TUHH
Hamburg
University of
Technology

# Module Manual

Bachelor of Science (B.Sc.)

# Engineering Science

Cohort: Winter Term 2020

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# Program description

## Content

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

## Career prospects

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

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

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

## Learning target

### Knowledge

Students can:

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

### Skills

Graduates are able to

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

### Social Competence

Graduates are able to

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

### Autonomy

Graduates are able to

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

## Program structure

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

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

## Core Qualification

### Module M0745: Electrical Engineering I (GES)

**Courses**

| Title | Typ | Hrs/wk | CP |
|---|---|---|---|
| Electrical Engineering I (L0677) | Lecture | 3 | 5 |
| Electrical Engineering I (L0679) | Recitation Section (small) | 2 | 1 |

| | |
|---|---|
| **Module Responsible** | Prof. Manfred Kasper |
| **Admission Requirements** | None |
| **Recommended Previous Knowledge** | None |
| **Educational Objectives** | After taking part successfully, students have reached the following learning results |
| **Professional Competence** | |
| *Knowledge* | The students know the basic theory, relations and methods of direct current networks and of electric and magnetic fields. This includes especially:<br>• Kirchhoff's voltage and current laws,<br>• Ohm's law,<br>• methods to simplify and analyze direct current networks,<br>• description of electric and magnetic fields by use of vectorial field quantities,<br>• Basic material relations,<br>• Gauss's law,<br>• Ampère's law,<br>• induction law,<br>• Maxwell's equation in the integral form,<br>• concept and definition of resistance, capacitance and inductance. |
| *Skills* | The students are able to establish relations between currents and voltages in simple direct current networks and to apply these to calculate and dimension networks. Student know to apply the fundamental laws of electric and magnetic fields and are able to derive and evaluate relations between field quantities. Students know to calculate resistance, capacitance and inductance of simple geometric arrangements. |
| **Personal Competence** | |
| *Social Competence* | Students are able to solve specific problems alone or in a group and to present the results accordingly. Students can explain concepts and on the basis of examples verify and deepen their understanding. |
| *Autonomy* | Students are able to acquire particular knowledge using textbook in a self-learning process, to integrate, present and associate this knowledge with other fields. The students develop perseverance to also solve more complicated problems. |
| **Workload in Hours** | Independent Study Time 110, Study Time in Lecture 70 |
| **Credit points** | 6 |
| **Course achievement** | Compulsory: No; Bonus: 10 %; Form: Excercises; Description: |
| **Examination** | Written exam |
| **Examination duration and scale** | 120 minutes |
| **Assignment for the Following Curricula** | Engineering Science: Core Qualification: Compulsory<br>General Engineering Science (English program, 7 semester): Core Qualification: Compulsory |

### Course L0677: Electrical Engineering I

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|---|---|
| **Typ** | Lecture |
| **Hrs/wk** | 3 |
| **CP** | 5 |
| **Workload in Hours** | Independent Study Time 108, Study Time in Lecture 42 |
| **Lecturer** | Dr. rer. nat. Thomas Kusserow |
| **Language** | EN |
| **Cycle** | WiSe |
| **Content** | 1. Basics of Resistive Circuits<br>2. Simplifying Resistive Circuits<br>3. Network Analysis<br>4. The Electrostatic Field<br>5. Stationary Currents in Conductive Media<br>6. Electrostatic Field in Non-Conductive Media<br>7. Static Magnetic Field<br>8. Induction and Time-Dependent Fields |
| **Literature** | 1. M. Kasper, Lecture Notes Electrical Engineering Fundamentals 1, 2013<br>2. A. R. Hambley: Electrical Engineering, Principles and Applications, Pearson Education, 2008<br>3. P. M. Fishbane: Physics for Scientists and Engineers, Prentice Hall, 1996<br>4. M. Albach: Grundlagen der Elektrotechnik 1, Pearson Education, 2004<br>5. F. Moeller, H. Frohne, K.H. Löcherer, H. Müller: Grundlagen der Elektrotechnik, Teubner, 2005 |

| Course L0679: Electrical Engineering I | |
|---|---|
| **Typ** | Recitation Section (small) |
| **Hrs/wk** | 2 |
| **CP** | 1 |
| **Workload in Hours** | Independent Study Time 2, Study Time in Lecture 28 |
| **Lecturer** | Dr. rer. nat. Thomas Kusserow |
| **Language** | EN |
| **Cycle** | WiSe |
| **Content** | See interlocking course |
| **Literature** | See interlocking course |

