<b>Content</b>	<ul style="list-style-type: none"> <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>
<b>Literature</b>	<ul style="list-style-type: none"> <li>• Pfeifer, Tilo: Quality Management. Strategies, Methods, Techniques; Hanser-Verlag, München 2002</li> <li>• Pfeifer, Tilo: Qualitätsmanagement. Strategien, Methoden, Techniken; Hanser-Verlag, München, 3. Aufl. 2001</li> <li>• Mitra, Amitava: Fundamentals of Quality Control and Improvement; Wiley; Macmillan, 2008</li> <li>• Kleppmann, W.: Taschenbuch Versuchsplanung. Produkte und Prozesse optimieren; Hanser-Verlag, München, 6. Aufl. 2009</li> </ul>

Module M0610: Electrical Machines and Actuators			
Courses			
Title	Typ	Hrs/wk	CP
Electrical Machines and Actuators (L0293)	Lecture	3	4
Electrical Machines and Actuators (L0294)	Recitation Section (large)	2	2
<b>Module Responsible</b>	Prof. Thorsten Kern		
<b>Admission Requirements</b>	None		
<b>Recommended Previous Knowledge</b>	Basics of mathematics, in particular complex numbers, integrals, differentials Basics of electrical engineering and mechanical engineering		
<b>Educational Objectives</b>	After taking part successfully, students have reached the following learning results		
<b>Professional Competence</b>	<p><i>Knowledge</i> Students can draw and explain the basic principles of electric and magnetic fields. 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.</p> <p><i>Skills</i> Students are 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 of electric machines. They can calculate 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.</p>		
<b>Personal Competence</b>	<p><i>Social Competence</i> none</p> <p><i>Autonomy</i> Students are able independently to calculate electric and magnetic fields for applications. They are able to analyse independently the operational performance of electric machines from the characteristic data and they can calculate thereof selected quantities and characteristic curves.</p>		
<b>Workload in Hours</b>	Independent Study Time 110, Study Time in Lecture 70		
<b>Credit points</b>	6		
<b>Course achievement</b>	None		
<b>Examination</b>	Subject theoretical and practical work		
<b>Examination duration and scale</b>	Design of four machines and actuators, review of design files		
<b>Assignment for the Following Curricula</b>	<p>General Engineering Science (German program, 7 semester): Specialisation Electrical Engineering: Elective Compulsory</p> <p>General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Energy Systems: Compulsory</p> <p>General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Mechatronics: Compulsory</p> <p>General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Theoretical Mechanical Engineering: Elective Compulsory</p> <p>General Engineering Science (German program, 7 semester): Specialisation Energy and Environmental Engineering: Compulsory</p> <p>Digital Mechanical Engineering: Core Qualification: Compulsory</p> <p>Electrical Engineering: Core Qualification: Elective Compulsory</p> <p>Energy and Environmental Engineering: Core Qualification: Compulsory</p> <p>General Engineering Science (English program, 7 semester): Specialisation Mechanical Engineering: Elective Compulsory</p> <p>Green Technologies: Energy, Water, Climate: Specialisation Energy Technology: Elective Compulsory</p> <p>Logistics and Mobility: Specialisation Engineering Science: Elective Compulsory</p> <p>Logistics and Mobility: Specialisation Traffic Planning and Systems: Elective Compulsory</p> <p>Logistics and Mobility: Specialisation Production Management and Processes: Elective Compulsory</p> <p>Mechanical Engineering: Core Qualification: Elective Compulsory</p> <p>Mechatronics: Core Qualification: Compulsory</p> <p>Technomathematics: Specialisation III. Engineering Science: Elective Compulsory</p> <p>Engineering and Management - Major in Logistics and Mobility: Specialisation Traffic Planning and Systems: Elective Compulsory</p> <p>Engineering and Management - Major in Logistics and Mobility: Specialisation Production Management and Processes: Elective Compulsory</p>		

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

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

Module M0680: Fluid Dynamics			
Courses			
Title	Typ	Hrs/wk	CP
Fluid Mechanics (L0454)	Lecture	3	4
Fluid Mechanics (L0455)	Recitation Section (large)	2	2
<b>Module Responsible</b>	Prof. Thomas Rung		
<b>Admission Requirements</b>	None		
<b>Recommended Previous Knowledge</b>	Sound knowledge of engineering mathematics, engineering mechanics and thermodynamics.		
<b>Educational Objectives</b>	After taking part successfully, students have reached the following learning results		
<b>Professional Competence</b>	<p><i>Knowledge</i> Students will have the required sound knowledge to explain the general principles of fluid engineering and physics of fluids. Students can scientifically outline the rationale of flow physics using mathematical models and are familiar with methods for the performance analysis and the prediction of fluid engineering devices.</p> <p><i>Skills</i> Students are able to apply fluid-engineering principles and flow-physics models for the analysis of technical systems. The lecture enables the student to carry out all necessary theoretical calculations for the fluid dynamic design of engineering devices on a scientific level.</p> <p><b>Personal Competence</b></p> <p><i>Social Competence</i> The students are able to discuss problems and jointly develop solution strategies.</p> <p><i>Autonomy</i> The students are able to develop solution strategies for complex problems self-consistent and critically analyse results.</p>		
<b>Workload in Hours</b>	Independent Study Time 110, Study Time in Lecture 70		
<b>Credit points</b>	6		
<b>Course achievement</b>	None		
<b>Examination</b>	Written exam		
<b>Examination duration and scale</b>	180 min		
<b>Assignment for the Following Curricula</b>	General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Biomedical Engineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Naval Architecture: Compulsory Mechanical Engineering: Core Qualification: Compulsory Naval Architecture: Core Qualification: Compulsory Technomathematics: Specialisation III. Engineering Science: Elective Compulsory		

Course L0454: Fluid Mechanics	
<b>Typ</b>	Lecture
<b>Hrs/wk</b>	3
<b>CP</b>	4
<b>Workload in Hours</b>	Independent Study Time 78, Study Time in Lecture 42
<b>Lecturer</b>	Prof. Thomas Rung
<b>Language</b>	DE/EN
<b>Cycle</b>	SoSe
<b>Content</b>	<ul style="list-style-type: none"> <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 style="list-style-type: none"> <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>
<b>Literature</b>	<ul style="list-style-type: none"> <li>• the course primarily refers to / das Modul stützt sich bevorzugt auf : Munson, B.R.; Rothmayer, A.P.; Okiishi, T.H.; Huebsch, W.W.: <b>Fundamentals of Fluid Mechanics</b>, John Wiley &amp; Sons.</li> <li>• Spurk, J.; Aksel, N.: Strömungslehre, Springer.</li> <li>• Schade, H.; Kunz, E., Kameier, F.; Paschereit, C.O.: Strömungslehre, De Gruyter.</li> <li>• Herwig, H.: Strömungsmechanik, Springer.</li> <li>• Herwig, H.: Strömungsmechanik von A-Z, Vieweg.</li> </ul>

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



Module M0934: Advanced Materials			
<b>Courses</b>			
<b>Title</b>		<b>Typ</b>	<b>Hrs/wk</b>
Advanced Materials Characterization (L1087)		Lecture	2
Advanced Materials Design (L1091)		Lecture	2
Advanced Materials Design (L1092)		Recitation Section (large)	2
<b>Module Responsible</b>	Prof. Patrick Huber		
<b>Admission Requirements</b>	None		
<b>Recommended Previous Knowledge</b>	Fundamentals of Materials Science (I and II)		
<b>Educational Objectives</b>	After taking part successfully, students have reached the following learning results		
<b>Professional Competence</b>			
<i>Knowledge</i>	The students will be able to explain the properties of advanced materials along with their applications in technology, in particular metallic, ceramic, polymeric, semiconductor, modern composite materials (biomaterials) and nanomaterials.		
<i>Skills</i>	The students will be able to select material configurations according to the technical needs and, if necessary, to design new materials considering architectural principles from the micro- to the macroscale. The students will also gain an overview on modern materials science, which enables them to select optimum materials combinations depending on the technical applications.		
<b>Personal Competence</b>			
<i>Social Competence</i>	The students are able to present solutions to specialists and to develop ideas further.		
<i>Autonomy</i>	The students are able to ... <ul style="list-style-type: none"> <li>• assess their own strengths and weaknesses.</li> <li>• define tasks independently.</li> </ul>		
<b>Workload in Hours</b>	Independent Study Time 96, Study Time in Lecture 84		
<b>Credit points</b>	6		
<b>Course achievement</b>	None		
<b>Examination</b>	Written exam		
<b>Examination duration and scale</b>	90 min		
<b>Assignment for the Following Curricula</b>	General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Biomechanics: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Materials in Engineering Sciences: Compulsory Data Science: Specialisation Materials Science: Compulsory General Engineering Science (English program, 7 semester): Specialisation Mechanical Engineering: Elective Compulsory Mechanical Engineering: Core Qualification: Elective Compulsory		

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

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

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

Module M0960: Mechanics IV (Oscillations, Analytical Mechanics, Multibody Systems, Numerical Mechanics)			
<b>Courses</b>			
<b>Title</b>		<b>Typ</b>	<b>Hrs/wk</b> <b>CP</b>
Mechanics IV (Oscillations, Analytical Mechanics, Numerical Mechanics) (L1137)		Lecture	3              3
Mechanics IV (Oscillations, Analytical Mechanics, Numerical Mechanics) (L1138)		Recitation Section (small)	2              2
Mechanics IV (Oscillations, Analytical Mechanics, Numerical Mechanics) (L1139)		Recitation Section (large)	1              1
<b>Module Responsible</b>	Prof. Robert Seifried		
<b>Admission Requirements</b>	None		
<b>Recommended Previous Knowledge</b>	Mathematics I-III and Mechanics I-III		
<b>Educational Objectives</b>	After taking part successfully, students have reached the following learning results		
<b>Professional Competence</b>			
<i>Knowledge</i>	The students can <ul style="list-style-type: none"> <li>• describe the axiomatic procedure used in mechanical contexts;</li> <li>• explain important steps in model design;</li> <li>• present technical knowledge.</li> </ul>		
<i>Skills</i>	The students can <ul style="list-style-type: none"> <li>• explain the important elements of mathematical / mechanical analysis and model formation, and apply it to the context of their own problems;</li> <li>• apply basic methods to engineering problems;</li> <li>• estimate the reach and boundaries of the methods and extend them to be applicable to wider problem sets.</li> </ul>		
<b>Personal Competence</b>			
<i>Social Competence</i>	The students can work in groups and support each other to overcome difficulties.		
<i>Autonomy</i>	Students are capable of determining their own strengths and weaknesses and to organize their time and learning based on those.		
<b>Workload in Hours</b>	Independent Study Time 96, Study Time in Lecture 84		
<b>Credit points</b>	6		
<b>Course achievement</b>	None		
<b>Examination</b>	Written exam		
<b>Examination duration and scale</b>	120 min		
<b>Assignment for the Following Curricula</b>	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 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)	
<b>Typ</b>	Lecture
<b>Hrs/wk</b>	3
<b>CP</b>	3
<b>Workload in Hours</b>	Independent Study Time 48, Study Time in Lecture 42
<b>Lecturer</b>	Prof. Robert Seifried
<b>Language</b>	DE
<b>Cycle</b>	SoSe
<b>Content</b>	<ul style="list-style-type: none"> <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>
<b>Literature</b>	K. Magnus, H.H. Müller-Slany: Grundlagen der Technischen Mechanik. 7. Auflage, Teubner (2009). D. Gross, W. Hauger, J. Schröder, W. Wall: Technische Mechanik 1-4. 11. Auflage, Springer (2011). W. Schiehlen, P. Eberhard: Technische Dynamik, Springer (2012).

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

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

Module M0596: Advanced Mechanical Design Project				
Courses				
Title	Typ		Hrs/wk	CP
Advanced Mechanical Design Project (L0266)	Project-/problem-based Learning		4	6
<b>Module Responsible</b>	Dr. Jens Schmidt			
<b>Admission Requirements</b>	None			
<b>Recommended Previous Knowledge</b>	<ul style="list-style-type: none"> <li>• Mechanical Engineering: Design</li> <li>• Advanced Mechanical Engineering Design</li> </ul>			
<b>Educational Objectives</b>	After taking part successfully, students have reached the following learning results			
<b>Professional Competence</b>				
<i>Knowledge</i>	After passing the module, students are able to: <ul style="list-style-type: none"> <li>• express the procedure for systematically handling of 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>			
<i>Skills</i>	After passing the module, students are able to: <ul style="list-style-type: none"> <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 and solution-oriented,</li> <li>• create a technical documentation including all necessary technical drawings to understand the functions of the system,</li> <li>• document calculations of selected machine elements clearly and in detail.</li> </ul>			
<b>Personal Competence</b>				
<i>Social Competence</i>	After passing the module, students are able to: <ul style="list-style-type: none"> <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>			
<i>Autonomy</i>	After passing the module, students are able to: <ul style="list-style-type: none"> <li>• independently solve complex design projects, while motivating themselves, acquiring necessary knowledge and selecting appropriate methods,</li> <li>• to independently solve problems.</li> </ul>			
<b>Workload in Hours</b>	Independent Study Time 124, Study Time in Lecture 56			
<b>Credit points</b>	6			
<b>Course achievement</b>	<b>Compulsory</b>	<b>Bonus</b>	<b>Form</b>	<b>Description</b>
	Yes	None	Attestation	
<b>Examination</b>	Written exam			
<b>Examination duration and scale</b>	180			
<b>Assignment for the Following Curricula</b>	General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Aircraft Systems Engineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Product Development and Production: Compulsory 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: Advanced Mechanical Design Project	
<b>Typ</b>	Project-/problem-based Learning
<b>Hrs/wk</b>	4
<b>CP</b>	6
<b>Workload in Hours</b>	Independent Study Time 124, Study Time in Lecture 56
<b>Lecturer</b>	Dr. Jens Schmidt, Dr. Volkert Wollesen
<b>Language</b>	DE
<b>Cycle</b>	WiSe
<b>Content</b>	<p>Das Konstruktionsprojekt gliedert sich in den Entwurf eines Getriebes sowie die Lösungsfindung.</p> <ul style="list-style-type: none"> <li>• Getriebekonstruktion in Einzelarbeit                             <ul style="list-style-type: none"> <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 style="list-style-type: none"> <li>◦ Methodische Erarbeitung von prinzipiellen Lösungskonzepten</li> <li>◦ Erstellen einer Dokumentation</li> </ul> </li> </ul>
<b>Literature</b>	<ul style="list-style-type: none"> <li>• Dubbel, Taschenbuch für den Maschinenbau; Grote, K.-H., 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: Introduction to Control Systems			
Courses			
Title	Typ	Hrs/wk	CP
Introduction to Control Systems (L0654)	Lecture	2	4
Introduction to Control Systems (L0655)	Recitation Section (small)	2	2
<b>Module Responsible</b>	Prof. Herbert Werner		
<b>Admission Requirements</b>	None		
<b>Recommended Previous Knowledge</b>	Representation of signals and systems in time and frequency domain, Laplace transform		
<b>Educational Objectives</b>	After taking part successfully, students have reached the following learning results		
<b>Professional Competence</b>	<p><i>Knowledge</i></p> <ul style="list-style-type: none"> <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> <p><i>Skills</i></p> <ul style="list-style-type: none"> <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> <p><b>Personal Competence</b></p> <p><i>Social Competence</i> Students can work in small groups to jointly solve technical problems, and experimentally validate their controller designs</p> <p><i>Autonomy</i> Students can obtain information from provided sources (lecture notes, software documentation, experiment guides) and use it when solving given problems.</p> <p>They can assess their knowledge in weekly on-line tests and thereby control their learning progress.</p>		
<b>Workload in Hours</b>	Independent Study Time 124, Study Time in Lecture 56		
<b>Credit points</b>	6		
<b>Course achievement</b>	None		
<b>Examination</b>	Written exam		
<b>Examination duration and scale</b>	120 min		
<b>Assignment for the Following Curricula</b>	<p>General Engineering Science (German program, 7 semester): Core Qualification: Compulsory</p> <p>Bioprocess Engineering: Core Qualification: Compulsory</p> <p>Computer Science: Specialisation Computational Mathematics: Elective Compulsory</p> <p>Data Science: Core Qualification: Elective Compulsory</p> <p>Electrical Engineering: Core Qualification: Compulsory</p> <p>Energy and Environmental Engineering: Core Qualification: Compulsory</p> <p>General Engineering Science (English program, 7 semester): Specialisation Electrical Engineering: Compulsory</p> <p>General Engineering Science (English program, 7 semester): Specialisation Civil Engineering: Compulsory</p> <p>General Engineering Science (English program, 7 semester): Specialisation Bioprocess Engineering: Compulsory</p> <p>General Engineering Science (English program, 7 semester): Specialisation Energy and Environmental Engineering: Compulsory</p> <p>General Engineering Science (English program, 7 semester): Specialisation Computer Science: Compulsory</p> <p>General Engineering Science (English program, 7 semester): Specialisation Mechanical Engineering, Focus Biomechanics: Compulsory</p> <p>General Engineering Science (English program, 7 semester): Specialisation Mechanical Engineering, Focus Energy Systems: Compulsory</p> <p>General Engineering Science (English program, 7 semester): Specialisation Mechanical Engineering, Focus Aircraft Systems Engineering: Compulsory</p> <p>General Engineering Science (English program, 7 semester): Specialisation Mechanical Engineering, Focus Materials in Engineering Sciences: Compulsory</p> <p>General Engineering Science (English program, 7 semester): Specialisation Mechanical Engineering, Focus Mechatronics: Compulsory</p> <p>General Engineering Science (English program, 7 semester): Specialisation Mechanical Engineering, Focus Product Development and Production: Compulsory</p> <p>General Engineering Science (English program, 7 semester): Specialisation Mechanical Engineering, Focus Theoretical Mechanical Engineering: Compulsory</p> <p>General Engineering Science (English program, 7 semester): Specialisation Naval Architecture: Compulsory</p> <p>General Engineering Science (English program, 7 semester): Specialisation Process Engineering: Compulsory</p>		

