



## **Module Manual**

Bachelor of Science

## **Mechanical Engineering**

Cohort: Winter Term 2018

Updated: 28th September 2018

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# Module Manual

Bachelor

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## Program description

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### 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.
  - 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.

### Module M0725: Production Engineering

#### Courses

Title	Typ	Hrs/wk	CP
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>	<p>Students are able to ...</p> <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>Knowledge</i>	
<b>Skills</b>	<p>Students are able to...</p> <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>
<i>Skills</i>	
<b>Personal Competence</b>	<p>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>
<i>Social Competence</i>	

<i>Autonomy</i>	<p>Students are able to ..</p> <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>Studienleistung</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): Specialisation Mechanical Engineering, Focus Theoretical Mechanical Engineering: Elective Compulsory</p> <p>General Engineering Science (German 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: Elective Compulsory</p> <p>General Engineering Science (English program, 7 semester): Specialisation Mechanical Engineering, Focus Product Development and Production: Compulsory</p> <p>Logistics and Mobility: Specialisation Engineering Science: Elective Compulsory</p> <p>Mechanical Engineering: Core qualification: Compulsory</p> <p>Mechatronics: Core qualification: Compulsory</p>

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>

Course L0611: Production Engineering 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. 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 M0782: Computer Science for Mechanical Engineers

### Courses

Title	Typ	Hrs/wk	CP
Computer Science for Mechanical Engineers (L0149)	Lecture	3	3
Computer Science for Mechanical Engineers (L0772)	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>Studienleistung</b>	<b>Compulsory Bonus</b>	<b>Form</b>	<b>Description</b>
	No      10 %	Excercises	Ergebnisse aus den Übungsaufgaben werden entsprechend der Ankündigung in der Vorlesung mit bis zu 10% der Klausurpunkte angerechnet.
<b>Examination</b>	Written exam		
<b>Examination duration and scale</b>	90 minutes		
<b>Assignment for the Following Curricula</b>	Mechanical Engineering: Core qualification: Compulsory Naval Architecture: Core qualification: Compulsory		

<b>Course L0149: Computer Science for Mechanical Engineers</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. Görschwin Fey, Prof. Görschwin Fey
<b>Language</b>	DE
<b>Cycle</b>	WiSe
<b>Content</b>	You are a student of mechanical engineering and want a solid introduction to computer science particularly tailored to suit your needs? Well, here it is. All you have to do is to start learning German right now because this is an introductory course being taught in German.
<b>Literature</b>	<p>Bjarne Stroustrup: Die C++-Programmiersprache: Aktuell zu C++11. Carl Hanser Verlag GmbH &amp; Co. KG (7. April 2015).</p> <p>Helmut Herold, Bruno Lurz, Jürgen Wohlrab, Matthias Hopf: Grundlagen der Informatik, 3. Auflage, 816 Seiten, Pearson Studium, 2017.</p> <p>Bjarne Stroustrup, Einführung in die Programmierung mit C++, 479 Seiten, Pearson Studium, 2010.</p> <p>Jürgen Wolf : Grundkurs C++: C++-Programmierung verständlich erklärt, Rheinwerk Computing, 3. Auflage, 2016.</p>

<b>Course L0772: Computer Science for Mechanical Engineers</b>	
<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, Prof. Görschwin Fey
<b>Language</b>	DE
<b>Cycle</b>	WiSe
<b>Content</b>	See interlocking course
<b>Literature</b>	See interlocking course

Module M0889: Mechanics I (Statics)			
<b>Courses</b>			
<b>Title</b>	<b>Typ</b>	<b>Hrs/wk</b>	<b>CP</b>
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>	<p>The students can</p> <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>Knowledge</i>			
<i>Skills</i>	<p>The students can</p> <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>	<p>The students can work in groups and support each other to overcome difficulties.</p>		
<i>Social Competence</i>			
<i>Autonomy</i>	<p>Students are capable of determining their own strengths and weaknesses and to organize their time and learning based on those.</p>		
<b>Workload in Hours</b>	Independent Study Time 110, Study Time in Lecture 70		
<b>Credit points</b>	6		
<b>Studienleistung</b>	<b>Compulsory Bonus</b>	<b>Form</b>	<b>Description</b>
	No 20 %	Midterm	Wird nur im WiSe angeboten
<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): Core qualification: Compulsory General Engineering Science (German program, 7 semester): Core qualification: Compulsory Civil- and Environmental Engineering: Core qualification: Compulsory Mechanical Engineering: Core qualification: Compulsory Mechatronics: Core qualification: Compulsory Naval Architecture: 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>	<p>K. Magnus, H.H. Müller-Slany: <b>Grundlagen der Technischen Mechanik. 7. Auflage, Teubner (2009).</b></p> <p>D. Gross, W. Hauger, J. Schröder, W. Wall: <b>Technische Mechanik 1. 11. Auflage, Springer (2011).</b></p>

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>	<p>Forces and equilibrium</p> <p>Constraints and reactions</p> <p>Frames</p> <p>Center of mass</p> <p>Friction</p> <p>Internal forces and moments for beams</p>
<b>Literature</b>	<p>K. Magnus, H.H. Müller-Slany: <b>Grundlagen der Technischen Mechanik. 7. Auflage, Teubner (2009).</b></p> <p>D. Gross, W. Hauger, J. Schröder, W. Wall: <b>Technische Mechanik 1. 11. Auflage, Springer (2011).</b></p>

<b>Course L1003: Mechanics I (Statics)</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>	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 M0577: Nontechnical Complementary 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>	<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>

*Knowledge*

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

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

**Specialized Competence (Knowledge)**

Students can

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

**Professional Competence (Skills)**

In selected sub-areas students can

*Skills*

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

**Personal Competence**

**Personal Competences (Social Skills)**

Students will be able

*Social Competence*

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

**Personal Competences (Self-reliance)**

Students are able in selected areas

*Autonomy*

- to reflect on their own profession and professionalism in the context of real-life fields of application
- to organize themselves and their own learning processes
- to reflect and decide questions in front of a broad education background
- to communicate a nontechnical item in a competent way in written form or verbally
- to organize themselves as an entrepreneurial subject country (as far as this study-focus would be chosen)

**Workload in Hours**

Depends on choice of courses

Credit points 6

**Courses**

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

# Module M0850: Mathematics I

## Courses

Title	Typ	Hrs/wk	CP
Analysis I (L1010)	Lecture	2	2
Analysis I (L1012)	Recitation Section (small)	1	1
Analysis I (L1013)	Recitation Section (large)	1	1
Linear Algebra I (L0912)	Lecture	2	2
Linear Algebra I (L0913)	Recitation Section (small)	1	1
Linear Algebra I (L0914)	Recitation Section (large)	1	1

**Module Responsible** | Prof. Anusch Taraz

**Admission Requirements** | None

**Recommended Previous Knowledge** | School mathematics

**Educational Objectives** | 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>
<i>Knowledge</i>	
<i>Skills</i>	
<b>Personal Competence</b>	
<i>Social Competence</i>	<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>
<i>Autonomy</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>
	<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>Studienleistung</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): Core qualification: Compulsory General Engineering Science (German program, 7 semester): Core qualification: Compulsory Civil- and Environmental Engineering: Core qualification: Compulsory Bioprocess Engineering: Core qualification: Compulsory Electrical Engineering: Core qualification: Compulsory Energy and Environmental Engineering: Core qualification: Compulsory Computational Science and Engineering: 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 Naval Architecture: Core qualification: Compulsory Process Engineering: 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
<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
<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>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
<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
<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>	<p>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.</p> <p>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.</p>		
<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 96, Study Time in Lecture 84		
<b>Credit points</b>	6		
<b>Studienleistung</b>	None		
<b>Examination</b>	Written exam		
<b>Examination duration and scale</b>	180 min		
	General Engineering Science (German program): Specialisation Energy and Environmental Engineering: Compulsory General Engineering Science (German program): Specialisation Mechanical Engineering: Compulsory General Engineering Science (German program): Specialisation Biomedical Engineering:		

<b>Assignment for the Following Curricula</b>	Compulsory General Engineering Science (German program): Specialisation Naval Architecture: Compulsory 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 Energy and Environmental Engineering: Core qualification: Compulsory General Engineering Science (English program): Specialisation Energy and Environmental Engineering: Compulsory General Engineering Science (English program): Specialisation Mechanical Engineering: Compulsory General Engineering Science (English program): Specialisation Biomedical Engineering: Compulsory General Engineering Science (English program): Specialisation Naval Architecture: 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 Naval Architecture: Compulsory General Engineering Science (English program, 7 semester): Specialisation Energy and Environmental Engineering: Compulsory Logistics and Mobility: Specialisation Engineering Science: Elective Compulsory Mechanical Engineering: Core qualification: Compulsory Mechatronics: Core qualification: Compulsory Naval Architecture: Core qualification: Compulsory Technomathematics: Specialisation III. Engineering Science: Elective Compulsory
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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>	Vorlesungsskript  W.D. Callister: Materials Science and Engineering - An Introduction. 5th ed., John Wiley & Sons, Inc., New York, 2000, ISBN 0-471-32013-7

Course 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>	Vorlesungsskript W.D. Callister: Materials Science and Engineering -An Introduction-5th ed., John Wiley & Sons, Inc., New York, 2000, ISBN 0-471-32013-7

Course L1095: Physical and Chemical Basics of Materials Science	
<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 makroskopic 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> <b>CP</b>
Team Project MB (L1236)		Project-/problem-based Learning	6            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 a 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 extend 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>Studienleistung</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		

<b>Course L1236: Team Project MB</b>	
<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 M0671: Technical Thermodynamics I

### Courses

Title	Typ	Hrs/wk	CP
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. Gerhard Schmitz		
<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>	<p><i>Knowledge</i></p> <p>Students are familiar with the laws of Thermodynamics. They know the relation of the kinds of energy according to 1<sup>st</sup> law of Thermodynamics and are aware about the limits of energy conversions according to 2<sup>nd</sup> law of Thermodynamics. They are able to distinguish between state variables and process variables and know the meaning of different state variables like temperature, enthalpy, entropy and also the meaning of exergy and anergy. They are able to draw the Carnot cycle in a Thermodynamics related diagram. They know the physical difference between 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.</p> <p><i>Skills</i></p> <p>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.</p> <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>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>Studienleistung</b>	None		
<b>Examination</b>	Written exam		
<b>Examination duration and scale</b>	90 min		
<b>Assignment for the</b>	General Engineering Science (German program): Core qualification: Compulsory General Engineering Science (German program, 7 semester): Core qualification: Compulsory Bioprocess Engineering: Core qualification: Compulsory Energy and Environmental Engineering: Core qualification: Compulsory General Engineering Science (English program): Core qualification: Compulsory General Engineering Science (English program, 7 semester): Core qualification: Compulsory Computational Science and Engineering: Specialisation Engineering Sciences: Elective		

<b>Following Curricula</b>	Compulsory Mechanical Engineering: Core qualification: Compulsory Mechatronics: Core qualification: Compulsory Naval Architecture: Core qualification: Compulsory Technomathematics: Specialisation III. Engineering Science: Elective Compulsory Process Engineering: Core qualification: Compulsory
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<b>Course L0437: Technical Thermodynamics I</b>	
<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. Gerhard Schmitz
<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. Gerhard Schmitz
<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. Gerhard Schmitz
<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

### Courses

Title	Typ	Hrs/wk	CP	
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> The students name the fundamental concepts and laws of statics such as stresses, strains, Hooke's linear law.</p> <p><i>Skills</i> The students apply the mathematical/mechanical analysis and modeling.</p> <p>The students apply the fundamental methods of elasto statics to simply engineering problems.</p> <p>The students estimate the validity and limitations of the introduced methods.</p>			
<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>Studienleistung</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): Core qualification: Compulsory General Engineering Science (German program, 7 semester): Core qualification: Compulsory Civil- and Environmental Engineering: Core qualification: Compulsory Mechanical Engineering: Core qualification: Compulsory Mechatronics: Core qualification: Compulsory Naval Architecture: 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>

Course L0494: Mechanics II	
<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

Course L1691: Mechanics II	
<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
<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

### Courses

Title	Typ	Hrs/wk	CP
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>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>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>		
<i>Knowledge</i>			
<i>Skills</i>			
<b>Personal Competence</b>			
<i>Social Competence</i>			
<i>Autonomy</i>	<ul style="list-style-type: none"> <li>• Students are able to discuss technical information in the lecture supported by activating methods.</li> <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>Studienleistung</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): Core qualification: Compulsory General Engineering Science (German program, 7 semester): Core qualification: Compulsory Energy and Environmental Engineering: Core qualification: Compulsory General Engineering Science (English program): Core qualification: Compulsory Logistics and Mobility: Core qualification: Compulsory Mechanical Engineering: Core qualification: Compulsory Mechatronics: Core qualification: Compulsory Naval Architecture: Core qualification: Compulsory		

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

**Course L0258: Fundamentals of Mechanical Engineering Design**

<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., Bodenstern, F., Springer-Verlag, aktuelle Auflage.</li> <li>• Roloff/Matek Maschinenelemente; Wittel, H., Muhs, D., Jannasch, D., Voßiek, J., Springer Vieweg, aktuelle Auflage.</li> <li>• Sowie weitere Bücher zu speziellen Themen</li> </ul>

Course L0259: Fundamentals of Mechanical Engineering Design	
<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

### Courses

Title	Typ	Hrs/wk	CP
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
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<b>Admission Requirements</b>	None
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<b>Recommended Previous Knowledge</b>	Mathematics I
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<b>Educational Objectives</b>	After taking part successfully, students have reached the following learning results
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<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>
<i>Knowledge</i>	
<i>Skills</i>	
<b>Personal Competence</b>	
<i>Social Competence</i>	<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>
<i>Autonomy</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>Studienleistung</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): Core qualification: Compulsory General Engineering Science (German program, 7 semester): Core qualification: Compulsory Civil- and Environmental Engineering: Core qualification: Compulsory Bioprocess Engineering: Core qualification: Compulsory Electrical Engineering: Core qualification: Compulsory Energy and Environmental Engineering: Core qualification: Compulsory Computational Science and Engineering: 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 Naval Architecture: Core qualification: Compulsory Process Engineering: 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
<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
<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
<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

### Courses

Title	Typ	Hrs/wk	CP
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>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>		
<i>Knowledge</i>			
<i>Skills</i>	<p>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>			
<i>Social Competence</i>	<ul style="list-style-type: none"> <li>• Students are able to discuss technical information in the lecture supported by activating methods.</li> </ul>		
<i>Autonomy</i>	<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>Studienleistung</b>	None		
<b>Examination</b>	Written exam		
<b>Examination duration and scale</b>	120		
	General Engineering Science (German program): Specialisation Mechanical Engineering, Focus Energy Systems: Compulsory		

**Assignment for the  
Following Curricula**

General Engineering Science (German program): Specialisation Mechanical Engineering, Focus Aircraft Systems Engineering: Compulsory

General Engineering Science (German program): Specialisation Mechanical Engineering, Focus Materials in Engineering Sciences: Compulsory

General Engineering Science (German program): Specialisation Mechanical Engineering, Focus Mechatronics: Compulsory

General Engineering Science (German program): Specialisation Mechanical Engineering, Focus Product Development and Production: Compulsory

General Engineering Science (German program): Specialisation Mechanical Engineering, Focus Theoretical Mechanical Engineering: Compulsory

General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Aircraft Systems Engineering: Compulsory

General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Materials in Engineering Sciences: Compulsory

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

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

General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Theoretical Mechanical Engineering: Compulsory

General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Biomechanics: Compulsory

General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Energy Systems: Compulsory

General Engineering Science (English program): Specialisation Mechanical Engineering, Focus Energy Systems: Compulsory

General Engineering Science (English program): Specialisation Mechanical Engineering, Focus Aircraft Systems Engineering: Compulsory

General Engineering Science (English program): Specialisation Mechanical Engineering, Focus Materials in Engineering Sciences: Compulsory

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

General Engineering Science (English program): Specialisation Mechanical Engineering, Focus Product Development and Production: Compulsory

General Engineering Science (English program): Specialisation Mechanical Engineering, Focus Theoretical Mechanical Engineering: Compulsory

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

General Engineering Science (English program, 7 semester): Specialisation Mechanical Engineering, Focus Materials in Engineering Sciences: Compulsory

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

General Engineering Science (English program, 7 semester): Specialisation Mechanical Engineering, Focus Product Development and Production: Compulsory

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

General Engineering Science (English program, 7 semester): Specialisation Mechanical Engineering, Focus Biomechanics: 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>

<b>Course L0265: Advanced Mechanical Engineering Design II</b>	
<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>

<b>Course L0263: Advanced Mechanical Engineering Design I</b>	
<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
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<b>Admission Requirements</b>	None
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<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>
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<b>Educational Objectives</b>	After taking part successfully, students have reached the following learning results
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<b>Professional Competence</b>	<p>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>
<i>Knowledge</i>	
<i>Skills</i>	<p>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>
<b>Personal Competence</b>	
<i>Social Competence</i>	<p>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>
<i>Autonomy</i>	<p>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
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<b>Credit points</b>	6		
<b>Studienleistung</b>	<b>Compulsory Bonus</b>	<b>Form</b>	<b>Description</b>
	Yes	None	Written elaboration
	Yes	None	Written elaboration
	Yes	None	Written elaboration
	Yes	None	Written elaboration
<b>Examination</b>	Written exam		
<b>Examination duration and scale</b>	180		
<b>Assignment for the Following Curricula</b>	<p>General Engineering Science (German program): Specialisation Energy and Environmental Engineering: Compulsory</p> <p>General Engineering Science (German program): Specialisation Mechanical Engineering: Compulsory</p> <p>General Engineering Science (German program): Specialisation Biomedical Engineering: Compulsory</p> <p>General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering: Compulsory</p> <p>General Engineering Science (German program, 7 semester): Specialisation Biomedical Engineering: Compulsory</p> <p>General Engineering Science (German program, 7 semester): Specialisation Energy and Environmental Engineering: Compulsory</p> <p>Energy and Environmental Engineering: Core qualification: Compulsory</p> <p>General Engineering Science (English program): Specialisation Energy and Environmental Engineering: Compulsory</p> <p>General Engineering Science (English program): Specialisation Mechanical Engineering: Compulsory</p> <p>General Engineering Science (English program): Specialisation Biomedical Engineering: Compulsory</p> <p>General Engineering Science (English program, 7 semester): Specialisation Mechanical Engineering: Compulsory</p> <p>General Engineering Science (English program, 7 semester): Specialisation Biomedical Engineering: Compulsory</p> <p>General Engineering Science (English program, 7 semester): Specialisation Energy and Environmental Engineering: Compulsory</p> <p>Mechanical Engineering: Core qualification: Compulsory</p> <p>Mechatronics: Core qualification: Compulsory</p> <p>Naval Architecture: Core qualification: Compulsory</p>		

<b>Course L0268: Embodiment Design and 3D-CAD</b>	
<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., Voßiek, 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>

<b>Course L0267: Team Project Design Methodology</b>	
<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

### Courses

Title	Typ	Hrs/wk	CP
Basics of Electrical Engineering (L0290)	Lecture	3	4
Basics of Electrical Engineering (L0292)	Recitation Section (small)	2	2
<b>Module Responsible</b>	Prof. Thanh Trung Do		
<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>	<p><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.</p> <p><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.</p> <p><b>Personal Competence</b></p> <p><i>Social Competence</i> none</p> <p><i>Autonomy</i> Students are able independently to analyse electric and electronic circuits and to calculate selected quantities in the circuits.</p>		
<b>Workload in Hours</b>	Independent Study Time 110, Study Time in Lecture 70		
<b>Credit points</b>	6		
<b>Studienleistung</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 Energy and Environmental Engineering: Core qualification: Compulsory Logistics and Mobility: Core qualification: Compulsory Mechanical Engineering: Core qualification: Compulsory Naval Architecture: Core qualification: Compulsory Process Engineering: Core qualification: 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. Thanh Trung Do
<b>Language</b>	DE
<b>Cycle</b>	WiSe
<b>Content</b>	<p>DC networks: Current, voltage, power, Kirchhoff's laws, equivalent sources, network analysis</p> <p>AC: Characteristics, RMS, complex representation, phasor diagrams, power</p> <p>Three phase AC: Characteristics, star-delta-connection, power, transformer</p> <p>Elektronics: Principle, operating behaviour and application of electronic devices 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>

Course L0292: Basics of Electrical Engineering	
<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. Thanh Trung Do, Weitere Mitarbeiter
<b>Language</b>	DE
<b>Cycle</b>	WiSe
<b>Content</b>	<p>Exercises to the analysis of circuits and the calculation of electrical quantities with the topics:</p> <p>DC networks: Current, voltage, power, Kirchhoff's laws, equivalent sources, network analysis</p> <p>AC: Characteristics, RMS, complex representation, phasor diagrams, power</p> <p>Three phase AC: Characteristics, star-delta-connection, power, transformer</p> <p>Elektronics: Principle, operating behaviour and application of electronic devices 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. Gerhard Schmitz		
<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></p> <p>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></p> <p>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>		
<b>Personal Competence</b>	<p><i>Social Competence</i></p> <p>The students are able to discuss in small groups and develop an approach.</p>		
<b>Autonomy</b>	<p>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>Studienleistung</b>	None		
<b>Examination</b>	Written exam		
<b>Examination duration and scale</b>	90 min		
	General Engineering Science (German program): Core qualification: Compulsory General Engineering Science (German program, 7 semester): Core qualification: Compulsory		

<b>Assignment for the Following Curricula</b>	Bioprocess Engineering: Core qualification: Compulsory Energy and Environmental Engineering: Core qualification: Compulsory General Engineering Science (English program): Core qualification: Compulsory General Engineering Science (English program, 7 semester): Core qualification: Compulsory Computational Science and Engineering: Specialisation Engineering Sciences: Elective Compulsory Mechanical Engineering: Core qualification: Compulsory Mechatronics: Core qualification: Compulsory Technomathematics: Specialisation III. Engineering Science: Elective Compulsory Technomathematics: Core qualification: Elective Compulsory Process Engineering: Core qualification: Compulsory
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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. Gerhard Schmitz
<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. Gerhard Schmitz
<b>Language</b>	DE
<b>Cycle</b>	WiSe
<b>Content</b>	See interlocking course
<b>Literature</b>	See interlocking course

<b>Course L0451: Technical Thermodynamics II</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>	Prof. Gerhard Schmitz
<b>Language</b>	DE
<b>Cycle</b>	WiSe
<b>Content</b>	See interlocking course
<b>Literature</b>	See interlocking course

## Module M0959: Mechanics III (Hydrostatics, Kinematics, Kinetics I)

### Courses

Title	Typ	Hrs/wk	CP
Mechanics III (Hydrostatics, Kinematics, Kinetics I) (L1134)	Lecture	3	3
Mechanics III (Hydrostatics, Kinematics, Kinetics I) (L1135)	Recitation Section (small)	2	2
Mechanics III (Hydrostatics, Kinematics, Kinetics I) (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>	<p>The students can</p> <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 statics.</li> </ul>		
<i>Knowledge</i>			
<i>Skills</i>	<p>The students can</p> <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>Studienleistung</b>	<b>Compulsory Bonus</b>	<b>Form</b>	<b>Description</b>
	No 20 %	Midterm	Wird nur im WiSe angeboten
<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): Core qualification: Compulsory General Engineering Science (German program, 7 semester): Core qualification: 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 (Hydrostatics, Kinematics, Kinetics I)	
<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>	Hydrostatics 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>
<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).