<p>General Engineering Science (English program, 7 semester): Specialisation Biomedical Engineering: Compulsory                  Green Technologies: Energy, Water, Climate: Core Qualification: Compulsory                  Computational Science and Engineering: Core Qualification: Compulsory                  Logistics and Mobility: Specialisation Engineering Science: Elective Compulsory                  Logistics and Mobility: Specialisation Information Technology: Elective Compulsory                  Logistics and Mobility: Specialisation Traffic Planning and Systems: Elective Compulsory                  Logistics and Mobility: Specialisation Production Management and Processes: Elective Compulsory                  Mechanical Engineering: Core Qualification: Compulsory                  Mechatronics: Core Qualification: Compulsory                  Technomathematics: Specialisation III. Engineering Science: Elective Compulsory                  Theoretical Mechanical Engineering: Technical Complementary Course Core Studies: Elective Compulsory                  Process Engineering: Core Qualification: Compulsory                  Engineering and Management - Major in Logistics and Mobility: Specialisation Information Technology: Elective Compulsory                  Engineering and Management - Major in Logistics and Mobility: Specialisation Traffic Planning and Systems: Elective Compulsory                  Engineering and Management - Major in Logistics and Mobility: Specialisation Production Management and Processes: Elective Compulsory</p>
---

Course L0654: Introduction to Control Systems	
<b>Typ</b>	Lecture
<b>Hrs/wk</b>	2
<b>CP</b>	4
<b>Workload in Hours</b>	Independent Study Time 92, Study Time in Lecture 28
<b>Lecturer</b>	Prof. Herbert Werner
<b>Language</b>	DE
<b>Cycle</b>	WiSe
<b>Content</b>	<p>Signals and systems</p> <ul style="list-style-type: none"> <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> </ul> <p>Feedback systems</p> <ul style="list-style-type: none"> <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> <li>• Internal model principle</li> </ul> <p>Root locus techniques</p> <ul style="list-style-type: none"> <li>• Root locus plots</li> <li>• Root locus design of PID controllers</li> </ul> <p>Frequency response techniques</p> <ul style="list-style-type: none"> <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> <p>Time delay systems</p> <ul style="list-style-type: none"> <li>• Root locus and frequency response of time delay systems</li> <li>• Smith predictor</li> </ul> <p>Digital control</p> <ul style="list-style-type: none"> <li>• Sampled-data systems, difference equations</li> <li>• Tustin approximation, digital implementation of PID controllers</li> </ul> <p>Software tools</p> <ul style="list-style-type: none"> <li>• Introduction to Matlab, Simulink, Control toolbox</li> <li>• Computer-based exercises throughout the course</li> </ul>
<b>Literature</b>	<ul style="list-style-type: none"> <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>



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

Module M0956: Measurement Technology for Mechanical Engineers				
<b>Courses</b>				
<b>Title</b>		<b>Typ</b>	<b>Hrs/wk</b>	<b>CP</b>
Practical Course: Measurement and Control Systems (L1119)		Practical Course	2	2
Measurement Technology for Mechanical Engineering (L1116)		Lecture	2	3
Measurement Technology for Mechanical Engineering (L1118)		Recitation Section (large)	1	1
<b>Module Responsible</b>	Prof. Thorsten Kern			
<b>Admission Requirements</b>	None			
<b>Recommended Previous Knowledge</b>	Basic knowledge of physics, chemistry and electrical engineering			
<b>Educational Objectives</b>	After taking part successfully, students have reached the following learning results			
<b>Professional Competence</b>				
<i>Knowledge</i>	Students are able to name the most important fundamentals of the Measurement Technology (Quantities and Units, Uncertainty, Calibration, Static and Dynamic Properties of Sensors and Systems).			
	They can outline the most important measuring methods for different kinds of quantities to be measured (Electrical Quantities, Temperature, mechanical quantities, Flow, Time, Frequency).			
	They can describe important methods of chemical Analysis (Gas Sensors, Spectroscopy, Gas Chromatography)			
<i>Skills</i>	Students can select suitable measuring methods to given problems and can use referring 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.			
<b>Personal Competence</b>				
<i>Social Competence</i>	Students can arrive at work results in groups and document them in a common report.			
<i>Autonomy</i>	Students are able to familiarize themselves with new measurement technologies.			
<b>Workload in Hours</b>	Independent Study Time 110, Study Time in Lecture 70			
<b>Credit points</b>	6			
<b>Course achievement</b>	<b>Compulsory</b>	<b>Bonus</b>	<b>Form</b>	<b>Description</b>
	Yes	None	Subject	theoretical and practical work
<b>Examination</b>	Subject theoretical and practical work			
<b>Examination duration and scale</b>	105 minutes			
<b>Assignment for the Following Curricula</b>	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 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 General Engineering Science (English program, 7 semester): Specialisation Energy and Environmental Engineering: Compulsory General Engineering Science (English program, 7 semester): Specialisation Mechanical Engineering: Compulsory General Engineering Science (English program, 7 semester): Specialisation Biomedical Engineering: Compulsory General Engineering Science (English program, 7 semester): Specialisation 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 Logistics and Mobility: Specialisation Production Management and Processes: Elective Compulsory Mechanical Engineering: Core Qualification: Compulsory Mechatronics: Core Qualification: Compulsory Engineering and Management - Major in Logistics and Mobility: Specialisation Production Management and Processes: Elective Compulsory			

Course L1119: Practical Course: Measurement and Control Systems	
<b>Typ</b>	Practical Course
<b>Hrs/wk</b>	2
<b>CP</b>	2
<b>Workload in Hours</b>	Independent Study Time 32, Study Time in Lecture 28
<b>Lecturer</b>	Prof. Thorsten Kern
<b>Language</b>	DE
<b>Cycle</b>	WiSe/SoSe
<b>Content</b>	<p>Experiment 1: Emission and immission measurement of gaseous pollutants: different technologies to determine different gaseous pollutants in automotive exhaust are used.</p> <p>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.</p> <p>Experiment 3: Michelson interferometer and fiber optic: fundamental optical phenonema will be understood and applications with Michelson interferometer and optical fibers demonstrated.</p> <p>Experiment 4: Identification of the parameters of a control system and optimal control parameters</p>
<b>Literature</b>	<p>Versuch 1:</p> <ul style="list-style-type: none"> <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> <p>Versuch 2:</p> <ul style="list-style-type: none"> <li>• Grundlagen über elektrische Maschinen, speziell: Asynchronmotoren</li> <li>• Simulationsmethoden, speziell: Verwendung von Blockschaltbildern</li> <li>• Betriebsverhalten von Kreispumpen, speziell: Kennlinien, Ähnlichkeitsgesetze</li> </ul> <p>Versuch 3:</p> <ul style="list-style-type: none"> <li>• Unger, H.-G.: Optische Nachrichtentechnik, Teil 1: Optische Wellenleiter. Hüthing Verlag, Heidelberg, 1984</li> <li>• Dakin, J., Cushaw, B.: Optical Fibre Sensors: Principles and Components. Artech House Boston, 1988</li> <li>• Culshaw, B., Dakin, J.: Optical Fibre Sensors: Systems and Application. Artech House Boston, 1989</li> </ul> <p>Versuch 4:</p> <ul style="list-style-type: none"> <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	
<b>Typ</b>	Lecture
<b>Hrs/wk</b>	2
<b>CP</b>	3
<b>Workload in Hours</b>	Independent Study Time 62, Study Time in Lecture 28
<b>Lecturer</b>	Prof. Thorsten Kern, Dennis Kähler
<b>Language</b>	EN
<b>Cycle</b>	WiSe
<b>Content</b>	<p>1 Fundamentals</p> <p>1.1 Quantities and Units</p> <p>1.2 Uncertainty</p> <p>1.3 Calibration</p> <p>1.4 Static and Dynamic Properties of Sensors and Systems</p> <p>2 Measurement of Electrical Quantities</p> <p>2.1 Current and Voltage</p> <p>2.2 Impedance</p> <p>2.3 Amplification</p> <p>2.4 Oscilloscope</p> <p>2.5 Analog-to-Digital Conversion</p> <p>2.6 Data Transmission</p> <p>3 Measurement of Nonelectric Quantities</p> <p>3.1 Temperature</p> <p>3.2 Length, Displacement, Angle</p> <p>3.3 Strain, Force, Pressure</p> <p>3.4 Flow</p> <p>3.5 Time, Frequency</p>
<b>Literature</b>	<p>Lerch, R.: „Elektrische Messtechnik; Analoge, digitale und computergestützte Verfahren“, Springer, 2006, ISBN: 978-3-540-34055-3.</p> <p>Profos, P. Pfeifer, T.: „Handbuch der industriellen Messtechnik“, Oldenbourg, 2002, ISBN: 978-3486217940.</p>

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

Module M0829: Foundations of Management			
<b>Courses</b>			
<b>Title</b>		<b>Typ</b>	<b>Hrs/wk</b> <b>CP</b>
Management Tutorial (L0882)		Recitation Section (small)	2                  3
Introduction to Management (L0880)		Lecture	3                  3
<b>Module Responsible</b>	Prof. Christoph Ihl		
<b>Admission Requirements</b>	None		
<b>Recommended Previous Knowledge</b>	Basic Knowledge of Mathematics and Business		
<b>Educational Objectives</b>	After taking part successfully, students have reached the following learning results		
<b>Professional Competence</b>	<p><i>Knowledge</i></p> <p>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</p> <ul style="list-style-type: none"> <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 entrepreneurial projects</li> <li>• describe and explain basic business functions as production, procurement and sourcing, supply chain management, organization and human resource 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> <p><i>Skills</i></p> <p>Students are able to analyse business units with respect to different criteria (organization, objectives, strategies etc.) and to carry out an Entrepreneurship project in a team. In particular, they are able to</p> <ul style="list-style-type: none"> <li>• analyse Management goals and structure them appropriately</li> <li>• analyse organisational and staff structures of companies</li> <li>• apply methods for decision making under multiple objectives, under uncertainty and under risk</li> <li>• analyse production and procurement systems and Business information systems</li> <li>• analyse and apply basic methods of marketing</li> <li>• select and apply basic methods from mathematical finance to predefined problems</li> <li>• apply basic methods from accounting, costing and controlling to predefined problems</li> </ul> <p><b>Personal Competence</b></p> <p><i>Social Competence</i></p> <p>Students are able to</p> <ul style="list-style-type: none"> <li>• work successfully in a team of students</li> <li>• to apply their knowledge from the lecture to an entrepreneurship project and write a coherent report on the project</li> <li>• to communicate appropriately and</li> <li>• to cooperate respectfully with their fellow students.</li> </ul> <p><i>Autonomy</i></p> <p>Students are able to</p> <ul style="list-style-type: none"> <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		
<b>Credit points</b>	6		
<b>Course achievement</b>	None		
<b>Examination</b>	Subject theoretical and practical work		
<b>Examination duration and scale</b>	several written exams during the semester		
<b>Assignment for the Following Curricula</b>	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 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 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		

	<p>General Engineering Science (English program, 7 semester): Specialisation Mechanical Engineering, Focus Materials in Engineering Sciences: Compulsory</p> <p>General Engineering Science (English program, 7 semester): Specialisation Mechanical Engineering, Focus Mechatronics: Compulsory</p> <p>General Engineering Science (English program, 7 semester): Specialisation Mechanical Engineering, Focus Product Development and Production: Compulsory</p> <p>General Engineering Science (English program, 7 semester): Specialisation Mechanical Engineering, Focus Theoretical Mechanical Engineering: Compulsory</p> <p>General Engineering Science (English program, 7 semester): Specialisation Naval Architecture: Compulsory</p> <p>General Engineering Science (English program, 7 semester): Specialisation Process Engineering: Compulsory</p> <p>General Engineering Science (English program, 7 semester): Specialisation Biomedical Engineering: Compulsory</p> <p>Green Technologies: Energy, Water, Climate: Core Qualification: Compulsory</p> <p>Computational Science and Engineering: Core Qualification: Compulsory</p> <p>Logistics and Mobility: Core Qualification: Compulsory</p> <p>Mechanical Engineering: Core Qualification: Compulsory</p> <p>Mechatronics: Core Qualification: Compulsory</p> <p>Orientation Studies: Core Qualification: Elective Compulsory</p> <p>Orientation Studies: Core Qualification: Elective Compulsory</p> <p>Naval Architecture: Core Qualification: Compulsory</p> <p>Technomathematics: Core Qualification: Compulsory</p> <p>Process Engineering: Core Qualification: Compulsory</p> <p>Engineering and Management - Major in Logistics and Mobility: Core Qualification: Compulsory</p>
--	--

Course L0882: Management Tutorial	
<b>Typ</b>	Recitation Section (small)
<b>Hrs/wk</b>	2
<b>CP</b>	3
<b>Workload in Hours</b>	Independent Study Time 62, Study Time in Lecture 28
<b>Lecturer</b>	Prof. Christoph Ihl, Katharina Roedelius
<b>Language</b>	DE
<b>Cycle</b>	WiSe/SoSe
<b>Content</b>	<p>In the management tutorial, the contents of the lecture will be deepened by practical examples and the application of the discussed tools.</p> <p>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 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.</p>
<b>Literature</b>	Relevante Literatur aus der korrespondierenden Vorlesung.

Course L0880: Introduction to Management	
<b>Typ</b>	Lecture
<b>Hrs/wk</b>	3
<b>CP</b>	3
<b>Workload in Hours</b>	Independent Study Time 48, Study Time in Lecture 42
<b>Lecturer</b>	Prof. Christoph Ihl, Prof. Thorsten Blecker, Prof. Christian Lütjhe, Prof. Christian Ringle, Prof. Kathrin Fischer, Prof. Cornelius Herstatt, Prof. Wolfgang Kersten, Prof. Matthias Meyer, Prof. Thomas Wrona
<b>Language</b>	DE
<b>Cycle</b>	WiSe/SoSe
<b>Content</b>	<ul style="list-style-type: none"> <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 Resource 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 opportunities, 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 resource 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>
<b>Literature</b>	<p>Bamberg, G., Coenenberg, A.: Betriebswirtschaftliche Entscheidungslehre, 14. Aufl., München 2008</p> <p>Eisenführ, F., Weber, M.: Rationales Entscheiden, 4. Aufl., Berlin et al. 2003</p> <p>Heinhold, M.: Buchführung in Fallbeispielen, 10. Aufl., Stuttgart 2006.</p> <p>Kruschwitz, L.: Finanzmathematik. 3. Auflage, München 2001.</p> <p>Pellens, B., Fülbier, R. U., Gassen, J., Sellhorn, T.: Internationale Rechnungslegung, 7. Aufl., Stuttgart 2008.</p> <p>Schweitzer, M.: Planung und Steuerung, in: Bea/Friedl/Schweitzer: Allgemeine Betriebswirtschaftslehre, Bd. 2: Führung, 9. Aufl., Stuttgart 2005.</p> <p>Weber, J., Schäffer, U. : Einführung in das Controlling, 12. Auflage, Stuttgart 2008.</p> <p>Weber, J./Weißenberger, B.: Einführung in das Rechnungswesen, 7. Auflage, Stuttgart 2006.</p>

## Specialization Biomechanics

Due to the ever increasing demands on the health system of an aging population, mechanization is of great importance. Both individual implants and instruments as well as large appliances used for diagnostics and therapy, medical and engineering science staff must work increasingly close together to meet the new requirements. For engineers, this means that they can understand and influence project management, and development and research have what they learn in this specialization in addition to specific engineering fundamentals and medical and business aspects of patient care.

Module M1277: MED I: Introduction to Anatomy			
Courses			
Title	Typ	Hrs/wk	CP
Introduction to Anatomy (L0384)	Lecture	2	3
<b>Module Responsible</b>	Prof. Udo Schumacher		
<b>Admission Requirements</b>	None		
<b>Recommended Previous Knowledge</b>	None		
<b>Educational Objectives</b>	After taking part successfully, students have reached the following learning results		
<b>Professional Competence</b>	<p><i>Knowledge</i> 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.</p> <p><i>Skills</i> 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.</p> <p><b>Personal Competence</b></p> <p><i>Social Competence</i> The students can participate in current discussions in biomedical research and medicine on a professional level.</p> <p><i>Autonomy</i> The students are able to access anatomical knowledge by themselves, can participate in conversations on the topic and acquire the relevant knowledge themselves.</p>		
<b>Workload in Hours</b>	Independent Study Time 62, Study Time in Lecture 28		
<b>Credit points</b>	3		
<b>Course achievement</b>	None		
<b>Examination</b>	Written exam		
<b>Examination duration and scale</b>	90 minutes		
<b>Assignment for the Following Curricula</b>	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 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		



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

Module M1278: MED I: Introduction to Radiology and Radiation Therapy			
Courses			
Title	Typ	Hrs/wk	CP
Introduction to Radiology and Radiation Therapy (L0383)	Lecture	2	3
<b>Module Responsible</b>	Prof. Ulrich Carl		
<b>Admission Requirements</b>	None		
<b>Recommended Previous Knowledge</b>	None		
<b>Educational Objectives</b>	After taking part successfully, students have reached the following learning results		
<b>Professional Competence</b>	<p><i>Knowledge</i></p> <p><b>Therapy</b></p> <p>The students can distinguish different types of currently used equipment with respect to its use in radiation therapy.</p> <p>The students can explain treatment plans used in radiation therapy in interdisciplinary contexts (e.g. surgery, internal medicine).</p> <p><b>The students can describe the patients' passage from their initial admittance through to follow-up care.</b></p> <p><b>Diagnostics</b></p> <p>The students can illustrate the technical base concepts of projection radiography, including angiography and mammography, as well as sectional imaging techniques (CT, MRT, US).</p> <p>The students can explain the diagnostic as well as therapeutic use of imaging techniques, as well as the technical basis for those techniques.</p> <p>The students can choose the right treatment method depending on the patient's clinical history and needs.</p> <p>The student can explain the influence of technical errors on the imaging techniques.</p> <p>The student can draw the right conclusions based on the images' diagnostic findings or the error protocol.</p> <p><i>Skills</i></p> <p><b>Therapy</b></p> <p>The students can distinguish curative and palliative situations and motivate why they came to that conclusion.</p> <p>The students can develop adequate therapy concepts and relate it to the radiation biological aspects.</p> <p>The students can use the therapeutic principle (effects vs adverse effects)</p> <p>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).</p> <p>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).</p> <p><b>Diagnostics</b></p> <p>The students can suggest solutions for repairs of imaging instrumentation after having done error analyses.</p> <p>The students can classify results of imaging techniques according to different groups of diseases based on their knowledge of anatomy, pathology and pathophysiology.</p> <p><b>Personal Competence</b></p> <p><i>Social Competence</i></p> <p>The students can assess the special social situation of tumor patients and interact with them in a professional way.</p> <p>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.</p> <p><i>Autonomy</i></p> <p>The students can apply their new knowledge and skills to a concrete therapy case.</p> <p>The students can introduce younger students to the clinical daily routine.</p> <p>The students are able to access anatomical knowledge by themselves, can participate competently in conversations on the topic and acquire the relevant knowledge themselves.</p>		
<b>Workload in Hours</b>	Independent Study Time 62, Study Time in Lecture 28		
<b>Credit points</b>	3		
<b>Course achievement</b>	None		
<b>Examination</b>	Written exam		
<b>Examination duration and scale</b>	90 minutes		
<b>Assignment for the Following Curricula</b>	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 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		

<b>Course L0383: Introduction to Radiology and Radiation Therapy</b>	
<b>Typ</b>	Lecture
<b>Hrs/wk</b>	2
<b>CP</b>	3
<b>Workload in Hours</b>	Independent Study Time 62, Study Time in Lecture 28
<b>Lecturer</b>	Prof. Ulrich Carl, Prof. Thomas Vestring
<b>Language</b>	DE
<b>Cycle</b>	SoSe
<b>Content</b>	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
<b>Literature</b>	<ul style="list-style-type: none"> <li>• "Technik der medizinischen Radiologie" von T. + J. Laubenberg - 7. Auflage - Deutscher Ärzteverlag - erschienen 1999</li> <li>• "Klinische Strahlenbiologie" von Th. Herrmann, M. Baumann und W. Dörr - 4. Auflage - Verlag Urban &amp; Fischer - erschienen 02.03.2006 ISBN: 978-3-437-23960-1</li> <li>• "Strahlentherapie und Onkologie für MTA-R" von R. Sauer - 5. Auflage 2003 - Verlag Urban &amp; Schwarzenberg - erschienen 08.12.2009 ISBN: 978-3-437-47501-6</li> <li>• "Taschenatlas der Physiologie" von S. Silbernagel und A. Despopoulos- 8. Auflage - Georg Thieme Verlag - erschienen 19.09.2012 ISBN: 978-3-13-567708-8</li> <li>• "Der Körper des Menschen " von A. Faller u. M. Schünke - 16. Auflage 2004 - Georg Thieme Verlag - erschienen 18.07.2012 ISBN: 978-3-13-329716-5</li> <li>• „Praxismanual Strahlentherapie“ von Stöver / Feyer - 1. Auflage - Springer-Verlag GmbH - erschienen 02.06.2000</li> </ul>

Module M1279: MED II: Introduction to Biochemistry and Molecular Biology			
Courses			
Title	Typ	Hrs/wk	CP
Introduction to Biochemistry and Molecular Biology (L0386)	Lecture	2	3
<b>Module Responsible</b>	Prof. Hans-Jürgen Kreienkamp		
<b>Admission Requirements</b>	None		
<b>Recommended Previous Knowledge</b>	None		
<b>Educational Objectives</b>	After taking part successfully, students have reached the following learning results		
<b>Professional Competence</b>			
<i>Knowledge</i>	The students can <ul style="list-style-type: none"> <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>		
<i>Skills</i>	The students can <ul style="list-style-type: none"> <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>		
<b>Personal Competence</b>			
<i>Social Competence</i>	The students can participate in discussions in research and medicine on a technical level.		
<i>Autonomy</i>	The students can develop understanding of topics from the course, using technical literature, by themselves.		
<b>Workload in Hours</b>	Independent Study Time 62, Study Time in Lecture 28		
<b>Credit points</b>	3		
<b>Course achievement</b>	None		
<b>Examination</b>	Written exam		
<b>Examination duration and scale</b>	60 minutes		
<b>Assignment for the Following Curricula</b>	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 Biomedical Engineering: Compulsory General Engineering Science (English program, 7 semester): Specialisation Mechanical Engineering, Focus Biomechanics: Compulsory Mechanical Engineering: Specialisation Biomechanics: Compulsory 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	
<b>Typ</b>	Lecture
<b>Hrs/wk</b>	2
<b>CP</b>	3
<b>Workload in Hours</b>	Independent Study Time 62, Study Time in Lecture 28
<b>Lecturer</b>	Prof. Hans-Jürgen Kreienkamp
<b>Language</b>	DE
<b>Cycle</b>	WiSe
<b>Content</b>	
<b>Literature</b>	Müller-Esterl, Biochemie, Spektrum Verlag, 2010; 2. Auflage Löffler, Basiswissen Biochemie, 7. Auflage, Springer, 2008

Module M1333: BIO I: Implants and Fracture Healing			
Courses			
Title	Typ	Hrs/wk	CP
Implants and Fracture Healing (L0376)	Lecture	2	3
<b>Module Responsible</b>	Prof. Michael Morlock		
<b>Admission Requirements</b>	None		
<b>Recommended Previous Knowledge</b>	It is recommended to participate in "Introduction into Anatomie" before attending "Implants and Fracture Healing".		
<b>Educational Objectives</b>	After taking part successfully, students have reached the following learning results		
<b>Professional Competence</b>	<p><i>Knowledge</i> 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.</p> <p><i>Skills</i> The students can determine the forces acting within the human body under quasi-static situations under specific assumptions.</p>		
<b>Personal Competence</b>	<p><i>Social Competence</i> The students can, in groups, solve basic numerical modeling tasks for the calculation of internal forces.</p> <p><i>Autonomy</i> The students can, in groups, solve basic numerical modeling tasks for the calculation of internal forces.</p>		
<b>Workload in Hours</b>	Independent Study Time 62, Study Time in Lecture 28		
<b>Credit points</b>	3		
<b>Course achievement</b>	None		
<b>Examination</b>	Written exam		
<b>Examination duration and scale</b>	90 min		
<b>Assignment for the Following Curricula</b>	General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Biomechanics: Compulsory General Engineering Science (German program, 7 semester): Specialisation Biomedical Engineering: Compulsory Engineering Science: Specialisation Biomedical Engineering: Compulsory General Engineering Science (English program, 7 semester): Specialisation Biomedical Engineering: Compulsory General Engineering Science (English program, 7 semester): Specialisation Mechanical Engineering, Focus Biomechanics: Compulsory Mechanical Engineering: Specialisation Biomechanics: Compulsory Biomedical Engineering: Specialisation Implants and Endoprostheses: Elective Compulsory Biomedical Engineering: Specialisation Artificial Organs and Regenerative Medicine: Elective Compulsory Biomedical Engineering: Specialisation Management and Business Administration: Elective Compulsory Biomedical Engineering: Specialisation Medical Technology and Control Theory: Elective Compulsory Orientation Studies: Core Qualification: Elective Compulsory Technomathematics: Specialisation III. Engineering Science: Elective Compulsory		

Course L0376: Implants and Fracture Healing	
<b>Typ</b>	Lecture
<b>Hrs/wk</b>	2
<b>CP</b>	3
<b>Workload in Hours</b>	Independent Study Time 62, Study Time in Lecture 28
<b>Lecturer</b>	Prof. Michael Morlock
<b>Language</b>	DE
<b>Cycle</b>	WiSe
<b>Content</b>	<p>Topics to be covered include:</p> <ol style="list-style-type: none"> <li>1. Introduction (history, definitions, background importance)</li> <li>2. Bone (anatomy, properties, biology, adaptations in femur, tibia, humerus, radius)</li> <li>3. Spine (anatomy, biomechanics, function, vertebral bodies, intervertebral disc, ligaments)               <ol style="list-style-type: none"> <li>3.1 The spine in its entirety</li> <li>3.2 Cervical spine</li> <li>3.3 Thoracic spine</li> <li>3.4 Lumbar spine</li> <li>3.5 Injuries and diseases</li> </ol> </li> <li>4. Pelvis (anatomy, biomechanics, fracture treatment)</li> <li>5 Fracture Healing               <ol style="list-style-type: none"> <li>5.1 Basics and biology of fracture repair</li> <li>5.2 Clinical principals and terminology of fracture treatment</li> <li>5.3 Biomechanics of fracture treatment                   <ol style="list-style-type: none"> <li>5.3.1 Screws</li> <li>5.3.2 Plates</li> <li>5.3.3 Nails</li> <li>5.3.4 External fixation devices</li> <li>5.3.5 Spine implants</li> </ol> </li> </ol> </li> <li>6.0 New Implants</li> </ol>
<b>Literature</b>	<p>Cochran V.B.: Orthopädische Biomechanik</p> <p>Mow V.C., Hayes W.C.: Basic Orthopaedic Biomechanics</p> <p>White A.A., Panjabi M.M.: Clinical biomechanics of the spine</p> <p>Nigg, B.: Biomechanics of the musculo-skeletal system</p> <p>Schiebler T.H., Schmidt W.: Anatomie</p> <p>Platzer: dtv-Atlas der Anatomie, Band 1 Bewegungsapparat</p>

Module M1280: MED II: Introduction to Physiology			
<b>Courses</b>			
<b>Title</b>		<b>Typ</b>	<b>Hrs/wk</b>
Introduction to Physiology (L0385)		Lecture	2
<b>CP</b>			3
<b>Module Responsible</b>	Dr. Roger Zimmermann		
<b>Admission Requirements</b>	None		
<b>Recommended Previous Knowledge</b>	None		
<b>Educational Objectives</b>	After taking part successfully, students have reached the following learning results		
<b>Professional Competence</b>			
<i>Knowledge</i>	The students can <ul style="list-style-type: none"> <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>		
<i>Skills</i>	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.		
<b>Personal Competence</b>			
<i>Social Competence</i>	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.		
<i>Autonomy</i>	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		
<b>Credit points</b>	3		
<b>Course achievement</b>	None		
<b>Examination</b>	Written exam		
<b>Examination duration and scale</b>	60 minutes		
<b>Assignment for the Following Curricula</b>	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 Medical Technology and Control Theory: Elective Compulsory Biomedical Engineering: Specialisation Management and Business Administration: Elective Compulsory Biomedical Engineering: Specialisation Artificial Organs and Regenerative Medicine: Elective Compulsory Biomedical Engineering: Specialisation Implants and Endoprostheses: Elective Compulsory Technomathematics: Specialisation III. Engineering Science: Elective Compulsory		

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

Module M1332: BIO I: Experimental Methods in Biomechanics				
<b>Courses</b>				
<b>Title</b>		<b>Typ</b>	<b>Hrs/wk</b>	<b>CP</b>
Experimental Methods in Biomechanics (L0377)		Lecture	2	3
<b>Module Responsible</b>	Prof. Michael Morlock			
<b>Admission Requirements</b>	None			
<b>Recommended Previous Knowledge</b>	It is recommended to participate in "Implantate und Frakturheilung" before attending "Experimentelle Methoden".			
<b>Educational Objectives</b>	After taking part successfully, students have reached the following learning results			
<b>Professional Competence</b>				
<i>Knowledge</i>	The students can describe the different ways how bones heal, and the requirements for their existence. The students can name different treatments for the spine and hollow bones under given fracture morphologies. The students can describe different measurement techniques for forces and movements, and choose the adequate technique for a given task.			
<i>Skills</i>	The students can describe the basic handling of several experimental techniques used in biomechanics.			
<b>Personal Competence</b>				
<i>Social Competence</i>	The students can, in groups, solve basic experimental tasks.			
<i>Autonomy</i>	The students can, in groups, solve basic experimental tasks.			
<b>Workload in Hours</b>	Independent Study Time 62, Study Time in Lecture 28			
<b>Credit points</b>	3			
<b>Course achievement</b>	None			
<b>Examination</b>	Written exam			
<b>Examination duration and scale</b>	90 min			
<b>Assignment for the Following Curricula</b>	General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Biomechanics: Compulsory General Engineering Science (German program, 7 semester): Specialisation Biomedical Engineering: Compulsory Engineering Science: Specialisation Biomedical Engineering: Elective Compulsory General Engineering Science (English program, 7 semester): Specialisation Mechanical Engineering, Focus Biomechanics: Compulsory General Engineering Science (English program, 7 semester): Specialisation Biomedical Engineering: Compulsory General Engineering Science (English program, 7 semester): Specialisation Biomedical Engineering: Elective Compulsory Mechanical Engineering: Specialisation Biomechanics: Compulsory Technomathematics: Specialisation III. Engineering Science: Elective Compulsory			
Course L0377: Experimental Methods in Biomechanics				
<b>Typ</b>	Lecture			
<b>Hrs/wk</b>	2			
<b>CP</b>	3			
<b>Workload in Hours</b>	Independent Study Time 62, Study Time in Lecture 28			
<b>Lecturer</b>	Prof. Michael Morlock			
<b>Language</b>	DE			
<b>Cycle</b>	SoSe			
<b>Content</b>				
<b>Literature</b>	Wird in der Veranstaltung bekannt gegeben			



## Specialization Energy Systems

The aim of this specialization is to familiarize students with different technologies for energy conversion, energy distribution and energy application. Processes can be analyzed using scientific methods, as well as abstracted and modeled, and are also documented. Students can evaluate data and results and from those develop strategies for the development of innovative solutions.