Course L1135: Mechanics III (Hydrostatics, Kinematics, Kinetics I)	
<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

Course L1136: Mechanics III (Hydrostatics, Kinematics, Kinetics 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. Robert Seifried
<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

**Module Responsible** | Prof. Anusch Taraz

**Admission Requirements** | None

**Recommended Previous Knowledge** | Mathematics I + II

**Educational Objectives** | 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>Studienleistung</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): Core qualification: Compulsory General Engineering Science (German program, 7 semester): Core qualification: Compulsory Civil- and Environmental Engineering: Core qualification: Compulsory Bioprocess Engineering: Core qualification: Compulsory Computer Science: Core qualification: Compulsory Electrical Engineering: Core qualification: Compulsory Energy and Environmental Engineering: Core qualification: Compulsory General Engineering Science (English program): Core qualification: Compulsory General Engineering Science (English program, 7 semester): Core qualification: Compulsory Computational Science and Engineering: Core qualification: Compulsory Computational Science and Engineering: Core qualification: Compulsory Mechanical Engineering: Core qualification: Compulsory Mechatronics: Core qualification: Compulsory Naval Architecture: Core qualification: Compulsory Process Engineering: Core qualification: Compulsory

Course L1028: Analysis III	
<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>	<p>Main features of the theory and numerical treatment of ordinary differential equations</p> <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>

Course L1032: Differential Equations 1 (Ordinary 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>	WiSe
<b>Content</b>	See interlocking course
<b>Literature</b>	See interlocking course

Course L1033: Differential Equations 1 (Ordinary 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>	WiSe
<b>Content</b>	See interlocking course
<b>Literature</b>	See interlocking course

## Module M0865: Fundamentals of Production and Quality Management

### Courses

Title	Typ	Hrs/wk	CP
Production Process Organization (L0925)	Lecture	2	3
Quality Management (L0926)	Lecture	2	3
<b>Module Responsible</b>	Prof. Hermann Lödging		
<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>Studienleistung</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): Specialisation Mechanical Engineering: Elective Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering: Elective Compulsory General Engineering Science (English program): Specialisation Mechanical Engineering: Elective Compulsory General Engineering Science (English program, 7 semester): Specialisation Mechanical Engineering: Elective Compulsory Logistics and Mobility: Specialisation Engineering Science: Elective Compulsory Mechanical Engineering: Core qualification: Elective 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

Course L0926: Quality Management	
<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			
<b>Courses</b>			
<b>Title</b>	<b>Typ</b>	<b>Hrs/wk</b>	<b>CP</b>
Electrical Machines (L0293)	Lecture	3	4
Electrical Machines (L0294)	Recitation Section (large)	2	2
<b>Module Responsible</b>	Prof. Thanh Trung Do		
<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></p> <p>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></p> <p>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></p> <p>none</p> <p><i>Autonomy</i></p> <p>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>Studienleistung</b>	None		
<b>Examination</b>	Written exam		
<b>Examination duration and scale</b>	120 Minuten		
	General Engineering Science (German program): Specialisation Energy and Environmental Engineering: Compulsory General Engineering Science (German program): Specialisation Mechanical Engineering: Elective Compulsory General Engineering Science (German program, 7 semester): Specialisation Energy and Environmental Engineering: Compulsory		

<b>Assignment for the Following Curricula</b>	<p>General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering: Elective 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): Specialisation Energy and Environmental Engineering: Compulsory</p> <p>General Engineering Science (English program): Specialisation Mechanical Engineering: Elective 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 Mechanical Engineering: Elective Compulsory</p> <p>Computational Science and Engineering: Specialisation Engineering Sciences: Elective Compulsory</p> <p>Logistics and Mobility: Specialisation Engineering Science: Elective Compulsory</p> <p>Mechanical Engineering: Core qualification: Elective Compulsory</p> <p>Mechatronics: Core qualification: Compulsory</p>
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Course L0293: Electrical Machines	
<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. Thanh Trung Do
<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</p> <p>Magnetic field: force, flux line, Ampere's law, field at boundaries, flux, magnetic circuit, hysteresis, induction, self-induction, mutual inductance, transformer</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 (Squirrelcage vs. sliprings),</p> <p>Synchronous machines, construction and layout, equivalent single line diagrams, no-load and short-circuit characteristics, vector diagrams, motor and generator operation</p> <p>drives with variable speed, inverter fed operation, special drives, step motors,</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>

<b>Course L0294: Electrical Machines</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. Thanh Trung Do, Weitere Mitarbeiter
<b>Language</b>	DE
<b>Cycle</b>	SoSe
<b>Content</b>	<p>Exercises to the application of electric and magnetic fields.</p> <p>Exercises to the operational performance of electric machines.</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>

Module M0680: Fluid Dynamics			
<b>Courses</b>			
<b>Title</b>	<b>Typ</b>	<b>Hrs/wk</b>	<b>CP</b>
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>			
<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.		
<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.		
<b>Personal Competence</b>			
<i>Social Competence</i>	The students are able to discuss problems and jointly develop solution strategies.		
<i>Autonomy</i>	The students are able to develop solution strategies for complex problems self-consistent and critically analyse results.		
<b>Workload in Hours</b>	Independent Study Time 110, Study Time in Lecture 70		
<b>Credit points</b>	6		
<b>Studienleistung</b>	None		
<b>Examination</b>	Written exam		
<b>Examination duration and scale</b>	180 min		
	General Engineering Science (German program): Specialisation Mechanical Engineering: Compulsory General Engineering Science (German program): Specialisation Biomedical Engineering: Compulsory General Engineering Science (German program): Specialisation Naval Architecture: Compulsory 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 (English program): Specialisation Mechanical Engineering:		

<b>Assignment for the Following Curricula</b>	Compulsory General Engineering Science (English program): Specialisation Biomedical Engineering: Compulsory General Engineering Science (English program): Specialisation Naval Architecture: 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 Naval Architecture: Compulsory Computational Science and Engineering: Specialisation Engineering Sciences: Elective Compulsory Mechanical Engineering: Core qualification: Compulsory Naval Architecture: Core qualification: Compulsory Technomathematics: Specialisation III. Engineering Science: Elective Compulsory
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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
<b>Cycle</b>	SoSe
<b>Content</b>	<ul style="list-style-type: none"> <li>• Overview</li> <li>• Physical/mathematical modelling</li> <li>• Special phenomena</li> <li>• Basic equations of fluid dynamics</li> <li>• The turbulence problem</li> <li>• One dimensional theory for inkompressibel flows</li> <li>• One dimensional theory for kompressibel flows</li> <li>• Flow over contours without friction</li> <li>• Flow over contours with friction</li> <li>• Flow through channels</li> <li>• Simplified equations for three dimensional flow</li> <li>• Special aspects of the numerical solution for complex flows</li> </ul>
<b>Literature</b>	<ul style="list-style-type: none"> <li>• Herwig, H.: Strömungsmechanik, 2. Auflage, Springer- Verlag, Berlin, Heidelberg, 2006</li> <li>• Herwig, H.: Strömungsmechanik von A-Z, Vieweg Verlag, Wiesbaden, 2004</li> </ul>

<b>Course L0455: Fluid Mechanics</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. Thomas Rung
<b>Language</b>	DE
<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> <b>CP</b>
Advanced Materials Characterization (L1087)		Lecture	2            2
Advanced Materials Design (L1091)		Lecture	2            2
Advanced Materials Design (L1092)		Recitation Section (large)	2            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>Studienleistung</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): Specialisation Mechanical Engineering: Elective Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering: Elective Compulsory General Engineering Science (English program): Specialisation Mechanical Engineering: Elective Compulsory General Engineering Science (English program, 7 semester): Specialisation Mechanical Engineering: Elective Compulsory Mechanical Engineering: Core qualification: Elective Compulsory		

<b>Course L1087: Advanced Materials Characterization</b>	
<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).

<b>Course L1091: Advanced Materials Design</b>	
<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. 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 (Kinetics II, Oscillations, Analytical Mechanics, Multibody Systems)

### Courses

Title	Typ	Hrs/wk	CP
Mechanics IV (Kinetics II, Oscillations, Analytical Mechanics, Multibody Systems) (L1137)	Lecture	3	3
Mechanics IV (Kinetics II, Oscillations, Analytical Mechanics, Multibody Systems) (L1138)	Recitation Section (small)	2	2
Mechanics IV (Kinetics II, Oscillations, Analytical Mechanics, Multibody Systems) (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>	<p>The students can</p> <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>	<p>The students can</p> <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>Studienleistung</b>	<b>Compulsory Bonus</b>	<b>Form</b>	<b>Description</b>
	No 20 %	Midterm	Wird nur im SoSe angeboten
<b>Examination</b>	Written exam		
<b>Examination duration and scale</b>	120 min		
	General Engineering Science (German program): Specialisation Mechanical Engineering: Compulsory General Engineering Science (German program): Specialisation Biomedical Engineering: Compulsory General Engineering Science (German program): Specialisation Naval Architecture:		

<b>Assignment for the Following Curricula</b>	Compulsory 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 (English program): Specialisation Mechanical Engineering: Compulsory General Engineering Science (English program): Specialisation Biomedical Engineering: Compulsory General Engineering Science (English program): Specialisation Naval Architecture: 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 Naval Architecture: Compulsory Mechanical Engineering: Core qualification: Compulsory Mechatronics: Core qualification: Compulsory Naval Architecture: Core qualification: Compulsory Technomathematics: Specialisation III. Engineering Science: Elective Compulsory Technomathematics: Core qualification: Elective Compulsory Theoretical Mechanical Engineering: Technical Complementary Course Core Studies: Elective Compulsory
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Course L1137: Mechanics IV (Kinetics II, Oscillations, Analytical Mechanics, Multibody Systems)	
<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>• Simple impact problems</li> <li>• Principles of analytical mechanics</li> <li>• Elements of vibration theory</li> <li>• Vibration of Multi-degree of freedom systems</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 (Kinetics II, Oscillations, Analytical Mechanics, Multibody 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. 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 (Kinetics II, Oscillations, Analytical Mechanics, Multibody Systems)</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>	<p>After passing the module, students are able to:</p> <ul style="list-style-type: none"> <li>express the procedure for systematically handling of</li> <li>complex design tasks ,</li> <li>describe working principles, their use and combination possibilities,</li> <li>explain guidelines for designing for function and manufacturing,</li> <li>explain advanced use-oriented knowledge of machine elements.</li> </ul>		
<i>Knowledge</i>	<p>After passing the module, students are able to:</p> <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>		
<i>Skills</i>	<p>After passing the module, students are able to:</p> <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>		
<b>Personal Competence</b>	<p>After passing the module, students are able to:</p> <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>		
<i>Social Competence</i>	<p>After passing the module, students are able to:</p> <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>		
<i>Autonomy</i>	<p>After passing the module, students are able to:</p> <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>Studienleistung</b>	<b>Compulsory Bonus</b>	<b>Form</b>	<b>Description</b>
	Yes          None	Attestation	
<b>Examination</b>	Written exam		
<b>Examination duration and scale</b>	180		
	General Engineering Science (German program): Specialisation Mechanical Engineering,		