Module M0684: Heat Transfer			
<b>Courses</b>			
<b>Title</b>	<b>Typ</b>	<b>Hrs/wk</b>	<b>CP</b>
Heat Transfer (L0458)	Lecture	3	4
Heat Transfer (L0459)	Recitation Section (large)	2	2
<b>Module Responsible</b>	Dr. Andreas Moschallski		
<b>Admission Requirements</b>	None		
<b>Recommended Previous Knowledge</b>	Technical Thermodynamics I, II and Fluid Dynamics		
<b>Educational Objectives</b>	After taking part successfully, students have reached the following learning results		
<b>Professional Competence</b>			
<i>Knowledge</i>	The students are able to		
	- describe the different physical mechanism of Heat Transfer,		
	- explain the technical terms,		
	- to analyse complex heat transfer processes in a critical way.		
<i>Skills</i>	The students are able to		
	- understand the physics of Heat Transfer,		
	- calculate and evaluate complex Heat Transfer processes,		
	- solve exercises self-consistent and in small groups.		
<b>Personal Competence</b>			
<i>Social Competence</i>	The students are able to discuss in small groups and develop an approach.		
<i>Autonomy</i>	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 in Lecture 70		
<b>Credit points</b>	6		
<b>Course achievement</b>	None		
<b>Examination</b>	Written exam		
<b>Examination duration and scale</b>	120 min		
<b>Assignment for the Following Curricula</b>	General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Energy Systems: Compulsory General Engineering Science (German program, 7 semester): Specialisation Biomedical Engineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Theoretical Mechanical Engineering: Compulsory Energy Systems: Technical Complementary Course Core Studies: 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	
<b>Typ</b>	Lecture
<b>Hrs/wk</b>	3
<b>CP</b>	4
<b>Workload in Hours</b>	Independent Study Time 78, Study Time in Lecture 42
<b>Lecturer</b>	Dr. Andreas Moschallski
<b>Language</b>	DE
<b>Cycle</b>	WiSe
<b>Content</b>	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
<b>Literature</b>	- Herwig, H.; Moschallski, A.: Wärmeübertragung, 4. Auflage, Springer Vieweg Verlag, Wiesbaden, 2019 - Herwig, H.: Wärmeübertragung von A-Z, Springer- Verlag, Berlin, Heidelberg, 2000 - Baehr, H.D.; Stephan, K.: Wärme- und Stoffübertragung, 2. Auflage, Springer Verlag, Berlin, Heidelberg, 1996

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

Module M1022: Reciprocating Machinery			
<b>Courses</b>			
Title	Typ	Hrs/wk	CP
Fundamentals of Reciprocating Engines and Turbomachinery - Part Reciprocating Engines (L0633)	Lecture	1	1
Fundamentals of Reciprocating Engines and Turbomachinery - Part Reciprocating Engines (L0634)	Recitation Section (large)	1	1
Internal Combustion Engines I (L0059)	Lecture	2	2
Internal Combustion Engines I (L0639)	Recitation Section (large)	1	2
<b>Module Responsible</b>	Prof. Christopher Friedrich Wirz		
<b>Admission Requirements</b>	None		
<b>Recommended Previous Knowledge</b>	Thermodynamics, Mechanics, Machine Elements		
<b>Educational Objectives</b>	After taking part successfully, students have reached the following learning results		
<b>Professional Competence</b>	<p><i>Knowledge</i> As a result of the part module „Fundamentals of Reciprocating Machinery“, the students are able to reflect fundamentals regarding power and working machinery and describe the qualitative and quantitative correlations of operating methods and efficiencies of multiple types of engines, compressors and pumps. They are able to utilize technical terms and parameters as well as aspects regarding the development of power density and efficiency, furthermore to give an overview of charging systems, fuels and emissions. The students are able to select specific types of machinery and assess design related and operational problems.</p> <p>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.</p> <p><i>Skills</i> 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.</p> <p><b>Personal Competence</b></p> <p><i>Social Competence</i> The students are able to communicate and cooperate in a professional environment in the field of machinery design and application.</p> <p><i>Autonomy</i> The widespread scope of gained knowledge enables the students to handle situations in their future profession independently and confidently.</p>		
<b>Workload in Hours</b>	Independent Study Time 110, Study Time in Lecture 70		
<b>Credit points</b>	6		
<b>Course achievement</b>	None		
<b>Examination</b>	Written exam		
<b>Examination duration and scale</b>	120 min		
<b>Assignment for the Following Curricula</b>	General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Energy Systems: 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 Mechanical Engineering, Focus Energy Systems: Compulsory Green Technologies: Energy, Water, Climate: Specialisation Energy Technology: Elective Compulsory Mechanical Engineering: Specialisation Energy Systems: Compulsory		

Course L0633: Fundamentals of Reciprocating Engines and Turbomachinery - Part Reciprocating Engines	
<b>Typ</b>	Lecture
<b>Hrs/wk</b>	1
<b>CP</b>	1
<b>Workload in Hours</b>	Independent Study Time 16, Study Time in Lecture 14
<b>Lecturer</b>	Prof. Christopher Friedrich Wirz
<b>Language</b>	DE
<b>Cycle</b>	WiSe
<b>Content</b>	<ul style="list-style-type: none"> <li>• Verbrennungsmotoren                             <ul style="list-style-type: none"> <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> </ul> </li> <li>• Kolbenverdichter                             <ul style="list-style-type: none"> <li>◦ Thermodynamik des Kolbenverdichters</li> <li>◦ Einteilung und Verwendung</li> </ul> </li> <li>• Kolbenpumpen                             <ul style="list-style-type: none"> <li>◦ Prinzip der Kolbenpumpen</li> <li>◦ Einteilung und Verwendung</li> </ul> </li> </ul>
<b>Literature</b>	<ul style="list-style-type: none"> <li>• A. Urlaub: Verbrennungsmotoren</li> <li>• W. Kalide: Kraft- und Arbeitsmaschinen</li> </ul>

Course L0634: Fundamentals of Reciprocating Engines and Turbomachinery - Part Reciprocating Engines	
<b>Typ</b>	Recitation Section (large)
<b>Hrs/wk</b>	1
<b>CP</b>	1
<b>Workload in Hours</b>	Independent Study Time 16, Study Time in Lecture 14
<b>Lecturer</b>	Prof. Christopher Friedrich Wirz
<b>Language</b>	DE
<b>Cycle</b>	WiSe
<b>Content</b>	See interlocking course
<b>Literature</b>	See interlocking course

Course L0059: Internal Combustion Engines I	
<b>Typ</b>	Lecture
<b>Hrs/wk</b>	2
<b>CP</b>	2
<b>Workload in Hours</b>	Independent Study Time 32, Study Time in Lecture 28
<b>Lecturer</b>	Prof. Wolfgang Thiemann
<b>Language</b>	DE
<b>Cycle</b>	SoSe
<b>Content</b>	<ul style="list-style-type: none"> <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>
<b>Literature</b>	<ul style="list-style-type: none"> <li>• Vorlesungsskript</li> <li>• Übungsaufgaben mit Lösungsweg</li> <li>• Literaturliste</li> </ul>

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

Module M0655: Computational Fluid Dynamics I			
Courses			
Title	Typ	Hrs/wk	CP
Computational Fluid Dynamics I (L0235)	Lecture	2	3
Computational Fluid Dynamics I (L0419)	Recitation Section (large)	2	3
<b>Module Responsible</b>	Prof. Thomas Rung		
<b>Admission Requirements</b>	None		
<b>Recommended Previous Knowledge</b>	<ul style="list-style-type: none"> <li>• Mathematical Methods for Engineers</li> <li>• Fundamentals of Differential/integral calculus and series expansions</li> </ul>		
<b>Educational Objectives</b>	After taking part successfully, students have reached the following learning results		
<b>Professional Competence</b>			
<i>Knowledge</i>	The students are able to list the basic numerics of partial differential equations.		
<i>Skills</i>	The students are able develop appropriate numerical integration in space and time for the governing partial differential equations. They can code computational algorithms in a structured way.		
<b>Personal Competence</b>			
<i>Social Competence</i>	The students can arrive at work results in groups and document them.		
<i>Autonomy</i>	The students can independently analyse approaches to solving specific problems.		
<b>Workload in Hours</b>	Independent Study Time 124, Study Time in Lecture 56		
<b>Credit points</b>	6		
<b>Course achievement</b>	None		
<b>Examination</b>	Written exam		
<b>Examination duration and scale</b>	2h		
<b>Assignment for the Following Curricula</b>	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 Aircraft Systems Engineering: Elective Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Energy Systems: Elective Compulsory General Engineering Science (German program, 7 semester): Specialisation Naval Architecture: Compulsory General Engineering Science (German program, 7 semester): Specialisation Energy and Environmental Engineering: Compulsory Energy Systems: Technical Complementary Course Core Studies: 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, Focus Energy Systems: Elective Compulsory General Engineering Science (English program, 7 semester): Specialisation Naval Architecture: Compulsory General Engineering Science (English program, 7 semester): Specialisation Mechanical Engineering, Focus Aircraft Systems Engineering: Elective Compulsory Mechanical Engineering: Specialisation Energy Systems: Elective Compulsory Mechanical Engineering: Specialisation Aircraft Systems Engineering: Elective Compulsory Naval Architecture: Core Qualification: Compulsory Technomathematics: Specialisation III. Engineering Science: Elective Compulsory		

Course L0235: Computational Fluid Dynamics I	
<b>Typ</b>	Lecture
<b>Hrs/wk</b>	2
<b>CP</b>	3
<b>Workload in Hours</b>	Independent Study Time 62, Study Time in Lecture 28
<b>Lecturer</b>	Prof. Thomas Rung
<b>Language</b>	DE
<b>Cycle</b>	WiSe
<b>Content</b>	<p>Fundamentals of computational modelling of thermofluid dynamic problems. Development of numerical algorithms.</p> <ol style="list-style-type: none"> <li>1. Partial differential equations</li> <li>2. Foundations of finite numerical approximations</li> <li>3. Computation of potential flows</li> <li>4. Introduction of finite-differences</li> <li>5. Approximation of convective, diffusive and transient transport processes</li> <li>6. Formulation of boundary conditions and initial conditions</li> <li>7. Assembly and solution of algebraic equation systems</li> <li>8. Facets of weighted -residual approaches</li> <li>9. Finite volume methods</li> <li>10. Basics of grid generation</li> </ol>
<b>Literature</b>	Ferziger and Peric: <i>Computational Methods for Fluid Dynamics</i> , Springer

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

Module M0662: Numerical Mathematics I			
Courses			
Title	Typ	Hrs/wk	CP
Numerical Mathematics I (L0417)	Lecture	2	3
Numerical Mathematics I (L0418)	Recitation Section (small)	2	3
<b>Module Responsible</b>	Prof. Sabine Le Borne		
<b>Admission Requirements</b>	None		
<b>Recommended Previous Knowledge</b>	<ul style="list-style-type: none"> <li>Mathematik I + II for Engineering Students (german or english) <b>or</b> Analysis &amp; Linear Algebra I + II for Technomathematicians</li> <li>basic MATLAB/Python knowledge</li> </ul>		
<b>Educational Objectives</b>	After taking part successfully, students have reached the following learning results		
<b>Professional Competence</b> <i>Knowledge</i>	Students are able to <ul style="list-style-type: none"> <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>		
<i>Skills</i>	Students are able to <ul style="list-style-type: none"> <li>implement, apply and compare numerical methods using MATLAB/Python,</li> <li>justify the convergence behaviour of numerical methods with respect to the problem and solution algorithm,</li> <li>select and execute a suitable solution approach for a given problem.</li> </ul>		
<b>Personal Competence</b> <i>Social Competence</i>	Students are able to <ul style="list-style-type: none"> <li>work together in heterogeneously composed teams (i.e., teams from different study programs and background knowledge), explain theoretical foundations and support each other with practical aspects regarding the implementation of algorithms.</li> </ul>		
<i>Autonomy</i>	Students are capable <ul style="list-style-type: none"> <li>to assess whether the supporting theoretical and practical excercises are better solved individually or in a team,</li> <li>to assess their individual progress and, if necessary, to ask questions and seek help.</li> </ul>		
<b>Workload in Hours</b>	Independent Study Time 124, Study Time in Lecture 56		
<b>Credit points</b>	6		
<b>Course achievement</b>	None		
<b>Examination</b>	Written exam		
<b>Examination duration and scale</b>	90 minutes		
<b>Assignment for the Following Curricula</b>	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 General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Aircraft Systems Engineering: Elective Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Mechatronics: Elective Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Energy Systems: Elective Compulsory Bioprocess Engineering: Specialisation A - General Bioprocess Engineering: Elective Compulsory Computer Science: Specialisation Computational Mathematics: Elective Compulsory Computer Science: Specialisation II. Mathematics and Engineering Science: Elective Compulsory Data Science: Core Qualification: Compulsory Electrical Engineering: Core Qualification: Elective Compulsory Engineering Science: Core Qualification: Compulsory Engineering Science: Core Qualification: Compulsory General Engineering Science (English program, 7 semester): Core Qualification: Compulsory General Engineering Science (English program, 7 semester): Specialisation Computer Science: 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 General Engineering Science (English program, 7 semester): Specialisation Mechanical Engineering, Focus Mechatronics: Elective Compulsory		



Computational Science and Engineering: Core Qualification: Compulsory Mechanical Engineering: Specialisation Theoretical Mechanical Engineering: Compulsory Mechanical Engineering: Specialisation Energy Systems: Elective Compulsory Mechanical Engineering: Specialisation Mechatronics: Elective Compulsory Theoretical Mechanical Engineering: Technical Complementary Course Core Studies: Elective Compulsory Process Engineering: Specialisation Process Engineering: Elective Compulsory
--

**Course L0417: Numerical Mathematics I**

<b>Typ</b>	Lecture
<b>Hrs/wk</b>	2
<b>CP</b>	3
<b>Workload in Hours</b>	Independent Study Time 62, Study Time in Lecture 28
<b>Lecturer</b>	Prof. Sabine Le Borne
<b>Language</b>	EN
<b>Cycle</b>	WiSe
<b>Content</b>	<ol style="list-style-type: none"> <li>1. Finite precision arithmetic, error analysis, conditioning and stability</li> <li>2. Linear systems of equations: LU and Cholesky factorization, condition</li> <li>3. Interpolation: polynomial, spline and trigonometric interpolation</li> <li>4. Nonlinear equations: fixed point iteration, root finding algorithms, Newton's method</li> <li>5. Linear and nonlinear least squares problems: normal equations, Gram Schmidt and Householder orthogonalization, singular value decomposition, regularization, Gauss-Newton and Levenberg-Marquardt methods</li> <li>6. Eigenvalue problems: power iteration, inverse iteration, QR algorithm</li> <li>7. Numerical differentiation</li> <li>8. Numerical integration: Newton-Cotes rules, error estimates, Gauss quadrature, adaptive quadrature</li> </ol>
<b>Literature</b>	<ul style="list-style-type: none"> <li>• Gander/Gander/Kwok: Scientific Computing: An introduction using Maple and MATLAB, Springer (2014)</li> <li>• Stoer/Bulirsch: Numerische Mathematik 1, Springer</li> <li>• Dahmen, Reusken: Numerik für Ingenieure und Naturwissenschaftler, Springer</li> </ul>

**Course L0418: Numerical Mathematics I**

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

Module M0639: Gas and Steam Power Plants				
<b>Courses</b>				
<b>Title</b>		<b>Typ</b>	<b>Hrs/wk</b>	<b>CP</b>
Gas and Steam Power Plants (L0206)		Lecture	3	5
Gas and Steam Power Plants (L0210)		Recitation Section (large)	1	1
<b>Module Responsible</b>	Dr. Kristin Abel-Günther			
<b>Admission Requirements</b>	None			
<b>Recommended Previous Knowledge</b>	<ul style="list-style-type: none"> <li>• "Technical Thermodynamics I and II"</li> <li>• "Heat Transfer"</li> <li>• "Fluid Mechanics"</li> </ul>			
<b>Educational Objectives</b>	After taking part successfully, students have reached the following learning results			
<b>Professional Competence</b>	<p><i>Knowledge</i> 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.</p> <p>The students have basic knowledge about the principles, operation and design of turbomachinery</p> <p><i>Skills</i> The students will be able, using theories and methods of the energy technology from fossil fuels and based on well-founded knowledge on the function and construction of gas and steam power plants, to identify basic associations in the production of heat and electricity, so as to develop conceptual solutions. Through analysis of the problem and exposure to the inherent interplay between heat and power generation the students are endowed with the capability and methodology to develop realistic optimal concepts for the generation of electricity and the production of heat. From the technical basics the students become the ability to follow better the deliberations on the electricity mix composition within the energy-political triangle (economy, secure supply and environmental protection).</p> <p>Within the framework of the exercise the students learn the use of the specialised software suite EBSILON Professional™. With this tool small practical tasks are solved with the PC, to highlight aspects of the design and development of power plant cycles.</p> <p>The students are able to do simplified calculations on turbomachinery either as part of a plant, as single component or at stage level.</p>			
<b>Personal Competence</b>	<p><i>Social Competence</i> An excursion within the framework of the lecture is planned for students that are interested. The students get in this manner direct contact with a modern power plant in this region. The students will obtain first-hand experience with a power plant in operation and gain insights into the conflicts between technical and political issues.</p> <p><i>Autonomy</i> The students assisted by the tutors will be able to develop alone simple simulation models and run with these scenario analyses. In this manner the theoretical and practical knowledge from the lecture is consolidated and the potential effects from different process combinations and boundary conditions highlighted. The students are able independently to analyse the operational performance of steam power plants and calculate selected quantities and characteristic curves.</p>			
<b>Workload in Hours</b>	Independent Study Time 124, Study Time in Lecture 56			
<b>Credit points</b>	6			
<b>Course achievement</b>	<b>Compulsory</b>	<b>Bonus</b>	<b>Form</b>	<b>Description</b>
	No	5 %	Attestation	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
<b>Examination</b>	Written exam			
<b>Examination duration and scale</b>	Written examination of 120 min			
<b>Assignment for the Following Curricula</b>	General Engineering Science (German program, 7 semester): Specialisation Green Technologies, Focus Renewable Energy: 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 Mechanical Engineering, Focus Energy Systems: Elective Compulsory Green Technologies: Energy, Water, Climate: Specialisation Energy Systems: Elective Compulsory Green Technologies: Energy, Water, Climate: Specialisation Energy Technology: Elective Compulsory Mechanical Engineering: Specialisation Energy Systems: Elective Compulsory			