<p><b>Assignment for the Following Curricula</b></p>	<p>Focus Aircraft Systems Engineering: Compulsory                  General Engineering Science (German program): Specialisation Mechanical Engineering,                  Focus Product Development and Production: Compulsory                  General Engineering Science (German program): Specialisation Mechanical Engineering,                  Focus Theoretical Mechanical Engineering: Compulsory                  General Engineering Science (German program, 7 semester): Specialisation Mechanical                  Engineering, Focus Aircraft Systems Engineering: Compulsory                  General Engineering Science (German program, 7 semester): Specialisation Mechanical                  Engineering, Focus Product Development and Production: Compulsory                  General Engineering Science (German program, 7 semester): Specialisation Mechanical                  Engineering, Focus Theoretical Mechanical Engineering: Compulsory                  General Engineering Science (English program): Specialisation Mechanical Engineering,                  Focus Aircraft Systems Engineering: Compulsory                  General Engineering Science (English program): Specialisation Mechanical Engineering,                  Focus Product Development and Production: Compulsory                  General Engineering Science (English program): Specialisation Mechanical Engineering,                  Focus Theoretical Mechanical Engineering: 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</p>
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<b>Course L0266: Advanced Mechanical Design Project</b>	
<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

<b>Courses</b>			
<b>Title</b>	<b>Typ</b>	<b>Hrs/wk</b>	<b>CP</b>
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>	<div style="display: flex; justify-content: space-between;"> <div style="width: 15%;"><i>Knowledge</i></div> <div> <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> </div> </div>		
<i>Skills</i>	<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>		
<b>Personal Competence</b>	<div style="display: flex; justify-content: space-between;"> <div style="width: 15%;"><i>Social Competence</i></div> <div>Students can work in small groups to jointly solve technical problems, and experimentally validate their controller designs</div> </div>		
<i>Autonomy</i>	<div style="display: flex; justify-content: space-between;"> <div style="width: 15%;"></div> <div>Students can obtain information from provided sources (lecture notes, software documentation, experiment guides) and use it when solving given problems.</div> </div> <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>Studienleistung</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): Core qualification: Compulsory</p> <p>General Engineering Science (German program, 7 semester): Specialisation Computer Science: Compulsory</p> <p>General Engineering Science (German program, 7 semester): Specialisation Bioprocess Engineering: Compulsory</p> <p>General Engineering Science (German program, 7 semester): Specialisation Naval Architecture: Compulsory</p> <p>General Engineering Science (German program, 7 semester): Specialisation Civil Engineering: Compulsory</p> <p>General Engineering Science (German program, 7 semester): Specialisation Electrical Engineering: Compulsory</p> <p>General Engineering Science (German program, 7 semester): Specialisation Biomedical Engineering: Compulsory</p> <p>General Engineering Science (German program, 7 semester): Specialisation Energy and Environmental Engineering: Compulsory</p> <p>General Engineering Science (German program, 7 semester): Specialisation Process Engineering: 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 Biomechanics: Compulsory</p> <p>General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Aircraft Systems Engineering: Compulsory</p> <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 Theoretical Mechanical Engineering: Compulsory</p> <p>General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Product Development and Production: Compulsory</p> <p>General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Energy Systems: Compulsory</p> <p>Bioprocess Engineering: Core qualification: Compulsory</p> <p>Computer Science: Specialisation Computational Mathematics: 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): Core qualification: Compulsory</p> <p>General Engineering Science (English program, 7 semester): Specialisation Computer Science: Compulsory</p> <p>General Engineering Science (English program, 7 semester): Specialisation Bioprocess 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 Civil Engineering: Compulsory</p> <p>General Engineering Science (English program, 7 semester): Specialisation Electrical Engineering: Compulsory</p> <p>General Engineering Science (English program, 7 semester): Specialisation Biomedical 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 Process Engineering: 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</p>

Engineering, Focus Biomechanics: Compulsory
General Engineering Science (English program, 7 semester): Specialisation Mechanical Engineering, Focus Aircraft Systems Engineering: Compulsory
General Engineering Science (English program, 7 semester): Specialisation Mechanical Engineering, Focus Materials in Engineering Sciences: Compulsory
General Engineering Science (English program, 7 semester): Specialisation Mechanical Engineering, Focus Theoretical Mechanical Engineering: Compulsory
General Engineering Science (English program, 7 semester): Specialisation Mechanical Engineering, Focus Product Development and Production: Compulsory
General Engineering Science (English program, 7 semester): Specialisation Mechanical Engineering, Focus Energy Systems: Compulsory
Computational Science and Engineering: Core qualification: Compulsory
Computational Science and Engineering: Core qualification: Compulsory
Logistics and Mobility: Specialisation Engineering Science: 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

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 and Process Engineers

### Courses

Title	Typ	Hrs/wk	CP
Practical Course: Measurement and Control Systems (L1119)	Practical Course	2	2
Measurement Technology for Mechanical and Process Engineers (L1116)	Lecture	2	3
Measurement Technology for Mechanical and Process Engineers (L1118)	Recitation Section (large)	1	1
<b>Module Responsible</b>	Dr. Sven Krause		
<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>	<p>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).</p> <p><i>Knowledge</i> They can outline the most important measuring methods for different kinds of quantities to be measured (Electrical Quantities, Temperature, mechanical quantities, Flow, Time, Frequency).</p> <p>They can describe important methods of chemical Analysis (Gas Sensors, Spectroscopy, Gas Chromatography)</p> <p>Students can select suitable measuring methods to given problems and can use referring measurement devices in practice.</p> <p><i>Skills</i> 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.</p>		
<b>Personal Competence</b>	<p><i>Social Competence</i> Students can arrive at work results in groups and document them in a common report.</p> <p><i>Autonomy</i> Students are able to familiarize themselves with new measurement technologies.</p>		
<b>Workload in Hours</b>	Independent Study Time 110, Study Time in Lecture 70		
<b>Credit points</b>	6		
<b>Studienleistung</b>	<b>Compulsory Bonus</b>	<b>Form</b>	<b>Description</b>
	Yes          None	Subject    theoretical    and practical work	
<b>Examination</b>	Written exam		
<b>Examination duration and scale</b>	105 minutes		
	General Engineering Science (German program): Specialisation Energy and Environmental Engineering: Compulsory General Engineering Science (German program): Specialisation Mechanical Engineering:		

<p><b>Assignment for the Following Curricula</b></p>	<p>Compulsory                  General Engineering Science (German program): Specialisation Biomedical Engineering: Compulsory                  General Engineering Science (German program): Specialisation Process Engineering: Compulsory                  General Engineering Science (German program, 7 semester): Specialisation Energy and Environmental Engineering: Compulsory                  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 Process Engineering: Compulsory                  Energy and Environmental Engineering: Core qualification: Compulsory                  General Engineering Science (English program): Specialisation Energy and Environmental Engineering: Compulsory                  General Engineering Science (English program): Specialisation Mechanical Engineering: Compulsory                  General Engineering Science (English program): Specialisation Biomedical Engineering: Compulsory                  General Engineering Science (English program): Specialisation Process Engineering: 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 Process Engineering: Compulsory                  Mechanical Engineering: Core qualification: Compulsory                  Mechatronics: Core qualification: Compulsory                  Process Engineering: Core qualification: Compulsory</p>
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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>	NN
<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 and Process Engineers	
<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. Sven Krause
<b>Language</b>	DE
<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> <p>4 Chemical Analysis</p> <p>4.1 Gas Sensors</p> <p>4.2 Spectroscopy</p> <p>4.3 Gas Chromatography</p> <p>At the end of each lecture students present single measuring techniques and results orally in front of the class.</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>

<b>Course L1118: Measurement Technology for Mechanical and Process Engineers</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>	Dr. Sven Krause
<b>Language</b>	DE
<b>Cycle</b>	WiSe
<b>Content</b>	See interlocking course
<b>Literature</b>	See interlocking course

## Module M0829: Foundations of Management

### Courses

Title	Typ	Hrs/wk	CP
Management Tutorial (L0882)	Recitation Section (large)	2	3
Introduction to Management (L0880)	Lecture	3	3

<b>Module Responsible</b>	Prof. Christoph Ihl
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<b>Admission Requirements</b>	None
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<b>Recommended Previous Knowledge</b>	Basic Knowledge of Mathematics and Business
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<b>Educational Objectives</b>	After taking part successfully, students have reached the following learning results
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<b>Professional Competence</b>	<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>
<i>Knowledge</i>	
<b>Skills</b>	<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>
<b>Personal Competence</b>	
<i>Social Competence</i>	<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>Students are able to</p>

<i>Autonomy</i>	<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>Studienleistung</b>	None
<b>Examination</b>	Subject theoretical and practical work
<b>Examination duration and scale</b>	several written exams during the semester
	<p>General Engineering Science (German program): Specialisation Electrical Engineering: Compulsory</p> <p>General Engineering Science (German program): Specialisation Computer Science: Compulsory</p> <p>General Engineering Science (German program): Specialisation Process Engineering: Compulsory</p> <p>General Engineering Science (German program): Specialisation Bioprocess Engineering: Compulsory</p> <p>General Engineering Science (German program): Specialisation Energy and Environmental Engineering: Compulsory</p> <p>General Engineering Science (German program): Specialisation Civil- and Environmental Engineering: Compulsory</p> <p>General Engineering Science (German program): Specialisation Mechanical Engineering: Compulsory</p> <p>General Engineering Science (German program): Specialisation Biomedical Engineering: Compulsory</p> <p>General Engineering Science (German program): Specialisation Naval Architecture: Compulsory</p> <p>General Engineering Science (German program, 7 semester): Specialisation Electrical Engineering: Compulsory</p> <p>General Engineering Science (German program, 7 semester): Specialisation Process Engineering: Compulsory</p> <p>General Engineering Science (German program, 7 semester): Specialisation Biomedical Engineering: Compulsory</p> <p>General Engineering Science (German program, 7 semester): Specialisation Naval Architecture: Compulsory</p> <p>General Engineering Science (German program, 7 semester): Specialisation Computer Science: Compulsory</p> <p>General Engineering Science (German program, 7 semester): Specialisation Bioprocess Engineering: Compulsory</p> <p>General Engineering Science (German program, 7 semester): Specialisation Civil Engineering: Compulsory</p> <p>General Engineering Science (German program, 7 semester): Specialisation Energy and Environmental Engineering: 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 Biomechanics: Compulsory</p> <p>General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Aircraft Systems Engineering: Compulsory</p> <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 Theoretical Mechanical Engineering: Compulsory</p> <p>General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Product Development and Production: Compulsory</p> <p>General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Energy Systems: Compulsory</p> <p>Civil- and Environmental Engineering: Core qualification: Compulsory</p> <p>Bioprocess Engineering: Core qualification: Compulsory</p>

**Assignment for the  
Following Curricula**

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

<b>Course L0882: Management Tutorial</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. Christoph Ihl, Katharina Roedelius, Tobias Vlcek
<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 self-selected projects that focus on the elaboration of an innovative business idea from the point of view of an established company or a startup. Again, the business knowledge from the lecture should come to practical use. The group projects are guided by a mentor.</p>
<b>Literature</b>	Relevante Literatur aus der korrespondierenden Vorlesung.

<b>Course L0880: Introduction to Management</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. Christoph Ihl, Prof. Thorsten Blecker, Prof. Christian Lühje, 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./Weißberger, 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></p> <p>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></p> <p>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>		
<b>Personal Competence</b>	<p><i>Social Competence</i></p> <p>The students can participate in current discussions in biomedical research and medicine on a professional level.</p> <p><i>Autonomy</i></p> <p>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>Studienleistung</b>	None		
<b>Examination</b>	Written exam		
<b>Examination duration and scale</b>	90 minutes		
	General Engineering Science (German program): Specialisation Mechanical Engineering, Focus Biomechanics: Compulsory General Engineering Science (German program): Specialisation Biomedical Engineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Biomedical Engineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Biomechanics: Compulsory		

<b>Assignment for the Following Curricula</b>	Electrical Engineering: Specialisation Medical Technology: Elective Compulsory General Engineering Science (English program): Specialisation Mechanical Engineering, Focus Biomechanics: Compulsory General Engineering Science (English program): Specialisation Biomedical Engineering: Compulsory General Engineering Science (English program, 7 semester): Specialisation Mechanical Engineering, Focus Biomechanics: Compulsory General Engineering Science (English program, 7 semester): Specialisation Biomedical Engineering: Compulsory 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
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Course L0384: Introduction to Anatomy	
<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, 16. Auflage, Thieme Verlag Stuttgart, 2012

## 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
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<b>Admission Requirements</b>	None
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<b>Recommended Previous Knowledge</b>	None
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<b>Educational Objectives</b>	After taking part successfully, students have reached the following learning results
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<b>Professional Competence</b>	<p><b>Therapy</b> 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>
<i>Knowledge</i>	<p><b>Diagnostics</b> The students can illustrate the technical base concepts of projection radiography, including angiography and mammography, as well as sectional imaging techniques (CT, MRT, US).</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>
<i>Skills</i>	<p><b>Therapy</b> 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> The students can suggest solutions for repairs of imaging instrumentation after having done error analyses.</p>

<b>Personal Competence</b>	The students can classify results of imaging techniques according to different groups of diseases based on their knowledge of anatomy, pathology and pathophysiology.
	<i>Social Competence</i> The students can assess the special social situation of tumor patients and interact with them in a professional way. The students are aware of the special, often fear-dominated behavior of sick people caused by diagnostic and therapeutic measures and can meet them appropriately.
	<i>Autonomy</i> The students can apply their new knowledge and skills to a concrete therapy case. The students can introduce younger students to the clinical daily routine. The students are able to access anatomical knowledge by themselves, can participate competently in conversations on the topic and acquire the relevant knowledge themselves.
<b>Workload in Hours</b>	Independent Study Time 62, Study Time in Lecture 28
<b>Credit points</b>	3
<b>Studienleistung</b>	None
<b>Examination</b>	Written exam
<b>Examination duration and scale</b>	90 minutes
<b>Assignment for the Following Curricula</b>	<p>General Engineering Science (German program): Specialisation Mechanical Engineering, Focus Biomechanics: Compulsory</p> <p>General Engineering Science (German program): Specialisation Biomedical Engineering: Compulsory</p> <p>General Engineering Science (German program, 7 semester): Specialisation Biomedical Engineering: Compulsory</p> <p>General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Biomechanics: Compulsory</p> <p>Electrical Engineering: Specialisation Medical Technology: Elective Compulsory</p> <p>General Engineering Science (English program): Specialisation Mechanical Engineering, Focus Biomechanics: Compulsory</p> <p>General Engineering Science (English program): Specialisation Biomedical Engineering: 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 Biomedical Engineering: Compulsory</p> <p>Mechanical Engineering: Specialisation Biomechanics: Compulsory</p> <p>Biomedical Engineering: Specialisation Medical Technology and Control Theory: Elective Compulsory</p> <p>Biomedical Engineering: Specialisation Management and Business Administration: Elective Compulsory</p> <p>Biomedical Engineering: Specialisation Artificial Organs and Regenerative Medicine: Elective Compulsory</p> <p>Biomedical Engineering: Specialisation Implants and Endoprostheses: Elective Compulsory</p> <p>Technomathematics: Specialisation III. Engineering Science: Elective Compulsory</p>

Course L0383: Introduction to Radiology and Radiation Therapy	
<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

<p><b>Cycle</b> SoSe</p> <p><b>Content</b></p>	<p>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</p>
<p><b>Literature</b></p>	<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>	<p>The students can</p> <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>Knowledge</i>			
<i>Skills</i>	<p>The students can</p> <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>Studienleistung</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): Specialisation Mechanical Engineering, Focus Biomechanics: Compulsory General Engineering Science (German program): Specialisation Biomedical Engineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Biomedical Engineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Biomechanics: Compulsory Electrical Engineering: Specialisation Medical Technology: Elective Compulsory General Engineering Science (English program): Specialisation Mechanical Engineering, Focus Biomechanics: Compulsory General Engineering Science (English program): Specialisation Biomedical Engineering: Compulsory General Engineering Science (English program, 7 semester): Specialisation Mechanical Engineering, Focus Biomechanics: Compulsory General Engineering Science (English program, 7 semester): Specialisation Biomedical		

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

Course L0386: Introduction to Biochemistry and Molecular Biology	
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<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

<b>Courses</b>			
<b>Title</b>	<b>Typ</b>	<b>Hrs/wk</b>	<b>CP</b>
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>	The students can describe the different ways how bones heal, and the requirements for their existence.		
<i>Knowledge</i>	The students can name different treatments for the spine and hollow bones under given fracture morphologies.		
<i>Skills</i>	The students can determine the forces acting within the human body under quasi-static situations under specific assumptions.		
<b>Personal Competence</b>	The students can, in groups, solve basic numerical modeling tasks for the calculation of internal forces.		
<i>Social Competence</i>	The students can, in groups, solve basic numerical modeling tasks for the calculation of internal forces.		
<i>Autonomy</i>	The students can, in groups, solve basic numerical modeling tasks for the calculation of internal forces.		
<b>Workload in Hours</b>	Independent Study Time 62, Study Time in Lecture 28		
<b>Credit points</b>	3		
<b>Studienleistung</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): Specialisation Mechanical Engineering, Focus Biomechanics: Compulsory General Engineering Science (German program): 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 Biomedical Engineering: Compulsory General Engineering Science (English program): Specialisation Biomedical Engineering: Compulsory General Engineering Science (English program): Specialisation Mechanical Engineering, Focus Biomechanics: Compulsory General Engineering Science (English program, 7 semester): Specialisation Mechanical Engineering, Focus Biomechanics: Compulsory General Engineering Science (English program, 7 semester): Specialisation Biomedical Engineering: Compulsory Mechanical Engineering: Specialisation Biomechanics: Compulsory Biomedical Engineering: Specialisation Artificial Organs and Regenerative Medicine: Elective		

Compulsory

Biomedical Engineering: Specialisation Implants and Endoprotheses: Elective Compulsory

Biomedical Engineering: Specialisation Medical Technology and Control Theory: Elective Compulsory

Biomedical Engineering: Specialisation Management and Business Administration: Elective Compulsory

Technomathematics: Specialisation III. Engineering Science: Elective Compulsory

Course 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>	<b>CP</b>
Introduction to Physiology (L0385)	Lecture	2	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>	The students can		
<i>Knowledge</i>	<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>Studienleistung</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): Specialisation Mechanical Engineering, Focus Biomechanics: Compulsory General Engineering Science (German program): Specialisation Biomedical Engineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Biomedical Engineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Biomechanics: Compulsory Electrical Engineering: Specialisation Medical Technology: Elective Compulsory General Engineering Science (English program): Specialisation Mechanical Engineering, Focus Biomechanics: Compulsory General Engineering Science (English program): Specialisation Biomedical Engineering: Compulsory General Engineering Science (English program, 7 semester): Specialisation Mechanical Engineering, Focus Biomechanics: Compulsory General Engineering Science (English program, 7 semester): Specialisation Biomedical		

	Engineering: Compulsory 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 Endoprotheses: Elective Compulsory Technomathematics: Core qualification: Elective Compulsory Technomathematics: Specialisation III. Engineering Science: Elective Compulsory
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<b>Course L0385: Introduction to Physiology</b>	
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<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. Roger Zimmermann
<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>	<p>The students can describe the different ways how bones heal, and the requirements for their existence.</p> <p>The students can name different treatments for the spine and hollow bones under given fracture morphologies.</p> <p>The students can describe different measurement techniques for forces and movements, and choose the adequate technique for a given task.</p>		
<i>Knowledge</i>			
<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>Studienleistung</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): Specialisation Mechanical Engineering, Focus Biomechanics: Compulsory General Engineering Science (German program): 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 Biomedical Engineering: Compulsory General Engineering Science (English program): Specialisation Biomedical Engineering: Compulsory General Engineering Science (English program): Specialisation Mechanical Engineering, Focus Biomechanics: Compulsory General Engineering Science (English program, 7 semester): Specialisation Mechanical Engineering, Focus Biomechanics: Compulsory General Engineering Science (English program, 7 semester): Specialisation Biomedical Engineering: Compulsory Mechanical Engineering: Specialisation Biomechanics: Compulsory		

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

Course L0377: Experimental Methods in Biomechanics	
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<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.

<b>Module M0639: Gas and Steam Power Plants</b>	
<b>Courses</b>	
<b>Title</b>	<b>Typ</b>
Gas and Steam Power Plants (L0206)	Lecture
Gas and Steam Power Plants (L0210)	Recitation Section (large)
<b>Hrs/wk</b>	<b>CP</b>
3	4
2	2
<b>Module Responsible</b>	Prof. Alfons Kather
<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></p> <p>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></p> <p>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> <p><i>Personal Competence</i></p>

<p><i>Social Competence</i></p>	<p>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></p>	<p>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>		
<p><b>Workload in Hours</b></p>	<p>Independent Study Time 110, Study Time in Lecture 70</p>		
<p><b>Credit points</b></p>	<p>6</p>		
<p><b>Studienleistung</b></p>	<p><b>Compulsory Bonus</b></p>	<p><b>Form</b></p>	<p><b>Description</b></p>
<p>No</p>	<p>5 %</p>	<p>Attestation</p>	<p>15-minütiges, unbenotetes Testat über EBSILON Professional; nur bestanden/nicht bestanden (keine anteiligen Punkte)</p>
<p>No</p>	<p>5 %</p>	<p>Excercises</p>	<p>10 Übungsaufgaben im Laufe der Vorlesungen à 5 Minuten; bis zu 5 % Bonus je nach Anteil richtiger Abgaben</p>
<p><b>Examination</b></p>	<p>Written exam</p>		
<p><b>Examination duration and scale</b></p>	<p>Written examination of 120 min</p>		
<p><b>Assignment for the Following Curricula</b></p>	<p>General Engineering Science (German program): Specialisation Energy and Enviromental Engineering: Compulsory                  General Engineering Science (German program): Specialisation Mechanical Engineering, Focus Energy Systems: Compulsory                  General Engineering Science (German program, 7 semester): Specialisation Energy and Enviromental Engineering: Compulsory                  General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Energy Systems: Elective Compulsory                  Energy and Environmental Engineering: Core qualification: Compulsory                  General Engineering Science (English program): Specialisation Energy and Enviromental Engineering: Compulsory                  General Engineering Science (English program): Specialisation Mechanical Engineering, Focus Energy Systems: Compulsory                  General Engineering Science (English program, 7 semester): Specialisation Energy and Enviromental Engineering: Compulsory                  General Engineering Science (English program, 7 semester): Specialisation Mechanical Engineering, Focus Energy Systems: Elective Compulsory                  Mechanical Engineering: Specialisation Energy Systems: Compulsory</p>		

Course L0206: Gas and Steam Power Plants	
<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. Alfons Kather
<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>	2
<b>CP</b>	2
<b>Workload in Hours</b>	Independent Study Time 32, Study Time in Lecture 28
<b>Lecturer</b>	Prof. Alfons Kather

<p><b>Language Cycle</b></p>	<p>DE WiSe</p>
<p><b>Content</b></p>	<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>
<p><b>Literature</b></p>	<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>

## 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>	The students are able to		
<i>Knowledge</i>	<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>		
<i>Skills</i>	<ul style="list-style-type: none"> <li>The students are able to</li> <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>		
<b>Personal Competence</b>	The students are able to discuss in small groups and develop an approach.		
<i>Social Competence</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.		
<i>Autonomy</i>			
<b>Workload in Hours</b>	Independent Study Time 110, Study Time in Lecture 70		
<b>Credit points</b>	6		
<b>Studienleistung</b>	None		
<b>Examination</b>	Written exam		
<b>Examination duration and scale</b>	120 min		
	General Engineering Science (German program): Specialisation Mechanical Engineering, Focus Biomechanics: Compulsory General Engineering Science (German program): Specialisation Mechanical Engineering, Focus Energy Systems: Compulsory General Engineering Science (German program): Specialisation Biomedical Engineering: Compulsory General Engineering Science (German program): Specialisation Mechanical Engineering, Focus Theoretical Mechanical Engineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Energy Systems: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Theoretical Mechanical Engineering: Compulsory		