Course L0206: Gas and Steam Power Plants	
<b>Typ</b>	Lecture
<b>Hrs/wk</b>	3
<b>CP</b>	5
<b>Workload in Hours</b>	Independent Study Time 108, Study Time in Lecture 42
<b>Lecturer</b>	Dr. Kristin Abel-Günther
<b>Language</b>	DE
<b>Cycle</b>	WiSe
<b>Content</b>	<p>In the 1<sup>st</sup> part of the lecture an overview on thermal power plants is offered, including:</p> <ul style="list-style-type: none"> <li>• Electricity demand and Forecasting</li> <li>• Thermodynamic fundamentals</li> <li>• Energy Conversion in thermal power plants</li> <li>• Types of power plant</li> <li>• Layout of the power plant block</li> <li>• Individual elements of the power plant</li> <li>• Cooling systems</li> <li>• Flue gas cleaning</li> <li>• Operation characteristics of the power plant</li> <li>• Construction materials for power plants</li> <li>• Location of power plants</li> <li>• Solar thermal plants/geothermal plants/Carbon Capture and Storage plants.</li> </ul> <p>These are complemented in the 2<sup>nd</sup> part of the module by the more specialised issues:</p> <ul style="list-style-type: none"> <li>• Energy balance of a turbomachine</li> <li>• Theory of turbine and compressor stage</li> <li>• Equal and positive pressure blading</li> <li>• Flow losses</li> <li>• Characteristic numbers</li> <li>• Axial and radial design</li> <li>• Design features</li> <li>• Hydraulic turbomachines</li> <li>• Pump and water turbine designs</li> <li>• Design examples of reciprocating engines and turbomachinery</li> <li>• Steam power plants</li> <li>• Gas turbine systems.</li> </ul>
<b>Literature</b>	<ul style="list-style-type: none"> <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	
<b>Typ</b>	Recitation Section (large)
<b>Hrs/wk</b>	1
<b>CP</b>	1
<b>Workload in Hours</b>	Independent Study Time 16, Study Time in Lecture 14
<b>Lecturer</b>	Dr. Kristin Abel-Günther
<b>Language</b>	DE
<b>Cycle</b>	WiSe
<b>Content</b>	<p>In the 1<sup>st</sup> part of the lecture a general introduction into fluid-flow machines and steam power plants is offered, including:</p> <ul style="list-style-type: none"> <li>• Energy balance of a fluid-flow machine</li> <li>• Theory of turbine and compressor stage</li> <li>• Equal and positive pressure blading</li> <li>• Flow losses</li> <li>• Characteristic numbers</li> <li>• Axial and radial design</li> <li>• Design features</li> <li>• Hydraulic fluid-flow machines</li> <li>• Pump and water turbine designs</li> <li>• Design examples of reciprocating engines and turbomachinery</li> <li>• Steam power plants</li> <li>• Gas turbine systems</li> <li>• Diesel engine systems</li> <li>• Waste heat utilisation</li> </ul> <p>followed by the more specialised issues:</p> <ul style="list-style-type: none"> <li>• Electricity Demand and Forecasting</li> <li>• Thermodynamic fundamentals</li> <li>• Energy Conversion in Thermal Power Plants</li> <li>• Types of Power Plant</li> <li>• Layout of the power plant block</li> <li>• Individual elements of the power plant</li> <li>• Cooling systems</li> <li>• Flue gas cleaning</li> <li>• Operation characteristics of the power plant</li> <li>• Construction materials</li> <li>• Location of power plants</li> </ul> <p>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.</p> <p>Within the framework of the exercise the students learn the use of the specialised software suite EBSILON Professional™. 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.</p>
<b>Literature</b>	<ul style="list-style-type: none"> <li>• Skripte</li> <li>• Kalide: Kraft- und Arbeitsmaschinen</li> <li>• Thomas, H.J.: Thermische Kraftanlagen. Springer-Verlag, 1985</li> <li>• Strauß, K.: Kraftwerkstechnik. Springer-Verlag, 2006</li> <li>• Kugeler und Phlippen: Energietechnik. Springer-Verlag, 1990</li> <li>• T . Bohn (Hrsg.): Handbuchreihe Energie, Band 7: Gasturbinenkraftwerke, Kombikraftwerke, Heizkraftwerke und Industriekraftwerke, Technischer Verlag Resch / Verlag TÜV Rheinland</li> </ul>

## Specialization Aircraft Systems Engineering

The specialization "Aircraft Systems" prepares students for a variety of careers in the aviation industry, and neighboring fields. Students will gain knowledge on how to deal with the methods of systems engineering, as well as the use of modern, computer-aided techniques for system design, analysis and evaluation. In addition, the necessary competencies of aeronautical engineering in aircraft systems, cabin systems, pneumatic conveying systems and aircraft design and flight physics and materials technology.

Module M1320: Simulation and Design of Mechatronic Systems			
Courses			
Title	Typ	Hrs/wk	CP
Simulation and Design of Mechatronic Systems (L1822)	Lecture	2	2
Simulation and Design of Mechatronic Systems (L1823)	Recitation Section (large)	1	2
Simulation and Design of Mechatronic Systems (L1824)	Practical Course	1	2
<b>Module Responsible</b>	NN		
<b>Admission Requirements</b>	None		
<b>Recommended Previous Knowledge</b>	Fundamentals of mechanics, control theory and electrical engineering		
<b>Educational Objectives</b>	After taking part successfully, students have reached the following learning results		
<b>Professional Competence</b>			
<i>Knowledge</i>	Students are able to describe methods and calculations for design, modeling, simulation and optimization of mechatronic systems.		
<i>Skills</i>	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.		
<b>Personal Competence</b>			
<i>Social Competence</i>	Students are able to work goal-oriented in small mixed groups and present results to target groups.		
<i>Autonomy</i>	Students are able to recognize and improve knowledge deficits independently. With instructor assistance, students are able to evaluate their own knowledge level and define a further course of study.		
<b>Workload in Hours</b>	Independent Study Time 124, Study Time in Lecture 56		
<b>Credit points</b>	6		
<b>Course achievement</b>	None		
<b>Examination</b>	Written exam		
<b>Examination duration and scale</b>	90 min		
<b>Assignment for the Following Curricula</b>	General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Mechatronics: Elective Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Aircraft Systems Engineering: Elective Compulsory Digital Mechanical Engineering: Core Qualification: Compulsory 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 Aircraft Systems Engineering: Elective Compulsory General Engineering Science (English program, 7 semester): Specialisation Mechanical Engineering, Focus Mechatronics: Elective Compulsory Mechanical Engineering: Specialisation Theoretical Mechanical Engineering: Elective Compulsory Mechanical Engineering: Specialisation Aircraft Systems Engineering: Compulsory Mechanical Engineering: Specialisation Aircraft Systems Engineering: Elective Compulsory Mechanical Engineering: Specialisation Mechatronics: Compulsory Mechanical Engineering: Specialisation Mechatronics: Elective Compulsory Mechatronics: Core Qualification: Compulsory Mechatronics: Core Qualification: Elective Compulsory		

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

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

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

Module M0599: Integrated Product Development and Lightweight Design				
<b>Courses</b>				
<b>Title</b>		<b>Typ</b>	<b>Hrs/wk</b>	<b>CP</b>
CAE-Team Project (L0271)		Project-/problem-based Learning	2	2
Development of Lightweight Design Products (L0270)		Lecture	2	2
Integrated Product Development I (L0269)		Lecture	2	2
<b>Module Responsible</b>	Prof. Dieter Krause			
<b>Admission Requirements</b>	None			
<b>Recommended Previous Knowledge</b>	Advanced Knowledge about engineering design: Fundamentals of Mechanical Engineering Design Mechanical Engineering: Design Advanced Mechanical Engineering Design			
<b>Educational Objectives</b>	After taking part successfully, students have reached the following learning results			
<b>Professional Competence</b>	After completing the module, students are capable of: <ul style="list-style-type: none"> <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>			
<i>Knowledge</i>				
<i>Skills</i>	After completing the module, students are able to: <ul style="list-style-type: none"> <li>evaluate different CAD- and PDM-Systems with regards to the desired requirements such as classification schemes and product structuring</li> <li>design an exemplary product using CAD-,PDM- and/or FEM-Systems with shared workload</li> </ul>			
<b>Personal Competence</b>	After completing the module, students are able to: <ul style="list-style-type: none"> <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>			
<i>Social Competence</i>				
<i>Autonomy</i>	Students are capable of: <ul style="list-style-type: none"> <li>independently adapt to a CAE-Tool and complete a given practical task with it</li> </ul>			
<b>Workload in Hours</b>	Independent Study Time 96, Study Time in Lecture 84			
<b>Credit points</b>	6			
<b>Course achievement</b>	<b>Compulsory</b>	<b>Bonus</b>	<b>Form</b>	<b>Description</b>
	Yes	20 %	Subject theoretical and practical work	andCAE-Teamprojekt inkl. Vortrag und Ausarbeitung
<b>Examination</b>	Written exam			
<b>Examination duration and scale</b>	90			
<b>Assignment for the Following Curricula</b>	General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Aircraft Systems Engineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Product Development and Production: Compulsory Engineering Science: Specialisation Mechanical Engineering: Elective 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: Elective Compulsory Mechanical Engineering: Specialisation Product Development and Production: Compulsory Mechanical Engineering: Specialisation Aircraft Systems Engineering: Compulsory Product Development, Materials and Production: Technical Complementary Course Core Studies: Elective Compulsory			

Course L0271: CAE-Team Project	
<b>Typ</b>	Project-/problem-based Learning
<b>Hrs/wk</b>	2
<b>CP</b>	2
<b>Workload in Hours</b>	Independent Study Time 32, Study Time in Lecture 28
<b>Lecturer</b>	Prof. Dieter Krause
<b>Language</b>	DE
<b>Cycle</b>	SoSe
<b>Content</b>	<ul style="list-style-type: none"> <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> <p><b>Description</b></p> <p>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.</p>
<b>Literature</b>	-

Course L0270: Development of Lightweight Design Products	
<b>Typ</b>	Lecture
<b>Hrs/wk</b>	2
<b>CP</b>	2
<b>Workload in Hours</b>	Independent Study Time 32, Study Time in Lecture 28
<b>Lecturer</b>	Prof. Dieter Krause, Prof. Benedikt Kriegesmann
<b>Language</b>	DE
<b>Cycle</b>	SoSe
<b>Content</b>	<ul style="list-style-type: none"> <li>• Lightweight design materials</li> <li>• Product development process for lightweight structures</li> <li>• Dimensioning of lightweight structures</li> </ul>
<b>Literature</b>	<ul style="list-style-type: none"> <li>• Schürmann, H., „Konstruieren mit Faser-Kunststoff-Verbunden“, Springer, Berlin, 2005.</li> <li>• Klein, B., „Leichtbau-Konstruktion“, Vieweg &amp; Sohn, Braunschweig, 1989.</li> <li>• Krause, D., „Leichtbau“, In: Handbuch Konstruktion, Hrsg.: Rieg, F., Steinhilper, R., München, Carl Hanser Verlag, 2012.</li> <li>• Schulte, K., Fiedler, B., „Structure and Properties of Composite Materials“, Hamburg, TUHH - TuTech Innovation GmbH, 2005.</li> <li>• Wiedemann, J., „Leichtbau Band 1: Elemente“, Springer, Berlin, Heidelberg, 1986.</li> </ul>

Course L0269: Integrated Product Development I	
<b>Typ</b>	Lecture
<b>Hrs/wk</b>	2
<b>CP</b>	2
<b>Workload in Hours</b>	Independent Study Time 32, Study Time in Lecture 28
<b>Lecturer</b>	Prof. Dieter Krause
<b>Language</b>	DE
<b>Cycle</b>	SoSe
<b>Content</b>	<ul style="list-style-type: none"> <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>
<b>Literature</b>	<ul style="list-style-type: none"> <li>• Ehrlenspiel, K.: Integrierte Produktentwicklung, München, Carl Hanser Verlag</li> <li>• Lee, K.: Principles of CAD / CAM / CAE Systems, Addison Wesley</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: Aeronautical Systems			
<b>Courses</b>			
<b>Title</b>	<b>Typ</b>	<b>Hrs/wk</b>	<b>CP</b>
Fundamentals of Aircraft Systems (L0741)	Lecture	2	2
Fundamentals of Aircraft Systems (L0742)	Recitation Section (small)	1	1
Air Transportation Systems (L0591)	Lecture	2	2
Air Transportation Systems (L0816)	Recitation Section (large)	1	1
<b>Module Responsible</b>	Prof. Frank Thielecke		
<b>Admission Requirements</b>	None		
<b>Recommended Previous Knowledge</b>	Basics of mathematics, mechanics and thermodynamics		
<b>Educational Objectives</b>	After taking part successfully, students have reached the following learning results		
<b>Professional Competence</b>	<p><i>Knowledge</i> 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 relationships, the key parameters, roles and ways of working in different subsystems in the air transport is acquired.</p> <p><i>Skills</i> 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.</p>		
<b>Personal Competence</b>	<p><i>Social Competence</i> Students are made aware of interdisciplinary communication in groups.</p> <p><i>Autonomy</i> Students are able to independently analyze different system concepts and their technical implementation as well as to think system oriented.</p>		
<b>Workload in Hours</b>	Independent Study Time 96, Study Time in Lecture 84		
<b>Credit points</b>	6		
<b>Course achievement</b>	None		
<b>Examination</b>	Written exam		
<b>Examination duration and scale</b>	150 min		
<b>Assignment for the Following Curricula</b>	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 Logistics and Mobility: Specialisation Traffic Planning and Systems: Elective Compulsory Mechanical Engineering: Specialisation Aircraft Systems Engineering: Compulsory Engineering and Management - Major in Logistics and Mobility: Specialisation Traffic Planning and Systems: Elective Compulsory		

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

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

Course L0591: Air Transportation Systems	
<b>Typ</b>	Lecture
<b>Hrs/wk</b>	2
<b>CP</b>	2
<b>Workload in Hours</b>	Independent Study Time 32, Study Time in Lecture 28
<b>Lecturer</b>	Prof. Volker Gollnick
<b>Language</b>	DE
<b>Cycle</b>	SoSe
<b>Content</b>	<ol style="list-style-type: none"> <li>1. Air transport as part of the global transportation system</li> <li>2. Legal basis of air transportation</li> <li>3. Safety and security aspects</li> <li>4. Aircraft basics</li> <li>5. The role of the aircraft manufacturer</li> <li>6. The role of the aircraft operator</li> <li>7. Airport operation</li> <li>8. The principles of air traffic management</li> <li>9. Environmental aspects of air transportation</li> </ol>
<b>Literature</b>	<ol style="list-style-type: none"> <li>1. V. Gollnick, D. Schmitt: "Air Transport System", Springer-Verlag, ISBN 978-3-7091-1879-5</li> <li>2. H. Mensen: "Handbuch der Luftfahrt", Springer-Verlag, 2003</li> <li>3. J.P. Clark: "Buying the Big Jets", ISBN 9781317170341 , Taylor &amp; Francis, 2017</li> <li>4. Mike Hirst: The Air Transport System, AIAA, 2008</li> <li>5. D.P. Raymer: "Aircraft Design - A Conceptual Approach", AIAA Education Series, 2006, ISBN 1-56347-281-3</li> <li>6. N. Ashford: "Airport Operations", McGraw-Hill, 1997, ISBN 0-07-003077-4</li> <li>7. P. Maurer: "Luftverkehrsmanagement", Oldenbourg-Verlag, ISBN 3-486-27422-8</li> <li>8. H. Mensen: "Moderne Flugsicherung", Springer-Verlag, 2004, ISBN 3-540-20581-0</li> </ol>

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

## Specialization Materials in Engineering Sciences

In the specialization "materials in engineering", students work mainly with construction materials, modeling materials and nanotechnology and hybrid materials.