<b>Assignment for the Following Curricula</b>	General Engineering Science (German program, 7 semester): Specialisation Biomedical Engineering: Compulsory General Engineering Science (English program): Specialisation Biomedical Engineering: Compulsory General Engineering Science (English program): Specialisation Mechanical Engineering, Focus Biomechanics: Compulsory General Engineering Science (English program): Specialisation Mechanical Engineering, Focus Energy Systems: Compulsory General Engineering Science (English program): Specialisation Mechanical Engineering, Focus Theoretical Mechanical Engineering: 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 Theoretical Mechanical Engineering: Compulsory General Engineering Science (English program, 7 semester): Specialisation Biomedical Engineering: Compulsory Mechanical Engineering: Specialisation Energy Systems: Compulsory Mechanical Engineering: Specialisation Theoretical Mechanical Engineering: Compulsory
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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, convective heat transfer, Two- phase heat transfer (evaporation, condensation), thermal radiation, heat exchangers, measurement methods
<b>Literature</b>	- Herwig, H.; Moschallski, A.: Wärmeübertragung, 3. Auflage, Springer Vieweg Verlag, Wiesbaden, 2014 - 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>				
<b>Title</b>	<b>Typ</b>	<b>Hrs/wk</b>	<b>CP</b>	
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></p> <p>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></p> <p>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></p> <p>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></p> <p>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>Studienleistung</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): Specialisation Mechanical Engineering, Focus Energy Systems: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Energy Systems: Compulsory General Engineering Science (English program): Specialisation Mechanical Engineering, Focus Energy Systems: Compulsory General Engineering Science (English program, 7 semester): Specialisation Mechanical Engineering, Focus Energy Systems: Compulsory Mechanical Engineering: Specialisation Energy Systems: Compulsory

<b>Course L0633: Fundamentals of Reciprocating Engines and Turbomachinery - Part Reciprocating Engines</b>
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<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>

Course L0639: Internal Combustion Engines I	
<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

## 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>	Prof. Uwe Weltin
<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>Studienleistung</b>	None
<b>Examination</b>	Written exam
<b>Examination duration and scale</b>	90 min
	General Engineering Science (German program): Specialisation Mechanical Engineering, Focus Mechatronics: Compulsory General Engineering Science (German program): Specialisation Mechanical Engineering, Focus Aircraft Systems Engineering: Compulsory General Engineering Science (German program): Specialisation Mechanical Engineering, Focus Theoretical Mechanical Engineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical

<b>Assignment for the Following Curricula</b>	Engineering, Focus Mechatronics: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Aircraft Systems Engineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Theoretical Mechanical Engineering: Elective Compulsory General Engineering Science (English program): Specialisation Mechanical Engineering, Focus Aircraft Systems Engineering: Compulsory General Engineering Science (English program): Specialisation Mechanical Engineering, Focus Mechatronics: Compulsory General Engineering Science (English program): Specialisation Mechanical Engineering, Focus Theoretical Mechanical 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 Aircraft Systems Engineering: Compulsory General Engineering Science (English program, 7 semester): Specialisation Mechanical Engineering, Focus Theoretical Mechanical Engineering: Elective Compulsory Mechanical Engineering: Specialisation Aircraft Systems Engineering: Compulsory Mechanical Engineering: Specialisation Mechatronics: Compulsory Mechanical Engineering: Specialisation Theoretical Mechanical Engineering: Compulsory Mechatronics: Core qualification: Compulsory
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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>	Prof. Uwe Weltin
<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>	Prof. Uwe Weltin
<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>	Prof. Uwe Weltin
<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:		
<i>Knowledge</i>	<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>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:		
<i>Social Competence</i>	<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>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>Studienleistung</b>	<b>Compulsory Bonus</b>	<b>Form</b>	<b>Description</b>
	Yes      20 %	Subject      theoretical	and CAE-Teamprojekt inkl. Vortrag und

	practical work	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): Specialisation Mechanical Engineering, Focus Aircraft Systems Engineering: Compulsory General Engineering Science (German program): Specialisation Mechanical Engineering, Focus Product Development and Production: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Aircraft Systems Engineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Product Development and Production: Compulsory General Engineering Science (English program): Specialisation Mechanical Engineering, Focus Aircraft Systems Engineering: Compulsory General Engineering Science (English program): 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 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>	<p><b>Description</b></p> <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>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

### Courses

<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>			
<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.		
<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.		
<b>Personal Competence</b>			
<i>Social Competence</i>	Students are made aware of interdisciplinary communication in groups.		
<i>Autonomy</i>	Students are able to independently analyze different system concepts and their technical implementation as well as to think system oriented.		
<b>Workload in Hours</b>	Independent Study Time 96, Study Time in Lecture 84		
<b>Credit points</b>	6		
<b>Studienleistung</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): Specialisation Mechanical Engineering, Focus Aircraft Systems Engineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Aircraft Systems Engineering: Compulsory General Engineering Science (English program): Specialisation Mechanical Engineering, Focus Aircraft Systems Engineering: Compulsory General Engineering Science (English program, 7 semester): Specialisation Mechanical Engineering, Focus Aircraft Systems Engineering: Compulsory Logistics and Mobility: Specialisation Logistics and Mobility: Elective Compulsory Mechanical Engineering: Specialisation Aircraft Systems Engineering: Compulsory		

<b>Course L0741: Fundamentals of Aircraft Systems</b>	
<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>	<ul style="list-style-type: none"> <li>- Development of aircrafts, fundamentals of flight physics, propulsion systems, analysis of ranges and loads, aircraft-structures and materials</li> <li>- Hydraulic and electrical power systems, landing gear systems, flight-control and high-lift systems, air conditioning systems</li> </ul>
<b>Literature</b>	<ul style="list-style-type: none"> <li>- Shevell, R. S.: Fundamentals of Flight</li> <li>- TÜV Rheinland: Luftfahrzeugtechnik in Theorie und Praxis</li> <li>- Wild: Transport Category Aircraft Systems</li> </ul>

<b>Course L0742: Fundamentals of Aircraft Systems</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>	Prof. Frank Thielecke
<b>Language</b>	DE
<b>Cycle</b>	SoSe
<b>Content</b>	See interlocking course
<b>Literature</b>	See interlocking course

<b>Course L0591: Air Transportation Systems</b>	
<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> <li>10. Future perspectives of air transport</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. K. Hünecke: "Die Technik des modernen Verkehrsflugzeugs", Motorbuch-Verlag, 2000, ISBN 3-613-01895-0</li> <li>4. I. Moir, A. Seabridge: "Aircraft Systems", AIAA Education Series, 2001, ISBN 1-56347-506-5</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>

<b>Course L0816: Air Transportation Systems</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. Volker Gollnick
<b>Language</b>	DE
<b>Cycle</b>	SoSe
<b>Content</b>	Practical exercises to understand <ul style="list-style-type: none"> <li>• aircraft movement in wind conditions</li> <li>• aircraft performance analyses</li> <li>• radio navigation principles</li> </ul> Objective: Understanding and application of principle methods to practical aviation problems
<b>Literature</b>	Hünnecke: Das moderne Verkehrsflugzeug von heute Flühr: Avionik und Flugsicherungstechnik

## Specialization Materials in Engineering Sciences

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

<b>Module M0988: Structural Materials</b>	
<b>Courses</b>	
<b>Title</b>	<b>Typ</b> <b>Hrs/wk</b> <b>CP</b>
Fundamentals of Mechanical Properties of Materials (L1090)	Lecture                      2                      3
Welding Technology (L1123)	Lecture                      3                      3
<b>Module Responsible</b>	Prof. Claus Emmelmann
<b>Admission Requirements</b>	None
<b>Recommended Previous Knowledge</b>	Fundamentals of Materials Science
<b>Educational Objectives</b>	After taking part successfully, students have reached the following learning results
<b>Professional Competence</b>	
<i>Knowledge</i>	The students get to know the principles that are responsible for the mechanical behaviour of metals. They acquire basic knowledge in modelling of the materials behaviour. Furthermore, the students learn about the behaviour of metals under static and dynamic loads. The students get to know the most important welding technologies and the corresponding systems. They learn about the influence of welding on the materials and design.
<i>Skills</i>	The students know the mechanical properties of metals and the underlying principles. They are able to name the influencing factors on the welding behaviour of steel materials.  The students are able to select between alloys according to the desired mechanical properties and weldability. They can distinguish between different welding techniques and select the suitable technique and system components for a defined application. They are able to dimension weld joints within design tasks.
<b>Personal Competence</b>	
<i>Social Competence</i>	none
<i>Autonomy</i>	none
<b>Workload in Hours</b>	Independent Study Time 110, Study Time in Lecture 70
<b>Credit points</b>	6
<b>Studienleistung</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): Specialisation Mechanical Engineering, Focus Materials in Engineering Sciences: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Materials in Engineering Sciences: Compulsory General Engineering Science (English program): Specialisation Mechanical Engineering, Focus Materials in Engineering Sciences: Compulsory General Engineering Science (English program, 7 semester): Specialisation Mechanical Engineering, Focus Materials in Engineering Sciences: Compulsory

<b>Course L1090: Fundamentals of Mechanical Properties of Materials</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. Norbert Huber, Dr. Erica Lilleodden
<b>Language</b>	EN
<b>Cycle</b>	SoSe
<b>Content</b>	<ol style="list-style-type: none"> <li>1. Introduction and overview</li> <li>2. Bonding and crystallography, stress, strain, linear elasticity</li> <li>3. Plasticity of metallic materials</li> <li>4. Dislocations: Structure, stress, strain, strain energy</li> <li>5. Dislocations: Motion and forces</li> <li>6. Partial dislocations, dislocation interactions, jogs and kinks</li> <li>7. Strengthening mechanisms</li> <li>8. Introduction to modelling of materials behaviour, classification of phenomena</li> <li>9. Linear and nonlinear elasticity</li> <li>10. Plasticity, tensile loading, cyclic loading</li> <li>11. Viscoelasticity, effects of loading history, creep, relaxation</li> <li>12. Viscoplasticity, overstress, rate sensitivity of metallic materials</li> <li>13. Identification of material parameters</li> </ol>
<b>Literature</b>	<p>Hull and Bacon: Introduction to Dislocations (1984)</p> <p>G. Gottstein: Physik. Grundlagen der Materialk. (2001)</p> <p>N.Huber: Scriptum „Materialtheorie“ Uni Karlsruhe (1998)</p> <p>P. Haupt: Cont. Mechanics and Theory of Materials (2002)</p>

Course L1123: Welding Technology	
<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. Claus Emmelmann, Prof. Karl-Ulrich Kainer
<b>Language</b>	DE
<b>Cycle</b>	WiSe
<b>Content</b>	<ul style="list-style-type: none"> <li>- phase transitions, phase diagrams and thermal activated processes</li> <li>- fundamentals of steels, heat treatment applications for steels and time temperature transformation diagrams</li> <li>- properties of weldable carbon and fine grained steels</li> <li>- properties of weldable low- and high-alloy steels, corrosion resistant steels and high-strength steels</li> <li>- structure and properties of non-ferrite metals (aluminum, titanium)</li> <li>- NDT/DT Methods for materials and welds</li> <li>- gas fusion welding, fundamentals of electric arc welding technologies</li> <li>- structure and influence parameters for the welded joint</li> <li>- submerged arc welding/tungsten inert gas welding/inert gas metal arc welding (MIG)/active gas metal arc welding (MAG)/Plasma Welding</li> <li>- resistance welding/ polymer welding/ hybrid-welding</li> <li>- deposition welding</li> <li>- electron beam welding/ laser beam welding</li> <li>- weld joint designs and declarations</li> <li>- computation methods for weld joint dimensioning</li> </ul>
<b>Literature</b>	<p>Schulze, G.: Die Metallurgie des Schweißens, 4. Aufl., Berlin 2010 Strassburg, F.W. und Wehner H.: Schweißen nichtrostender Stähle, 4. Aufl. Düsseldorf, 2009 Dilthey, U.: Schweißtechnische Fertigungsverfahren, Bd. 1: Schweiß- und Schneidtechnologien, 3. Aufl., Berlin 2006.</p> <p>Dilthey, U.: Schweißtechnische Fertigungsverfahren, Bd. 2: Verhalten der Werkstoffe beim Schweißen, 3. Aufl., Berlin 2005.</p> <p>Dilthey, U.: Schweißtechnische Fertigungsverfahren, Bd. 3: Gestaltung und Festigkeit von Schweißkonstruktionen, 2. Aufl., Berlin 2002.</p>

Module M1009: Material Science Laboratory			
<b>Courses</b>			
<b>Title</b>		<b>Typ</b>	<b>Hrs/wk</b> <b>CP</b>
Companion Lecture for Materials Science Laboratory (L1088)		Lecture	2            2
Material Science Laboratory (L1235)		Practical Course	4            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>Studienleistung</b>	None		
<b>Examination</b>	Written exam		
<b>Examination duration and scale</b>	1,5 h written Exam (50%) covering the lesson		
<b>Assignment for the Following Curricula</b>	General Engineering Science (German program): Specialisation Mechanical Engineering, Focus Materials in Engineering Sciences: Compulsory General Engineering Science (German program): Specialisation Mechanical Engineering, Focus Product Development and Production: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Materials in Engineering Sciences: Compulsory General Engineering Science (English program): Specialisation Mechanical Engineering, Focus Materials in Engineering Sciences: Compulsory General Engineering Science (English program): Specialisation Mechanical Engineering, Focus Product Development and Production: 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

<b>Course L1088: Companion Lecture for Materials Science Laboratory</b>	
<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>	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. Bodo Fiedler, Prof. Stefan Müller, Prof. Patrick Huber, 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 M1005: Enhanced Fundamentals of Materials Science

### Courses

Title	Typ	Hrs/wk	CP
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>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>The students are able to apply the appropriate physical and chemical methods for the above mentioned subjects.</p> <p>The students are capable to understand independently the structure and properties of ceramics, metals and polymers. They should be able to critically evaluate the profundness of their knowledge.</p>		
<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>Studienleistung</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): Specialisation Mechanical Engineering, Focus Materials in Engineering Sciences: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Materials in Engineering Sciences: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Product Development and Production: Compulsory General Engineering Science (English program): Specialisation Mechanical Engineering, Focus Materials in Engineering Sciences: Compulsory General Engineering Science (English program, 7 semester): Specialisation Mechanical		

Engineering, Focus Materials in Engineering Sciences: Compulsory  
 General Engineering Science (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  
 Technomathematics: Core qualification: 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. Bodo Fiedler
<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</p> <p>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</p> <p>Struktur und mechanische Eigenschaften G.W.Ehrenstein; Hanser Verlag; ISBN 3-446-12478-0; ca. 20 €</p> <p>Kunststoffphysik</p> <p>W.Retting, H.M.Laun; Hanser Verlag; ISBN 3446162356; ca. 25 €</p> <p>Werkstoffkunde Kunststoffe</p> <p>G.Menges; Hanser Verlag; ISBN 3-446-15612-7; ca. 25 €</p> <p>Kunststoff-Kompendium</p> <p>A.Frank, K. Biederbick; Vogel Buchverlag; ISBN 3-8023-0135-8; ca.30 €</p>

<b>Course L1234: Enhanced Fundamentals: Ceramics and Polymers</b>
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<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. Bodo Fiedler
<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, Prof. Patrick Huber
<b>Language</b>	DE
<b>Cycle</b>	SoSe
<b>Content</b>	<p>Enhanced Fundamentals of Metals:</p> <ul style="list-style-type: none"> <li>• Introduction to phenomenological thermodynamics</li> <li>• Elasticity</li> <li>• Thermal materials behavior (heat capacity, thermal expansion)</li> <li>• Conductors, semiconductors, isolators: conduction mechanisms and band structure</li> <li>• Superconductors</li> <li>• Dry corrosion</li> <li>• Electrochemistry in the material sciences</li> <li>• Wet corrosion</li> <li>• Alloy corrosion</li> <li>• Corrosion protection</li> <li>• Stainless steel</li> <li>• Battery materials</li> <li>• Supercapacitors</li> <li>• Fuel cells</li> <li>• Materials for hydrogen storage</li> <li>• Magnetism: phenomenology, Magnetometers, atomistics, micromagnetism</li> <li>• Magnetic materials</li> <li>• Magnetic materials: applications</li> </ul>
<b>Literature</b>	Vorlesungsskript

## Specialization Mechatronics

In the specialization "Mechatronics" students learn to combine the mechanical engineering content with the knowledge and skills of electrical engineering, to study in mechatronics, those sub-disciplines and related disciplines problems that arise.

### 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>	
<i>Knowledge</i>	<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>
<i>Skills</i>	<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>
<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 68, Study Time in Lecture 112
<b>Credit points</b>	6
<b>Studienleistung</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>	<p>General Engineering Science (German program): Specialisation Electrical Engineering: Compulsory</p> <p>General Engineering Science (German program): Specialisation Mechanical Engineering, Focus Mechatronics: Compulsory</p> <p>General Engineering Science (German program): Specialisation Mechanical Engineering, Focus Theoretical Mechanical Engineering: Compulsory</p> <p>General Engineering Science (German program): Specialisation Naval Architecture: Compulsory</p> <p>General Engineering Science (German program, 7 semester): Specialisation Electrical Engineering: 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: Compulsory</p> <p>General Engineering Science (German program, 7 semester): Specialisation Naval Architecture: Compulsory</p> <p>Computer Science: Specialisation Computational Mathematics: Elective Compulsory</p> <p>Electrical Engineering: Core qualification: Compulsory</p> <p>General Engineering Science (English program): Specialisation Electrical Engineering: Compulsory</p> <p>General Engineering Science (English program): Specialisation Naval Architecture: Compulsory</p> <p>General Engineering Science (English program): Specialisation Mechanical Engineering, Focus Mechatronics: Compulsory</p> <p>General Engineering Science (English program): Specialisation Mechanical Engineering, Focus Theoretical Mechanical Engineering: Compulsory</p> <p>General Engineering Science (English program, 7 semester): Specialisation Electrical Engineering: 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 Theoretical Mechanical Engineering: Compulsory</p> <p>General Engineering Science (English program, 7 semester): Specialisation Naval Architecture: Compulsory</p> <p>Computational Science and Engineering: Specialisation Engineering Sciences: Elective Compulsory</p> <p>Computational Science and Engineering: Specialisation Computer Science: Elective Compulsory</p> <p>Computational Science and Engineering: Specialisation Mathematics &amp; Engineering Science: Elective Compulsory</p> <p>Mechanical Engineering: Specialisation Theoretical Mechanical Engineering: Compulsory</p> <p>Mechanical Engineering: Specialisation Mechatronics: Compulsory</p> <p>Mechatronics: Core qualification: Compulsory</p> <p>Naval Architecture: Core qualification: Compulsory</p> <p>Theoretical Mechanical Engineering: Technical Complementary Course Core Studies: Elective Compulsory</p>

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>	Main features of complex analysis <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>	Prof. Uwe Weltin		
<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>Studienleistung</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): Specialisation Mechanical Engineering, Focus Mechatronics: Compulsory General Engineering Science (German program): Specialisation Mechanical Engineering, Focus Aircraft Systems Engineering: Compulsory General Engineering Science (German program): Specialisation Mechanical Engineering, Focus Theoretical Mechanical Engineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Mechatronics: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Aircraft Systems Engineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Theoretical Mechanical Engineering: Elective Compulsory General Engineering Science (English program): Specialisation Mechanical Engineering, Focus Aircraft Systems Engineering: Compulsory General Engineering Science (English program): Specialisation Mechanical Engineering, Focus Mechatronics: Compulsory General Engineering Science (English program): Specialisation Mechanical Engineering,		

	Focus Theoretical Mechanical 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 Aircraft Systems Engineering: Compulsory General Engineering Science (English program, 7 semester): Specialisation Mechanical Engineering, Focus Theoretical Mechanical Engineering: Elective Compulsory Mechanical Engineering: Specialisation Aircraft Systems Engineering: Compulsory Mechanical Engineering: Specialisation Mechatronics: Compulsory Mechanical Engineering: Specialisation Theoretical Mechanical Engineering: Compulsory Mechatronics: Core qualification: Compulsory
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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>	Prof. Uwe Weltin
<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>	Prof. Uwe Weltin
<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>	Prof. Uwe Weltin
<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

<b>Courses</b>			
<b>Title</b>	<b>Typ</b>	<b>Hrs/wk</b>	<b>CP</b>
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		
<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 are able to explain the functionality of different MOS devices in electronic circuits.</li> <li>Students know the fundamental digital logic circuits and can discuss their advantages and disadvantages.</li> <li>Students have solid knowledge about memory circuits and can explain their functionality and specifications.</li> <li>Students are able to explain how analog circuits functions and where they are applied.</li> <li>Students know the appropriate fields for the use of bipolar transistors.</li> </ul>		
<i>Knowledge</i>			
<i>Skills</i>			
<b>Personal Competence</b>			
<i>Social Competence</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>		
<i>Autonomy</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> <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>Studienleistung</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): Specialisation Electrical Engineering: Compulsory</p> <p>General Engineering Science (German program): Specialisation Mechanical Engineering, Focus Mechatronics: Compulsory</p> <p>General Engineering Science (German program, 7 semester): Specialisation Electrical Engineering: Compulsory</p> <p>General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Mechatronics: Compulsory</p> <p>Electrical Engineering: Core qualification: Compulsory</p> <p>General Engineering Science (English program): Specialisation Electrical Engineering: Compulsory</p> <p>General Engineering Science (English program): Specialisation Mechanical Engineering, Focus Mechatronics: Compulsory</p> <p>General Engineering Science (English program, 7 semester): Specialisation Electrical Engineering: Compulsory</p> <p>General Engineering Science (English program, 7 semester): Specialisation Mechanical Engineering, Focus Mechatronics: Compulsory</p> <p>Computational Science and Engineering: Specialisation Mathematics &amp; Engineering Science: Elective Compulsory</p> <p>Mechanical Engineering: Specialisation Mechatronics: Compulsory</p> <p>Mechatronics: Core qualification: Compulsory</p> <p>Technomathematics: Core qualification: Elective Compulsory</p> <p>Technomathematics: Specialisation III. Engineering Science: Elective Compulsory</p>