Module M1009: Material Science Laboratory			
<b>Courses</b>			
<b>Title</b>		<b>Typ</b>	<b>Hrs/wk</b>
Companion Lecture for Materials Science Laboratory (L1088)		Lecture	2
Material Science Laboratory (L1235)		Practical Course	4
<b>Module Responsible</b>	Prof. Bodo Fiedler		
<b>Admission Requirements</b>	None		
<b>Recommended Previous Knowledge</b>	none		
<b>Educational Objectives</b>	After taking part successfully, students have reached the following learning results		
<b>Professional Competence</b>			
<i>Knowledge</i>	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.		
<i>Skills</i>	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.		
<b>Personal Competence</b>			
<i>Social Competence</i>	Students are able to cooperate in small groups in order to conduct experiments in the context of materials sciences. They are able to effectively present and explain their results alone or in groups in front of a qualified audience.		
<i>Autonomy</i>	Students are capable of solving problems in the context of materials sciences 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.		
<b>Workload in Hours</b>	Independent Study Time 96, Study Time in Lecture 84		
<b>Credit points</b>	6		
<b>Course achievement</b>	None		
<b>Examination</b>	Subject theoretical and practical work		
<b>Examination duration and scale</b>	Test reports on the respective tests and online learning modules with integrated success control		
<b>Assignment for the Following Curricula</b>	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 Product Development and Production: Elective Compulsory General Engineering Science (English program, 7 semester): Specialisation Mechanical Engineering, Focus Materials in Engineering Sciences: Compulsory Mechanical Engineering: Specialisation Product Development and Production: Compulsory Mechanical Engineering: Specialisation Materials in Engineering Sciences: Compulsory Product Development, Materials and Production: Technical Complementary Course Core Studies: Elective Compulsory		
Course L1088: Companion Lecture for Materials Science Laboratory			
<b>Typ</b>	Lecture		
<b>Hrs/wk</b>	2		
<b>CP</b>	2		
<b>Workload in Hours</b>	Independent Study Time 32, Study Time in Lecture 28		
<b>Lecturer</b>	Prof. Dr. Kaline Pagnan Furlan		
<b>Language</b>	DE		
<b>Cycle</b>	WiSe		
<b>Content</b>	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 solidification of metals (thermodynamics and kinetics of solid-liquid phase transitions) 4. tensile test (elastic properties of solids) 5. Identification 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)		
<b>Literature</b>	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)		

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

Module M1746: Materials Engineering: Materials Selection, Processing and Modelling				
<b>Courses</b>				
<b>Title</b>		<b>Typ</b>	<b>Hrs/wk</b>	<b>CP</b>
Materials and Process Modeling (L2862)		Lecture	3	3
Materials Selection and Processing (L2861)		Lecture	3	3
<b>Module Responsible</b>	Prof. Norbert Huber			
<b>Admission Requirements</b>	None			
<b>Recommended Previous Knowledge</b>				
<b>Educational Objectives</b>	After taking part successfully, students have reached the following learning results			
<b>Professional Competence</b> <i>Knowledge</i>	The module deals with the production and properties of engineering materials. Particular attention is paid to material selection, material processing, the associated microstructure and the achievable mechanical properties. In conjunction with the costs, these are decisive for the applicability and economic efficiency. Metallic materials are in the foreground. Ceramics and polymers are also covered in the sense of a broad range of available materials.			
<b>Personal Competence</b> <i>Skills</i> <i>Social Competence</i> <i>Autonomy</i>	In parallel to the material-technological consideration, the modeling of material behavior by means of phenomenological material laws for plasticity under monotonic and cyclic loading is worked out. In addition to the evaluation of component behavior, plasticity also plays a major role in manufacturing processes and thus provides the basis for process simulation. Process models and simulation methods for selected manufacturing processes, such as rolling or forming, are presented for this topic area.			
<b>Workload in Hours</b>	Independent Study Time 96, Study Time in Lecture 84			
<b>Credit points</b>	6			
<b>Course achievement</b>	<b>Compulsory</b>	<b>Bonus</b>	<b>Form</b>	<b>Description</b>
	Yes	20 %	Excercises	Wir stellen Übungsaufgaben (ÜA), die während des Semesters erbracht und in den wöchentlichen Übungen vorgestellt werden. Diese können im Umfang von bis zu 20% bei der Prüfung berücksichtigt werden.
<b>Examination</b>	Written exam			
<b>Examination duration and scale</b>	120 min			
<b>Assignment for the Following Curricula</b>	General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Materials in Engineering Sciences: Compulsory Mechanical Engineering: Specialisation Materials in Engineering Sciences: Compulsory			

Course L2862: Materials and Process Modeling	
<b>Typ</b>	Lecture
<b>Hrs/wk</b>	3
<b>CP</b>	3
<b>Workload in Hours</b>	Independent Study Time 48, Study Time in Lecture 42
<b>Lecturer</b>	Prof. Norbert Huber
<b>Language</b>	EN
<b>Cycle</b>	SoSe
<b>Content</b>	<ol style="list-style-type: none"> <li>1. Relevance of plasticity in materials processing and operation</li> <li>2. Fundamentals of plasticity in metals and alloys</li> <li>3. Modellierung von Materialverhalten</li> <li>4. Plasticity in cyclic loading</li> <li>5. Rate dependency, recrystallization</li> <li>6. Rolling, forming, and solid state joining processes</li> <li>7. Residual stress design</li> </ol>
<b>Literature</b>	<ul style="list-style-type: none"> <li>• Hull and Bacon: Introduction to Dislocations (1984)</li> <li>• G. Gottstein: Physik. Grundlagen der Materialk. (2001)</li> <li>• P. Haupt: Cont. Mechanics and Theory of Materials (2002)</li> <li>• N. Huber: Vorlesungsskript „Grundlagen der mechanischen Eigenschaften von Werkstoffen“, TUHH</li> </ul>

<b>Course L2861: Materials Selection and Processing</b>	
<b>Typ</b>	Lecture
<b>Hrs/wk</b>	3
<b>CP</b>	3
<b>Workload in Hours</b>	Independent Study Time 48, Study Time in Lecture 42
<b>Lecturer</b>	Prof. Dr. Kaline Pagnan Furlan
<b>Language</b>	EN
<b>Cycle</b>	SoSe
<b>Content</b>	<ol style="list-style-type: none"> <li>1. Introduction</li> <li>2. Overview of fabrication processes</li> <li>3. Shape considerations: macrostructural aspects</li> <li>4. Material properties: microstructural aspects</li> <li>5. Materials engineering: microstructure, shape and processing relation</li> <li>6. Materials engineering: function and costs relation</li> </ol>
<b>Literature</b>	<ul style="list-style-type: none"> <li>• M.F. Ashby, Materials Selection in Mechanical Design, 4th edition, Butterworth-Heinemann(2011)</li> <li>• W.F. Gale and T.C. Totemeier, Smithells Metals Reference Book, 8th edition, Butterworth-Heinemann(2004)</li> <li>• J. Beddoes and M. Bibby, Principles of Metal Manufacturing Processes, Butterworth-Heinemann(1999)</li> </ul>

Module M1005: Enhanced Fundamentals of Materials Science			
<b>Courses</b>			
<b>Title</b>	<b>Typ</b>	<b>Hrs/wk</b>	<b>CP</b>
Enhanced Fundamentals: Ceramics and Polymers (L1233)	Lecture	2	2
Enhanced Fundamentals: Ceramics and Polymers (L1234)	Recitation Section (large)	1	1
Enhanced Fundamentals: Metals (L1086)	Lecture	2	3
<b>Module Responsible</b>	Prof. Gerold Schneider		
<b>Admission Requirements</b>	None		
<b>Recommended Previous Knowledge</b>	Module "Fundamentals of Materials Science" Module "Materials Science Laboratory" Module "Advanced Materials"		
<b>Educational Objectives</b>	After taking part successfully, students have reached the following learning results		
<b>Professional Competence</b>	<p><i>Knowledge</i> 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.</p> <p><i>Skills</i> The students are able to apply the appropriate physical and chemical methods for the above mentioned subjects.</p> <p><b>Personal Competence</b></p> <p><i>Social Competence</i></p> <p><i>Autonomy</i> The students are capable to understand independently the structure and properties of ceramics, metals and polymers. They should be able to critically evaluate the profoundness of their knowledge.</p>		
<b>Workload in Hours</b>	Independent Study Time 110, Study Time in Lecture 70		
<b>Credit points</b>	6		
<b>Course achievement</b>	None		
<b>Examination</b>	Written exam		
<b>Examination duration and scale</b>	180 min		
<b>Assignment for the Following Curricula</b>	General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Materials in Engineering Sciences: Compulsory Data Science: Core Qualification: Elective 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 Product Development and Production: Compulsory Mechanical Engineering: Specialisation Materials in Engineering Sciences: Compulsory Technomathematics: Specialisation III. Engineering Science: Elective Compulsory		

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



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

Course L1086: Enhanced Fundamentals: Metals	
<b>Typ</b>	Lecture
<b>Hrs/wk</b>	2
<b>CP</b>	3
<b>Workload in Hours</b>	Independent Study Time 62, Study Time in Lecture 28
<b>Lecturer</b>	Prof. Jörg Weißmüller
<b>Language</b>	DE
<b>Cycle</b>	SoSe
<b>Content</b>	<p>Advanced understanding of metals:</p> <ul style="list-style-type: none"> <li>• Physical materials properties <ul style="list-style-type: none"> <li>o Materials behaviour - elastic, thermal, electrical</li> <li>o Superelasticity and shape memory effect</li> <li>o Fundamentals of electrical conductivity in metals and semiconductors</li> <li>o Superconductivity</li> </ul> </li> <li>• Chemical (or "dry") corrosion <ul style="list-style-type: none"> <li>o Driving forces and mechanisms</li> <li>o Passivation</li> <li>o Growth laws</li> </ul> </li> <li>• Introduction to electrochemistry <ul style="list-style-type: none"> <li>o Electrolytes</li> <li>o Ions</li> <li>o Solvation</li> <li>o Dissolution and deposition of metals</li> <li>o Galvanic cells and cell voltage</li> <li>o Galvanic series</li> <li>o Nernst equation</li> <li>o Polarizable electrodes</li> <li>o Electrochemical double layer</li> <li>o Capacitive and pseudocapacitive processes</li> <li>o Capacitive currents and Faraday currents</li> </ul> </li> <li>• Electrochemical (or "wet") corrosion and corrosion protection <ul style="list-style-type: none"> <li>o Basic observations</li> <li>o Galvanic corrosion</li> <li>o Protection against galvanic corrosion</li> <li>o Stainless steel</li> <li>o sacrificial anodes</li> <li>o Passivation and Pourbaix diagrams</li> <li>o Corrosion through gas reduction</li> <li>o Crevice corrosion</li> <li>o Stress corrosion cracking</li> <li>o Alloy corrosion and nanoporous metals</li> </ul> </li> <li>• Electrochemical energy storage <ul style="list-style-type: none"> <li>o How a battery works</li> <li>o Lead accumulators</li> <li>o Alkaline batteries</li> <li>o Nickel-metal hydride accumulators</li> <li>o Flux batteries</li> <li>o Lithium-ion accumulators</li> <li>o Electrolytic and super capacitors</li> <li>o Fuel cells</li> </ul> </li> <li>• Materials for hydrogen storage <ul style="list-style-type: none"> <li>o Storage strategies</li> <li>o Requirements for storage materials</li> <li>o State of the art</li> </ul> </li> <li>• Magnetism and magnetic materials <ul style="list-style-type: none"> <li>o Phenomenology: magnetic field and magnetization</li> <li>o Para-, ferro-, antiferromagnets; Curie transition</li> <li>o Magnetism at the atomic scale; exchange coupling</li> <li>o Magnetization isotherms, domains</li> <li>o Measurement methods</li> <li>o Magnetocrystalline anisotropy and domain walls</li> <li>o Hard magnetic materials and their applications</li> </ul> </li> </ul>

	<ul style="list-style-type: none"><li>o Soft magnetic materials and their applications</li></ul>
<b>Literature</b>	<ul style="list-style-type: none"><li>- Vorlesungsskript</li><li>- W.D. Callister, „Materialwissenschaften und Werkstofftechnik“, Wiley-VCH 2012</li><li>- Carl H. Hamann, Wolf Vielstich, "Elektrochemie", Wiley-VCH; 4. Auflage 2005</li><li>- Kurzweil, Dietlmeier, "Elektrochemische Speicher" Springer Vieweg (2015) (eBook: <a href="https://link.springer.com/book/10.1007/978-3-658-10900-4">https://link.springer.com/book/10.1007/978-3-658-10900-4</a> )</li><li>- B. D. Cullity, C.D. Graham, "Introduction to magnetic materials", John Wiley &amp; Sons, 2011</li><li>- D. Jiles, "Introduction to magnetism and magnetic materials", CRC press, 2015</li></ul>



Course L1043: Differential Equations 2 (Partial Differential Equations)	
<b>Typ</b>	Lecture
<b>Hrs/wk</b>	2
<b>CP</b>	1
<b>Workload in Hours</b>	Independent Study Time 2, Study Time in Lecture 28
<b>Lecturer</b>	Dozenten des Fachbereiches Mathematik der UHH
<b>Language</b>	DE
<b>Cycle</b>	SoSe
<b>Content</b>	<p>Main features of the theory and numerical treatment of partial differential equations</p> <ul style="list-style-type: none"> <li>• Examples of partial differential equations</li> <li>• First order quasilinear differential equations</li> <li>• Normal forms of second order differential equations</li> <li>• Harmonic functions and maximum principle</li> <li>• Maximum principle for the heat equation</li> <li>• Wave equation</li> <li>• Liouville's formula</li> <li>• Special functions</li> <li>• Difference methods</li> <li>• Finite elements</li> </ul>
<b>Literature</b>	<ul style="list-style-type: none"> <li>• <a href="http://www.math.uni-hamburg.de/teaching/export/tuhh/index.html">http://www.math.uni-hamburg.de/teaching/export/tuhh/index.html</a></li> </ul>

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

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

Course L1038: Complex Functions	
<b>Typ</b>	Lecture
<b>Hrs/wk</b>	2
<b>CP</b>	1
<b>Workload in Hours</b>	Independent Study Time 2, Study Time in Lecture 28
<b>Lecturer</b>	Dozenten des Fachbereiches Mathematik der UHH
<b>Language</b>	DE
<b>Cycle</b>	SoSe
<b>Content</b>	<p>Main features of complex analysis</p> <ul style="list-style-type: none"> <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>
<b>Literature</b>	<ul style="list-style-type: none"> <li>• <a href="http://www.math.uni-hamburg.de/teaching/export/tuhh/index.html">http://www.math.uni-hamburg.de/teaching/export/tuhh/index.html</a></li> </ul>

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

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

Module M1320: Simulation and Design of Mechatronic Systems			
<b>Courses</b>			
<b>Title</b>		<b>Typ</b>	<b>Hrs/wk</b> <b>CP</b>
Simulation and Design of Mechatronic Systems (L1822)		Lecture	2                  2
Simulation and Design of Mechatronic Systems (L1823)		Recitation Section (large)	1                  2
Simulation and Design of Mechatronic Systems (L1824)		Practical Course	1                  2
<b>Module Responsible</b>	NN		
<b>Admission Requirements</b>	None		
<b>Recommended Previous Knowledge</b>	Fundamentals of mechanics, control theory and electrical engineering		
<b>Educational Objectives</b>	After taking part successfully, students have reached the following learning results		
<b>Professional Competence</b>			
<i>Knowledge</i>	Students are able to describe methods and calculations for design, modeling, simulation and optimization of mechatronic systems.		
<i>Skills</i>	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.		
<b>Personal Competence</b>			
<i>Social Competence</i>	Students are able to work goal-oriented in small mixed groups and present results to target groups.		
<i>Autonomy</i>	Students are able to recognize and improve knowledge deficits independently.		
	With instructor assistance, students are able to evaluate their own knowledge level and define a further course of study.		
<b>Workload in Hours</b>	Independent Study Time 124, Study Time in Lecture 56		
<b>Credit points</b>	6		
<b>Course achievement</b>	None		
<b>Examination</b>	Written exam		
<b>Examination duration and scale</b>	90 min		
<b>Assignment for the Following Curricula</b>	General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Mechatronics: Elective Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Aircraft Systems Engineering: Elective Compulsory Digital Mechanical Engineering: Core Qualification: Compulsory 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 Aircraft Systems Engineering: Elective Compulsory General Engineering Science (English program, 7 semester): Specialisation Mechanical Engineering, Focus Mechatronics: Elective Compulsory Mechanical Engineering: Specialisation Theoretical Mechanical Engineering: Elective Compulsory Mechanical Engineering: Specialisation Aircraft Systems Engineering: Compulsory Mechanical Engineering: Specialisation Aircraft Systems Engineering: Elective Compulsory Mechanical Engineering: Specialisation Mechatronics: Compulsory Mechanical Engineering: Specialisation Mechatronics: Elective Compulsory Mechatronics: Core Qualification: Compulsory Mechatronics: Core Qualification: Elective Compulsory		

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

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

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

Module M0777: Semiconductor Circuit Design			
Courses			
Title	Typ	Hrs/wk	CP
Semiconductor Circuit Design (L0763)	Lecture	3	4
Semiconductor Circuit Design (L0864)	Recitation Section (small)	1	2
<b>Module Responsible</b>	Prof. Matthias Kuhl		
<b>Admission Requirements</b>	None		
<b>Recommended Previous Knowledge</b>	Fundamentals of electrical engineering Basics of physics, especially semiconductor physics		
<b>Educational Objectives</b>	After taking part successfully, students have reached the following learning results		
<b>Professional Competence</b> <i>Knowledge</i>	<ul style="list-style-type: none"> <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>		
<i>Skills</i>	<ul style="list-style-type: none"> <li>• Students can calculate the specifications of different MOS devices and can define the parameters of electronic circuits.</li> <li>• Students are able to develop different logic circuits and can design different types of logic circuits.</li> <li>• Students can use MOS devices, operational amplifiers and bipolar transistors for specific applications.</li> </ul>		
<b>Personal Competence</b> <i>Social Competence</i>	<ul style="list-style-type: none"> <li>• Students are able work efficiently in heterogeneous teams.</li> <li>• Students working together in small groups can solve problems and answer professional questions.</li> </ul>		
<i>Autonomy</i>	<ul style="list-style-type: none"> <li>• Students are able to assess their level of knowledge.</li> </ul>		
<b>Workload in Hours</b>	Independent Study Time 124, Study Time in Lecture 56		
<b>Credit points</b>	6		
<b>Course achievement</b>	None		
<b>Examination</b>	Written exam		
<b>Examination duration and scale</b>	120 min		
<b>Assignment for the Following Curricula</b>	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 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	
<b>Typ</b>	Lecture
<b>Hrs/wk</b>	3
<b>CP</b>	4
<b>Workload in Hours</b>	Independent Study Time 78, Study Time in Lecture 42
<b>Lecturer</b>	Prof. Matthias Kuhl
<b>Language</b>	DE
<b>Cycle</b>	SoSe
<b>Content</b>	<ul style="list-style-type: none"> <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>
<b>Literature</b>	<p>U. Tietze und Ch. Schenk, E. Gamm, Halbleiterschaltungstechnik, Springer Verlag, 14. Auflage, 2012, ISBN 3540428496</p> <p>R. J. Baker, CMOS - Circuit Design, Layout and Simulation, J. Wiley &amp; Sons Inc., 3. Auflage, 2011, ISBN: 0471700555</p> <p>H. Göbel, Einführung in die Halbleiter-Schaltungstechnik, Berlin, Heidelberg Springer-Verlag Berlin Heidelberg, 2011, ISBN: 9783642208874 ISBN: 9783642208867</p> <p>URL: <a href="http://site.ebrary.com/lib/alltitles/docDetail.action?docID=10499499">http://site.ebrary.com/lib/alltitles/docDetail.action?docID=10499499</a></p> <p>URL: <a href="http://dx.doi.org/10.1007/978-3-642-20887-4">http://dx.doi.org/10.1007/978-3-642-20887-4</a></p> <p>URL: <a href="http://ebooks.ciando.com/book/index.cfm/bok_id/319955">http://ebooks.ciando.com/book/index.cfm/bok_id/319955</a></p> <p>URL: <a href="http://www.ciando.com/img/bo">http://www.ciando.com/img/bo</a></p>