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>• Basic circuits with MOS transistors for logic gates and amplifiers</li> <li>• Typical applications for analog and digital circuits</li> <li>• Realization of logical functions</li> <li>• Memory circuits</li> <li>• Scaling-down of CMOS circuits and further performance improvements</li> <li>• Operational amplifiers and their applications</li> <li>• Basic circuits with bipolar transistors</li> <li>• Design of exemplary circuits</li> <li>• Electrical behavior of BiCMOS circuits</li> </ul> <p>From the summer semester 2017 onwards, students have the possibility to get a bonus of 0,3 to 0,7 for improving the (passed) exam by writing a test on either the 16.05., 13.06. or the 04.07.2017. The test includes 10 questions (time limit: 20 min.).</p>
<b>Literature</b>	<p>R. J. Baker, CMOS - Circuit Design, Layout and Simulation, J. Wiley &amp; Sons Inc., 3. Auflage, 2011, ISBN: 047170055S</p> <p>H.-G. Wagemann und T. Schönauer, Silizium-Planartechnologie, Grundprozesse, Physik und Bauelemente, Teubner-Verlag, 2003, ISBN 3519004674</p> <p>K. Hoffmann, Systemintegration, Oldenbourg-Verlag, 2. Aufl. 2006, ISBN: 3486578944</p> <p>U. Tietze und Ch. Schenk, E. Gamm, Halbleiterschaltungstechnik, Springer Verlag, 14. Auflage, 2012, ISBN 3540428496</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>

<b>Course L0864: Semiconductor Circuit Design</b>	
<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
<b>Language</b>	DE
<b>Cycle</b>	SoSe
<b>Content</b>	<ul style="list-style-type: none"> <li>• Basic circuits with MOS transistors for logic gates and amplifiers</li> <li>• Typical applications for analog and digital circuits</li> <li>• Realization of logical functions</li> <li>• Memory circuits</li> <li>• Scaling-down of CMOS circuits and further performance improvements</li> <li>• Operational amplifiers and their applications</li> <li>• Basic circuits with bipolar transistors</li> <li>• Design of exemplary circuits</li> <li>• Electrical behavior of BiCMOS circuits</li> </ul>
<b>Literature</b>	<p>R. J. Baker, CMOS - Circuit Design, Layout and Simulation, J. Wiley &amp; Sons Inc., 3. Auflage, 2011, ISBN: 047170055S</p> <p>H.-G. Wagemann und T. Schönauer, Silizium-Planartechnologie, Grundprozesse, Physik und Bauelemente, Teubner-Verlag, 2003, ISBN 3519004674</p> <p>K. Hoffmann, Systemintegration, Oldenbourg-Verlag, 2. Aufl. 2006, ISBN: 3486578944</p> <p>U. Tietze und Ch. Schenk, E. Gamm, Halbleiterschaltungstechnik, Springer Verlag, 14. Auflage, 2012, ISBN 3540428496</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>	Students are able to ...
<i>Knowledge</i>	<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>
<i>Skills</i>	Students are able to... <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>
<b>Personal Competence</b>	Students are able to ...
<i>Social Competence</i>	<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 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>Studienleistung</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): Specialisation Mechanical Engineering, Focus Product Development and Production: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Product Development and Production: Compulsory General Engineering Science (English program): 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
	Conrad, K.J <i>Taschenbuch der Werkzeugmaschinen</i> 9783446406414 Fachbuchverlag 2006

<b>Literature</b>	<i>Perović, Božina</i>
	<i>Spanende Werkzeugmaschinen - Ausführungsformen und Vergleichstabellen</i>
	<i>ISBN: 3540899529</i>
	<i>Berlin [u.a.]: Springer, 2009</i>
	<i>Weck, Manfred</i>
	<i>Werkzeugmaschinen 1 - Maschinenarten und Anwendungsbereiche</i>
	<i>ISBN: 9783540225041</i>
	<i>Berlin [u.a.]: Springer, 2005</i>
	<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>
	<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>

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>Blechbearbeitung</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

### Courses

Title	Typ	Hrs/wk	CP
Companion Lecture for Materials Science Laboratory (L1088)	Lecture	2	2
Material Science Laboratory (L1235)	Practical Course	4	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>Studienleistung</b>	None		
<b>Examination</b>	Written exam		
<b>Examination duration and scale</b>	1,5 h written Exam (50%) covering the lesson		
<b>Assignment for the Following Curricula</b>	General Engineering Science (German program): Specialisation Mechanical Engineering, Focus Materials in Engineering Sciences: Compulsory General Engineering Science (German program): Specialisation Mechanical Engineering, Focus Product Development and Production: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Materials in Engineering Sciences: Compulsory General Engineering Science (English program): Specialisation Mechanical Engineering, Focus Materials in Engineering Sciences: Compulsory General Engineering Science (English program): Specialisation Mechanical Engineering, Focus Product Development and Production: 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

<b>Course L1088: Companion Lecture for Materials Science Laboratory</b>	
<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>	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. Bodo Fiedler, Prof. Stefan Müller, Prof. Patrick Huber, 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

### Courses

Title	Typ	Hrs/wk	CP
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:		
<i>Knowledge</i>	<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>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:		
<i>Social Competence</i>	<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>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>Studienleistung</b>	<b>Compulsory Bonus</b>	<b>Form</b>	<b>Description</b>
	Yes 20 %	Subject theoretical	and CAE-Teamprojekt inkl. Vortrag und

	practical work	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): Specialisation Mechanical Engineering, Focus Aircraft Systems Engineering: Compulsory General Engineering Science (German program): Specialisation Mechanical Engineering, Focus Product Development and Production: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Aircraft Systems Engineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Product Development and Production: Compulsory General Engineering Science (English program): Specialisation Mechanical Engineering, Focus Aircraft Systems Engineering: Compulsory General Engineering Science (English program): 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 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>	<p><b>Description</b></p> <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>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.

<b>Module M0684: Heat Transfer</b>	
<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 <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>
<i>Skills</i>	The students are able to <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>
<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>Studienleistung</b>	None
<b>Examination</b>	Written exam
<b>Examination duration and scale</b>	120 min
	General Engineering Science (German program): Specialisation Mechanical Engineering, Focus Biomechanics: Compulsory General Engineering Science (German program): Specialisation Mechanical Engineering,

<b>Assignment for the Following Curricula</b>	Focus Energy Systems: Compulsory General Engineering Science (German program): Specialisation Biomedical Engineering: Compulsory General Engineering Science (German program): Specialisation Mechanical Engineering, Focus Theoretical Mechanical Engineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Energy Systems: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Theoretical Mechanical Engineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Biomedical Engineering: Compulsory General Engineering Science (English program): Specialisation Biomedical Engineering: Compulsory General Engineering Science (English program): Specialisation Mechanical Engineering, Focus Biomechanics: Compulsory General Engineering Science (English program): Specialisation Mechanical Engineering, Focus Energy Systems: Compulsory General Engineering Science (English program): Specialisation Mechanical Engineering, Focus Theoretical Mechanical Engineering: 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 Theoretical Mechanical Engineering: Compulsory General Engineering Science (English program, 7 semester): Specialisation Biomedical Engineering: Compulsory Mechanical Engineering: Specialisation Energy Systems: Compulsory Mechanical Engineering: Specialisation Theoretical Mechanical Engineering: Compulsory
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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, convective heat transfer, Two-phase heat transfer (evaporation, condensation), thermal radiation, heat exchangers, measurement methods
<b>Literature</b>	- Herwig, H.; Moschallski, A.: Wärmeübertragung, 3. Auflage, Springer Vieweg Verlag, Wiesbaden, 2014 - 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 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>	Prof. Uwe Weltin		
<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>Studienleistung</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): Specialisation Mechanical Engineering, Focus Mechatronics: Compulsory General Engineering Science (German program): Specialisation Mechanical Engineering, Focus Aircraft Systems Engineering: Compulsory General Engineering Science (German program): Specialisation Mechanical Engineering, Focus Theoretical Mechanical Engineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Mechatronics: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Aircraft Systems Engineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Theoretical Mechanical Engineering: Elective Compulsory General Engineering Science (English program): Specialisation Mechanical Engineering, Focus Aircraft Systems Engineering: Compulsory General Engineering Science (English program): Specialisation Mechanical Engineering, Focus Mechatronics: Compulsory General Engineering Science (English program): Specialisation Mechanical Engineering,		

	Focus Theoretical Mechanical 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 Aircraft Systems Engineering: Compulsory General Engineering Science (English program, 7 semester): Specialisation Mechanical Engineering, Focus Theoretical Mechanical Engineering: Elective Compulsory Mechanical Engineering: Specialisation Aircraft Systems Engineering: Compulsory Mechanical Engineering: Specialisation Mechatronics: Compulsory Mechanical Engineering: Specialisation Theoretical Mechanical Engineering: Compulsory Mechatronics: Core qualification: Compulsory
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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>	Prof. Uwe Weltin
<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>	Prof. Uwe Weltin
<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>	Prof. Uwe Weltin
<b>Language</b>	DE
<b>Cycle</b>	WiSe
<b>Content</b>	See interlocking course
<b>Literature</b>	See interlocking course

## 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

**Module Responsible** | Prof. Anusch Taraz

**Admission Requirements** | None

**Recommended Previous Knowledge** | Mathematics 1 - III

**Educational Objectives** | After taking part successfully, students have reached the following 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>
<i>Knowledge</i>	
<i>Skills</i>	
<b>Personal Competence</b>	
<i>Social Competence</i>	<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>
<b>Social Competence</b>	<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 68, Study Time in Lecture 112
<b>Credit points</b>	6
<b>Studienleistung</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>	<p>General Engineering Science (German program): Specialisation Electrical Engineering: Compulsory</p> <p>General Engineering Science (German program): Specialisation Mechanical Engineering, Focus Mechatronics: Compulsory</p> <p>General Engineering Science (German program): Specialisation Mechanical Engineering, Focus Theoretical Mechanical Engineering: Compulsory</p> <p>General Engineering Science (German program): Specialisation Naval Architecture: Compulsory</p> <p>General Engineering Science (German program, 7 semester): Specialisation Electrical Engineering: 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: Compulsory</p> <p>General Engineering Science (German program, 7 semester): Specialisation Naval Architecture: Compulsory</p> <p>Computer Science: Specialisation Computational Mathematics: Elective Compulsory</p> <p>Electrical Engineering: Core qualification: Compulsory</p> <p>General Engineering Science (English program): Specialisation Electrical Engineering: Compulsory</p> <p>General Engineering Science (English program): Specialisation Naval Architecture: Compulsory</p> <p>General Engineering Science (English program): Specialisation Mechanical Engineering, Focus Mechatronics: Compulsory</p> <p>General Engineering Science (English program): Specialisation Mechanical Engineering, Focus Theoretical Mechanical Engineering: Compulsory</p> <p>General Engineering Science (English program, 7 semester): Specialisation Electrical Engineering: 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 Theoretical Mechanical Engineering: Compulsory</p> <p>General Engineering Science (English program, 7 semester): Specialisation Naval Architecture: Compulsory</p> <p>Computational Science and Engineering: Specialisation Engineering Sciences: Elective Compulsory</p> <p>Computational Science and Engineering: Specialisation Computer Science: Elective Compulsory</p> <p>Computational Science and Engineering: Specialisation Mathematics &amp; Engineering Science: Elective Compulsory</p> <p>Mechanical Engineering: Specialisation Theoretical Mechanical Engineering: Compulsory</p> <p>Mechanical Engineering: Specialisation Mechatronics: Compulsory</p> <p>Mechatronics: Core qualification: Compulsory</p> <p>Naval Architecture: Core qualification: Compulsory</p> <p>Theoretical Mechanical Engineering: Technical Complementary Course Core Studies: Elective Compulsory</p>

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>	Main features of complex analysis <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

## Thesis

The work at the Bachelor 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>				
<i>Knowledge</i>	<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>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>				
<i>Social Competence</i>	<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>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> </ul>			

	<ul style="list-style-type: none"> <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>Studienleistung</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 Electrical Engineering: Thesis: Compulsory Energy and Environmental Engineering: Thesis: Compulsory General Engineering Science (English program): Thesis: Compulsory General Engineering Science (English program, 7 semester): Thesis: Compulsory Computational Science and Engineering: 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 xx: Thesis: Compulsory Process Engineering: Thesis: Compulsory