Course L0864: Semiconductor Circuit Design	
<b>Typ</b>	Recitation Section (small)
<b>Hrs/wk</b>	1
<b>CP</b>	2
<b>Workload in Hours</b>	Independent Study Time 46, Study Time in Lecture 14
<b>Lecturer</b>	Prof. Matthias Kuhl, Weitere Mitarbeiter
<b>Language</b>	DE
<b>Cycle</b>	SoSe
<b>Content</b>	<ul style="list-style-type: none"> <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>
<b>Literature</b>	<p>U. Tietze und Ch. Schenk, E. Gamm, Halbleiterschaltungstechnik, Springer Verlag, 14. Auflage, 2012, ISBN 3540428496</p> <p>R. J. Baker, CMOS - Circuit Design, Layout and Simulation, J. Wiley &amp; Sons Inc., 3. Auflage, 2011, ISBN: 0471700555</p> <p>H. Göbel, Einführung in die Halbleiter-Schaltungstechnik, Berlin, Heidelberg Springer-Verlag Berlin Heidelberg, 2011, ISBN: 9783642208874 ISBN: 9783642208867</p> <p>URL: <a href="http://site.ebrary.com/lib/alltitles/docDetail.action?docID=10499499">http://site.ebrary.com/lib/alltitles/docDetail.action?docID=10499499</a></p> <p>URL: <a href="http://dx.doi.org/10.1007/978-3-642-20887-4">http://dx.doi.org/10.1007/978-3-642-20887-4</a></p> <p>URL: <a href="http://ebooks.ciando.com/book/index.cfm/bok_id/319955">http://ebooks.ciando.com/book/index.cfm/bok_id/319955</a></p> <p>URL: <a href="http://www.ciando.com/img/bo">http://www.ciando.com/img/bo</a></p>

**Specialization Product Development and Production**

The specialization "Product Development and Production" maps the product creation process from strategic product planning, through the systematic and methodical development of products, including concept development, design, material selection, simulation and test to production, the planning and control and the use of modern manufacturing processes, to high-performance materials.

<b>Module M0726: Production Technology</b>			
<b>Courses</b>			
<b>Title</b>	<b>Typ</b>	<b>Hrs/wk</b>	<b>CP</b>
Fundamentals of Machine Tools (L0689)	Lecture	2	2
Fundamentals of Machine Tools (L1992)	Recitation Section (large)	1	1
Forming and Cutting Technology (L0613)	Lecture	2	2
Forming and Cutting Technology (L0614)	Recitation Section (large)	1	1
<b>Module Responsible</b>	Prof. Wolfgang Hintze		
<b>Admission Requirements</b>	None		
<b>Recommended Previous Knowledge</b>	without major course assessment internship recommended Previous knowledge in mathematics, mechanics and electrical engineering		
<b>Educational Objectives</b>	After taking part successfully, students have reached the following learning results		
<b>Professional Competence</b>	<p><i>Knowledge</i> Students are able to ...</p> <ul style="list-style-type: none"> <li>explain the basics of chip formation and mechanisms and models of machining.</li> <li>explain methods and parameters for design and analysis of metal forming, machining processes and tools.</li> <li>explain technical concepts of machine tool building and give an overview on trends in the machine tool industry.</li> <li>explain types, constructions and functions of CNC-machines and give an overview on multi-machine systems.</li> <li>explain equipment components.</li> </ul> <p><i>Skills</i> Students are able to...</p> <ul style="list-style-type: none"> <li>select tool geometry, cutting materials, process parameters and appropriate measuring technique in accordance with the requirements.</li> <li>estimate occurring forces and temperatures during chip formation.</li> <li>select appropriate machine tools for machining and create NC programs for turning and milling.</li> <li>assess the quality of a machine tools and to detect weak points.</li> </ul> <p><b>Personal Competence</b></p> <p><i>Social Competence</i> Students are able to ...</p> <ul style="list-style-type: none"> <li>develop solutions in a production environment with qualified personnel at technical level and represent decisions.</li> </ul> <p><i>Autonomy</i> Students are able to ...</p> <ul style="list-style-type: none"> <li>interpret independently cutting processes.</li> <li>create independently NC programs.</li> <li>select independently machine tools by reference to appropriate requirements.</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		
<b>Credit points</b>	6		
<b>Course achievement</b>	None		
<b>Examination</b>	Written exam		
<b>Examination duration and scale</b>	180 min		
<b>Assignment for the Following Curricula</b>	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: Fundamentals of Machine Tools	
<b>Typ</b>	Lecture
<b>Hrs/wk</b>	2
<b>CP</b>	2
<b>Workload in Hours</b>	Independent Study Time 32, Study Time in Lecture 28
<b>Lecturer</b>	Prof. Thorsten Schüppstuhl
<b>Language</b>	DE
<b>Cycle</b>	WiSe
<b>Content</b>	Terminology and trends in machine tool building CNC controls NC programming and NC programming systems Types, construction and function of CNC machines Multi-machinesystems Equipmentcomponents for machine tools Assessment of machine tools
<b>Literature</b>	<p><i>Conrad, K./</i> <i>Taschenbuch der Werkzeugmaschinen</i> <i>9783446406414</i> <i>Fachbuchverlag 2006</i></p> <p><i>Perović, Božina</i> <i>Spanende Werkzeugmaschinen - Ausführungsformen und Vergleichstabellen</i> <i>ISBN: 3540899529</i> <i>Berlin [u.a.]: Springer, 2009</i></p> <p><i>Weck, Manfred</i> <i>Werkzeugmaschinen 1 - Maschinenarten und Anwendungsbereiche</i> <i>ISBN: 9783540225041</i> <i>Berlin [u.a.]: Springer, 2005</i></p> <p><i>Weck, Manfred; Brecher, Christian</i> <i>Werkzeugmaschinen 4 - Automatisierung von Maschinen und Anlagen</i> <i>ISBN: 3540225072</i> <i>Berlin [u.a.]: Springer, 2006</i></p> <p><i>Weck, Manfred; Brecher, Christian</i> <i>Werkzeugmaschinen 5 - Messtechnische Untersuchung und Beurteilung, dynamische Stabilität</i> <i>ISBN: 3540225056</i> <i>Berlin [u.a.]: Springer, 2006</i></p>

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

Course L0613: Forming and Cutting Technology	
<b>Typ</b>	Lecture
<b>Hrs/wk</b>	2
<b>CP</b>	2
<b>Workload in Hours</b>	Independent Study Time 32, Study Time in Lecture 28
<b>Lecturer</b>	Prof. Wolfgang Hintze
<b>Language</b>	DE
<b>Cycle</b>	WiSe
<b>Content</b>	<ul style="list-style-type: none"> <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>
<b>Literature</b>	<p>Lange, K.; Umformtechnik Grundlagen, 2. Auflage, Springer (2002)</p> <p>Tönshoff, H.; Spanen Grundlagen, 2. Auflage, Springer Verlag (2004)</p> <p>König, W., Klocke, F.; Fertigungsverfahren Bd. 4 <i>Massivumformung</i>, 4. Auflage, VDI-Verlag (1996)</p> <p>König, W., Klocke, F.; Fertigungsverfahren Bd. 5 <i>Blecbearbeitung</i>, 3. Auflage, VDI-Verlag (1995)</p> <p>Klocke, F., König, W.; Fertigungsverfahren <i>Schleifen, Honen, Läppen</i>, 4. Auflage, Springer Verlag (2005)</p> <p>König, W., Klocke, F.; Fertigungsverfahren <i>Drehen, Fräsen, Bohren</i>, 7. Auflage, Springer Verlag (2002)</p>

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

Module M1009: Material Science Laboratory			
<b>Courses</b>			
<b>Title</b>		<b>Typ</b>	<b>Hrs/wk</b>
Companion Lecture for Materials Science Laboratory (L1088)		Lecture	2
Material Science Laboratory (L1235)		Practical Course	4
<b>Module Responsible</b>	Prof. Bodo Fiedler		
<b>Admission Requirements</b>	None		
<b>Recommended Previous Knowledge</b>	none		
<b>Educational Objectives</b>	After taking part successfully, students have reached the following learning results		
<b>Professional Competence</b>			
<i>Knowledge</i>	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.		
<i>Skills</i>	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.		
<b>Personal Competence</b>			
<i>Social Competence</i>	Students are able to cooperate in small groups in order to conduct experiments in the context of materials sciences. They are able to effectively present and explain their results alone or in groups in front of a qualified audience.		
<i>Autonomy</i>	Students are capable of solving problems in the context of materials sciences using provided literature. They are able to fill gaps in as well as extend their knowledge using the literature and other sources provided by the supervisor.		
<b>Workload in Hours</b>	Independent Study Time 96, Study Time in Lecture 84		
<b>Credit points</b>	6		
<b>Course achievement</b>	None		
<b>Examination</b>	Subject theoretical and practical work		
<b>Examination duration and scale</b>	Test reports on the respective tests and online learning modules with integrated success control		
<b>Assignment for the Following Curricula</b>	<p>General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Materials in Engineering Sciences: Compulsory</p> <p>General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Product Development and Production: Elective Compulsory</p> <p>General Engineering Science (English program, 7 semester): Specialisation Mechanical Engineering, Focus Materials in Engineering Sciences: Compulsory</p> <p>Mechanical Engineering: Specialisation Product Development and Production: Compulsory</p> <p>Mechanical Engineering: Specialisation Materials in Engineering Sciences: Compulsory</p> <p>Product Development, Materials and Production: Technical Complementary Course Core Studies: Elective Compulsory</p>		
Course L1088: Companion Lecture for Materials Science Laboratory			
<b>Typ</b>	Lecture		
<b>Hrs/wk</b>	2		
<b>CP</b>	2		
<b>Workload in Hours</b>	Independent Study Time 32, Study Time in Lecture 28		
<b>Lecturer</b>	Prof. Dr. Kaline Pagnan Furlan		
<b>Language</b>	DE		
<b>Cycle</b>	WiSe		
<b>Content</b>	<p>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:</p> <ol style="list-style-type: none"> <li>1. Phase diagrams, heat treatment, hardness measurements (thermodynamics, elastic properties of solids)</li> <li>2. notch impact test (elastic properties of solids)</li> <li>3. Processes during the solidification of metals (thermodynamics and kinetics of solid-liquid phase transitions)</li> <li>4. tensile test (elastic properties of solids)</li> <li>5. Identification of polymers (polymer physics)</li> <li>6. fiber-reinforced polymers (physical principles of composite materials)</li> <li>7. Production and microstructure of ceramic materials (physico-chemical principles of ceramics)</li> <li>8. Mechanical properties of ceramic materials (elastic properties of solids and composite materials)</li> </ol>		
<b>Literature</b>	<p>William D. Callister und David G. Rethwisch, Materialwissenschaften und Werkstofftechnik, Wiley&amp;Sons, Asia (2011)</p> <p>William D. Callister, Materials Science and Technology, Wiley&amp; Sons, Inc. (2007)</p>		

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

Module M0599: Integrated Product Development and Lightweight Design				
<b>Courses</b>				
<b>Title</b>		<b>Typ</b>	<b>Hrs/wk</b>	<b>CP</b>
CAE-Team Project (L0271)		Project-/problem-based Learning	2	2
Development of Lightweight Design Products (L0270)		Lecture	2	2
Integrated Product Development I (L0269)		Lecture	2	2
<b>Module Responsible</b>	Prof. Dieter Krause			
<b>Admission Requirements</b>	None			
<b>Recommended Previous Knowledge</b>	Advanced Knowledge about engineering design: Fundamentals of Mechanical Engineering Design Mechanical Engineering: Design Advanced Mechanical Engineering Design			
<b>Educational Objectives</b>	After taking part successfully, students have reached the following learning results			
<b>Professional Competence</b>	After completing the module, students are capable of: <ul style="list-style-type: none"> <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> After completing the module, students are able to: <ul style="list-style-type: none"> <li>evaluate different CAD- and PDM-Systems with regards to the desired requirements such as classification schemes and product structuring</li> <li>design an exemplary product using CAD-,PDM- and/or FEM-Systems with shared workload</li> </ul>			
<i>Knowledge</i>				
<i>Skills</i>				
<b>Personal Competence</b>	After completing the module, students are able to: <ul style="list-style-type: none"> <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>			
<i>Social Competence</i>	Students are capable of: <ul style="list-style-type: none"> <li>independently adapt to a CAE-Tool and complete a given practical task with it</li> </ul>			
<i>Autonomy</i>				
<b>Workload in Hours</b>	Independent Study Time 96, Study Time in Lecture 84			
<b>Credit points</b>	6			
<b>Course achievement</b>	<b>Compulsory</b>	<b>Bonus</b>	<b>Form</b>	<b>Description</b>
	Yes	20 %	Subject theoretical and practical work	andCAE-Teamprojekt inkl. Vortrag und Ausarbeitung
<b>Examination</b>	Written exam			
<b>Examination duration and scale</b>	90			
<b>Assignment for the Following Curricula</b>	General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Aircraft Systems Engineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Product Development and Production: Compulsory Engineering Science: Specialisation Mechanical Engineering: Elective 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: Elective Compulsory Mechanical Engineering: Specialisation Product Development and Production: Compulsory Mechanical Engineering: Specialisation Aircraft Systems Engineering: Compulsory Product Development, Materials and Production: Technical Complementary Course Core Studies: Elective Compulsory			

Course L0271: CAE-Team Project	
<b>Typ</b>	Project-/problem-based Learning
<b>Hrs/wk</b>	2
<b>CP</b>	2
<b>Workload in Hours</b>	Independent Study Time 32, Study Time in Lecture 28
<b>Lecturer</b>	Prof. Dieter Krause
<b>Language</b>	DE
<b>Cycle</b>	SoSe
<b>Content</b>	<ul style="list-style-type: none"> <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> <p><b>Description</b></p> <p>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.</p>
<b>Literature</b>	-

Course L0270: Development of Lightweight Design Products	
<b>Typ</b>	Lecture
<b>Hrs/wk</b>	2
<b>CP</b>	2
<b>Workload in Hours</b>	Independent Study Time 32, Study Time in Lecture 28
<b>Lecturer</b>	Prof. Dieter Krause, Prof. Benedikt Kriegesmann
<b>Language</b>	DE
<b>Cycle</b>	SoSe
<b>Content</b>	<ul style="list-style-type: none"> <li>• Lightweight design materials</li> <li>• Product development process for lightweight structures</li> <li>• Dimensioning of lightweight structures</li> </ul>
<b>Literature</b>	<ul style="list-style-type: none"> <li>• Schürmann, H., „Konstruieren mit Faser-Kunststoff-Verbunden“, Springer, Berlin, 2005.</li> <li>• Klein, B., „Leichtbau-Konstruktion“, Vieweg &amp; Sohn, Braunschweig, 1989.</li> <li>• Krause, D., „Leichtbau“, In: Handbuch Konstruktion, Hrsg.: Rieg, F., Steinhilper, R., München, Carl Hanser Verlag, 2012.</li> <li>• Schulte, K., Fiedler, B., „Structure and Properties of Composite Materials“, Hamburg, TUHH - TuTech Innovation GmbH, 2005.</li> <li>• Wiedemann, J., „Leichtbau Band 1: Elemente“, Springer, Berlin, Heidelberg, 1986.</li> </ul>

Course L0269: Integrated Product Development I	
<b>Typ</b>	Lecture
<b>Hrs/wk</b>	2
<b>CP</b>	2
<b>Workload in Hours</b>	Independent Study Time 32, Study Time in Lecture 28
<b>Lecturer</b>	Prof. Dieter Krause
<b>Language</b>	DE
<b>Cycle</b>	SoSe
<b>Content</b>	<ul style="list-style-type: none"> <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>
<b>Literature</b>	<ul style="list-style-type: none"> <li>• Ehrlenspiel, K.: Integrierte Produktentwicklung, München, Carl Hanser Verlag</li> <li>• Lee, K.: Principles of CAD / CAM / CAE Systems, Addison Wesley</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>



## Specialization Theoretical Mechanical Engineering

The focus of the specialization "Theoretical Mechanical Engineering" lies on theory-method-oriented content and principles as well as intensive scientific thinking training. The students enter a wide-open field of work, especially in the area of mechanical and automotive engineering, biotechnology and medical technology, power engineering, aerospace engineering, shipbuilding, automation technology, materials science and related fields.

Module M0662: Numerical Mathematics I			
<b>Courses</b>			
<b>Title</b>	<b>Typ</b>	<b>Hrs/wk</b>	<b>CP</b>
Numerical Mathematics I (L0417)	Lecture	2	3
Numerical Mathematics I (L0418)	Recitation Section (small)	2	3
<b>Module Responsible</b>	Prof. Sabine Le Borne		
<b>Admission Requirements</b>	None		
<b>Recommended Previous Knowledge</b>	<ul style="list-style-type: none"> <li>• Mathematik I + II for Engineering Students (german or english) <b>or</b> Analysis &amp; Linear Algebra I + II for Technomathematicians</li> <li>• basic MATLAB/Python knowledge</li> </ul>		
<b>Educational Objectives</b>	After taking part successfully, students have reached the following learning results		
<b>Professional Competence</b>	<p><i>Knowledge</i> Students are able to</p> <ul style="list-style-type: none"> <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> <p><i>Skills</i> Students are able to</p> <ul style="list-style-type: none"> <li>• implement, apply and compare numerical methods using MATLAB/Python,</li> <li>• justify the convergence behaviour of numerical methods with respect to the problem and solution algorithm,</li> <li>• select and execute a suitable solution approach for a given problem.</li> </ul> <p><b>Personal Competence</b></p> <p><i>Social Competence</i> Students are able to</p> <ul style="list-style-type: none"> <li>• work together in heterogeneously composed teams (i.e., teams from different study programs and background knowledge), explain theoretical foundations and support each other with practical aspects regarding the implementation of algorithms.</li> </ul> <p><i>Autonomy</i> Students are capable</p> <ul style="list-style-type: none"> <li>• to assess whether the supporting theoretical and practical excercises are better solved individually or in a team,</li> <li>• to assess their individual progress and, if necessary, to ask questions and seek help.</li> </ul>		
<b>Workload in Hours</b>	Independent Study Time 124, Study Time in Lecture 56		
<b>Credit points</b>	6		
<b>Course achievement</b>	None		
<b>Examination</b>	Written exam		
<b>Examination duration and scale</b>	90 minutes		
<b>Assignment for the Following Curricula</b>	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 General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Aircraft Systems Engineering: Elective Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Mechatronics: Elective Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Energy Systems: Elective Compulsory Bioprocess Engineering: Specialisation A - General Bioprocess Engineering: Elective Compulsory Computer Science: Specialisation Computational Mathematics: Elective Compulsory Computer Science: Specialisation II. Mathematics and Engineering Science: Elective Compulsory Data Science: Core Qualification: Compulsory Electrical Engineering: Core Qualification: Elective Compulsory Engineering Science: Core Qualification: Compulsory Engineering Science: Core Qualification: Compulsory General Engineering Science (English program, 7 semester): Core Qualification: Compulsory General Engineering Science (English program, 7 semester): Specialisation Computer Science: 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
General Engineering Science (English program, 7 semester): Specialisation Mechanical Engineering, Focus Mechatronics: Elective Compulsory
Computational Science and Engineering: Core Qualification: Compulsory
Mechanical Engineering: Specialisation Theoretical Mechanical Engineering: Compulsory
Mechanical Engineering: Specialisation Energy Systems: Elective Compulsory
Mechanical Engineering: Specialisation Mechatronics: Elective Compulsory
Theoretical Mechanical Engineering: Technical Complementary Course Core Studies: Elective Compulsory
Process Engineering: Specialisation Process Engineering: Elective Compulsory

Course L0417: Numerical Mathematics I	
<b>Typ</b>	Lecture
<b>Hrs/wk</b>	2
<b>CP</b>	3
<b>Workload in Hours</b>	Independent Study Time 62, Study Time in Lecture 28
<b>Lecturer</b>	Prof. Sabine Le Borne
<b>Language</b>	EN
<b>Cycle</b>	WiSe
<b>Content</b>	<ol style="list-style-type: none"> <li>1. Finite precision arithmetic, error analysis, conditioning and stability</li> <li>2. Linear systems of equations: LU and Cholesky factorization, condition</li> <li>3. Interpolation: polynomial, spline and trigonometric interpolation</li> <li>4. Nonlinear equations: fixed point iteration, root finding algorithms, Newton's method</li> <li>5. Linear and nonlinear least squares problems: normal equations, Gram Schmidt and Householder orthogonalization, singular value decomposition, regularization, Gauss-Newton and Levenberg-Marquardt methods</li> <li>6. Eigenvalue problems: power iteration, inverse iteration, QR algorithm</li> <li>7. Numerical differentiation</li> <li>8. Numerical integration: Newton-Cotes rules, error estimates, Gauss quadrature, adaptive quadrature</li> </ol>
<b>Literature</b>	<ul style="list-style-type: none"> <li>• Gander/Gander/Kwok: Scientific Computing: An introduction using Maple and MATLAB, Springer (2014)</li> <li>• Stoer/Bulirsch: Numerische Mathematik 1, Springer</li> <li>• Dahmen, Reusken: Numerik für Ingenieure und Naturwissenschaftler, Springer</li> </ul>

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

Module M0684: Heat Transfer			
<b>Courses</b>			
<b>Title</b>	<b>Typ</b>	<b>Hrs/wk</b>	<b>CP</b>
Heat Transfer (L0458)	Lecture	3	4
Heat Transfer (L0459)	Recitation Section (large)	2	2
<b>Module Responsible</b>	Dr. Andreas Moschallski		
<b>Admission Requirements</b>	None		
<b>Recommended Previous Knowledge</b>	Technical Thermodynamics I, II and Fluid Dynamics		
<b>Educational Objectives</b>	After taking part successfully, students have reached the following learning results		
<b>Professional Competence</b>	<p><i>Knowledge</i></p> <p>The students are able to</p> <ul style="list-style-type: none"> <li>- describe the different physical mechanism of Heat Transfer,</li> <li>- explain the technical terms,</li> <li>- to analyse complex heat transfer processes in a critical way.</li> </ul> <p><i>Skills</i></p> <p>The students are able to</p> <ul style="list-style-type: none"> <li>- understand the physics of Heat Transfer,</li> <li>- calculate and evaluate complex Heat Transfer processes,</li> <li>- solve excersises self-consistent and in small groups.</li> </ul> <p><b>Personal Competence</b></p> <p><i>Social Competence</i></p> <p>The students are able to discuss in small groups and develop an approach.</p> <p><i>Autonomy</i></p> <p>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.</p>		
<b>Workload in Hours</b>	Independent Study Time 110, Study Time in Lecture 70		
<b>Credit points</b>	6		
<b>Course achievement</b>	None		
<b>Examination</b>	Written exam		
<b>Examination duration and scale</b>	120 min		
<b>Assignment for the Following Curricula</b>	General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Energy Systems: Compulsory General Engineering Science (German program, 7 semester): Specialisation Biomedical Engineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Theoretical Mechanical Engineering: Compulsory Energy Systems: Technical Complementary Course Core Studies: 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	
<b>Typ</b>	Lecture
<b>Hrs/wk</b>	3
<b>CP</b>	4
<b>Workload in Hours</b>	Independent Study Time 78, Study Time in Lecture 42
<b>Lecturer</b>	Dr. Andreas Moschallski
<b>Language</b>	DE
<b>Cycle</b>	WiSe
<b>Content</b>	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
<b>Literature</b>	- Herwig, H.; Moschallski, A.: Wärmeübertragung, 4. Auflage, Springer Vieweg Verlag, Wiesbaden, 2019 - Herwig, H.: Wärmeübertragung von A-Z, Springer- Verlag, Berlin, Heidelberg, 2000 - Baehr, H.D.; Stephan, K.: Wärme- und Stoffübertragung, 2. Auflage, Springer Verlag, Berlin, Heidelberg, 1996

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

**Module M1573: Modeling, Simulation and Optimization (EN)**

Courses			
Title	Typ	Hrs/wk	CP
Modeling, Simulation and Optimization (L2446)	Integrated Lecture	4	6
<b>Module Responsible</b>	Prof. Benedikt Kriegesmann		
<b>Admission Requirements</b>	None		
<b>Recommended Previous Knowledge</b>	Sound knowledge of engineering mathematics, engineering mechanics and fluid mechanics		
<b>Educational Objectives</b>	After taking part successfully, students have reached the following learning results		
<b>Professional Competence</b>	<p><i>Knowledge</i> Students will have an overview of various technical problems and the differential equations, which describe them. Students will give an overview of different solution approaches and for which kind of problems they can be used for.</p> <p><i>Skills</i> Students are able to solve different technical problems with the introduced discretization methods.</p>		
<b>Personal Competence</b>	<p><i>Social Competence</i> The students are able to discuss problems and jointly develop solution strategies.</p> <p><i>Autonomy</i> The students are able to develop solution strategies for complex problems self-consistent and critically analyse results.</p>		
<b>Workload in Hours</b>	Independent Study Time 124, Study Time in Lecture 56		
<b>Credit points</b>	6		
<b>Course achievement</b>	None		
<b>Examination</b>	Oral exam		
<b>Examination duration and scale</b>	30 min		
<b>Assignment for the Following Curricula</b>	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 Technomathematics: Specialisation III. Engineering Science: Elective Compulsory		

**Course L2446: Modeling, Simulation and Optimization**

<b>Typ</b>	Integrated Lecture
<b>Hrs/wk</b>	4
<b>CP</b>	6
<b>Workload in Hours</b>	Independent Study Time 124, Study Time in Lecture 56
<b>Lecturer</b>	Prof. Benedikt Kriegesmann, Prof. Thomas Rung, Prof. Alexander Düster, Prof. Robert Seifried
<b>Language</b>	EN
<b>Cycle</b>	SoSe
<b>Content</b>	<ul style="list-style-type: none"> <li>• Partial Differential Equations in technical problems</li> <li>• Overview of modelling approaches</li> <li>• Finite Approximation Methods - Finite Differences / Elements / Volumes</li> <li>• Introduction to the Discrete Element Method</li> <li>• Numerical methods for time dependent problems</li> <li>• Gradient-based optimization</li> </ul>
<b>Literature</b>	Michael Schäfer, Computational Engineering - Introduction to Numerical Methods, Springer.

Module M0854: Mathematics IV			
Courses			
Title	Typ	Hrs/wk	CP
Differential Equations 2 (Partial Differential Equations) (L1043)	Lecture	2	1
Differential Equations 2 (Partial Differential Equations) (L1044)	Recitation Section (small)	1	1
Differential Equations 2 (Partial Differential Equations) (L1045)	Recitation Section (large)	1	1
Complex Functions (L1038)	Lecture	2	1
Complex Functions (L1041)	Recitation Section (small)	1	1
Complex Functions (L1042)	Recitation Section (large)	1	1
<b>Module Responsible</b>	Prof. Anusch Taraz		
<b>Admission Requirements</b>	None		
<b>Recommended Previous Knowledge</b>	Mathematics 1 - III		
<b>Educational Objectives</b>	After taking part successfully, students have reached the following learning results		
<b>Professional Competence</b>	<ul style="list-style-type: none"> <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> <ul style="list-style-type: none"> <li>• Students can model problems in Mathematics IV with the help of the concepts studied in this course. Moreover, they are capable of solving them by applying established methods.</li> <li>• Students are able to discover and verify further logical connections between the concepts studied in the course.</li> <li>• For a given problem, the students can develop and execute a suitable approach, and are able to critically evaluate the results.</li> </ul> <ul style="list-style-type: none"> <li>• Students are able to work together in teams. They are capable to use mathematics as a common language.</li> <li>• In doing so, they can communicate new concepts according to the needs of their cooperating partners. Moreover, they can design examples to check and deepen the understanding of their peers.</li> </ul> <ul style="list-style-type: none"> <li>• Students are capable of checking their understanding of complex concepts on their own. They can specify open questions precisely and know where to get help in solving them.</li> <li>• Students have developed sufficient persistence to be able to work for longer periods in a goal-oriented manner on hard problems.</li> </ul>		
<i>Knowledge</i>			
<i>Skills</i>			
<b>Personal Competence</b>			
<i>Social Competence</i>			
<i>Autonomy</i>			
<b>Workload in Hours</b>	Independent Study Time 68, Study Time in Lecture 112		
<b>Credit points</b>	6		
<b>Course achievement</b>	None		
<b>Examination</b>	Written exam		
<b>Examination duration and scale</b>	60 min (Complex Functions) + 60 min (Differential Equations 2)		
<b>Assignment for the Following Curricula</b>	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 Electrical Engineering: Core Qualification: Compulsory General Engineering Science (English program, 7 semester): Specialisation Electrical Engineering: Compulsory General Engineering Science (English program, 7 semester): Specialisation Mechanical Engineering, Focus Mechatronics: Compulsory General Engineering Science (English program, 7 semester): Specialisation Mechanical Engineering, Focus Theoretical Mechanical Engineering: Compulsory Computational Science and Engineering: Specialisation II. Mathematics & Engineering Science: Elective Compulsory Mechanical Engineering: Specialisation Mechatronics: Compulsory Mechanical Engineering: Specialisation Theoretical Mechanical Engineering: Elective Compulsory Mechatronics: Core Qualification: Compulsory Naval Architecture: Core Qualification: Compulsory Theoretical Mechanical Engineering: Technical Complementary Course Core Studies: Elective Compulsory		

Course L1043: Differential Equations 2 (Partial Differential Equations)	
<b>Typ</b>	Lecture
<b>Hrs/wk</b>	2
<b>CP</b>	1
<b>Workload in Hours</b>	Independent Study Time 2, Study Time in Lecture 28
<b>Lecturer</b>	Dozenten des Fachbereiches Mathematik der UHH
<b>Language</b>	DE
<b>Cycle</b>	SoSe
<b>Content</b>	<p>Main features of the theory and numerical treatment of partial differential equations</p> <ul style="list-style-type: none"> <li>• Examples of partial differential equations</li> <li>• First order quasilinear differential equations</li> <li>• Normal forms of second order differential equations</li> <li>• Harmonic functions and maximum principle</li> <li>• Maximum principle for the heat equation</li> <li>• Wave equation</li> <li>• Liouville's formula</li> <li>• Special functions</li> <li>• Difference methods</li> <li>• Finite elements</li> </ul>
<b>Literature</b>	<ul style="list-style-type: none"> <li>• <a href="http://www.math.uni-hamburg.de/teaching/export/tuhh/index.html">http://www.math.uni-hamburg.de/teaching/export/tuhh/index.html</a></li> </ul>

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

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

Course L1038: Complex Functions	
<b>Typ</b>	Lecture
<b>Hrs/wk</b>	2
<b>CP</b>	1
<b>Workload in Hours</b>	Independent Study Time 2, Study Time in Lecture 28
<b>Lecturer</b>	Dozenten des Fachbereiches Mathematik der UHH
<b>Language</b>	DE
<b>Cycle</b>	SoSe
<b>Content</b>	<p>Main features of complex analysis</p> <ul style="list-style-type: none"> <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>
<b>Literature</b>	<ul style="list-style-type: none"> <li>• <a href="http://www.math.uni-hamburg.de/teaching/export/tuhh/index.html">http://www.math.uni-hamburg.de/teaching/export/tuhh/index.html</a></li> </ul>

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

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



**Thesis**

The work at the Bechelo thesis should show that the nominee or candidate is able to work on a problem from her or his field independently with scientific methods within an intended term.

Module M-001: Bachelor Thesis			
Courses			
Title	Typ	Hrs/wk	CP
<b>Module Responsible</b>	Professoren der TUHH		
<b>Admission Requirements</b>	<ul style="list-style-type: none"> <li>According to General Regulations §21 (1):</li> </ul> <p>At least 126 ECTS credit points have to be achieved in study programme. The examinations board decides on exceptions.</p>		
<b>Recommended Previous Knowledge</b>			
<b>Educational Objectives</b>	After taking part successfully, students have reached the following learning results		
<b>Professional Competence</b>	<ul style="list-style-type: none"> <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>		
<i>Knowledge</i>			
<i>Skills</i>	<ul style="list-style-type: none"> <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>		
<b>Personal Competence</b>	<ul style="list-style-type: none"> <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>		
<i>Social Competence</i>			
<i>Autonomy</i>	<ul style="list-style-type: none"> <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		
<b>Credit points</b>	12		
<b>Course achievement</b>	None		
<b>Examination</b>	Thesis		
<b>Examination duration and scale</b>	According to General Regulations		
<b>Assignment for the Following Curricula</b>	General Engineering Science (German program): Thesis: Compulsory General Engineering Science (German program, 7 semester): Thesis: Compulsory Civil- and Environmental Engineering: Thesis: Compulsory Bioprocess Engineering: Thesis: Compulsory Computer Science: Thesis: Compulsory Data Science: Thesis: Compulsory Digital Mechanical Engineering: Thesis: Compulsory Electrical Engineering: Thesis: Compulsory Energy and Environmental Engineering: Thesis: Compulsory Engineering Science: Thesis: Compulsory General Engineering Science (English program): Thesis: Compulsory General Engineering Science (English program, 7 semester): Thesis: Compulsory Green Technologies: Energy, Water, Climate: Thesis: Compulsory Computational Science and Engineering: Thesis: Compulsory Logistics and Mobility: Thesis: Compulsory Mechanical Engineering: Thesis: Compulsory 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

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