## Module M0736: Linear Algebra

**Courses**

| Title | Typ | Hrs/wk | CP |
|---|---|---|---|
| Linear Algebra (L0642) | Lecture | 4 | 4 |
| Linear Algebra (L0643) | Recitation Section (large) | 2 | 2 |
| Linear Algebra (L0645) | Recitation Section (small) | 2 | 2 |

| | |
|---|---|
| **Module Responsible** | Prof. Daniel Ruprecht |
| **Admission Requirements** | None |
| **Recommended Previous Knowledge** | None |
| **Educational Objectives** | After taking part successfully, students have reached the following learning results |
| **Professional Competence** | |
| *Knowledge* | • Students can name the basic concepts in linear algebra. They are able to explain them using appropriate examples.<br>• Students can discuss logical connections between these concepts. They are capable of illustrating these connections with the help of examples.<br>• They know proof strategies and can reproduce them. |
| *Skills* | • Students can model problems in linear algebra with the help of the concepts studied in this course. Moreover, they are capable of solving them by applying established methods.<br>• Students are able to discover and verify further logical connections between the concepts studied in the course.<br>• For a given problem, the students can develop and execute a suitable approach, and are able to critically evaluate the results. |
| **Personal Competence** | |
| *Social Competence* | - Students are able to work together (e.g. on their regular home work) in heterogeneously composed teams (i.e., teams from different study programs and background knowledge) and to present their results appropriately (e.g. during exercise class). |
| *Autonomy* | - Students are capable of checking their understanding of complex concepts on their own. They can specify open questions precisely and know where to get help in solving them.<br><br>- Students can put their knowledge in relation to the contents of other lectures.<br><br>- Students have developed sufficient persistence to be able to work for longer periods in a goal-oriented manner on hard problems. |
| **Workload in Hours** | Independent Study Time 128, Study Time in Lecture 112 |
| **Credit points** | 8 |
| **Course achievement** | None |
| **Examination** | Written exam |
| **Examination duration and scale** | 120 |
| **Assignment for the Following Curricula** | Computer Science: Core Qualification: Compulsory<br>Data Science: Core Qualification: Compulsory<br>Engineering Science: Core Qualification: Compulsory<br>General Engineering Science (English program, 7 semester): Core Qualification: Compulsory |

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

| Course L0643: Linear Algebra | |
|---|---|
| **Typ** | Recitation Section (large) |
| **Hrs/wk** | 2 |
| **CP** | 2 |
| **Workload in Hours** | Independent Study Time 32, Study Time in Lecture 28 |
| **Lecturer** | Dr. Julian Großmann, Dr. Sebastian Götschel, Jan Meichsner |
| **Language** | EN |
| **Cycle** | WiSe |
| **Content** | See interlocking course |
| **Literature** | See interlocking course |

| Course L0645: Linear Algebra | |
|---|---|
| **Typ** | Recitation Section (small) |
| **Hrs/wk** | 2 |
| **CP** | 2 |
| **Workload in Hours** | Independent Study Time 32, Study Time in Lecture 28 |
| **Lecturer** | Dr. Julian Großmann |
| **Language** | EN |
| **Cycle** | WiSe |
| **Content** | See interlocking course |
| **Literature** | See interlocking course |

## Module M1572: GES 101

**Courses**

| Title | Typ | Hrs/wk | CP |
|---|---|---|---|
| GES 101 (L2402) | Seminar | 2 | 2 |

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|---|---|
| **Module Responsible** | Prof. Robert Seifried |
| **Admission Requirements** | None |
| **Recommended Previous Knowledge** | non |
| **Educational Objectives** | After taking part successfully, students have reached the following learning results |
| **Professional Competence** | |
| *Knowledge* | An introduction to engineering science in a modern society - overcoming technical, economic, social and environmental challenges in Germany, Europe and worldwide. |
| *Skills* | |
| **Personal Competence** | |
| *Social Competence* | |
| *Autonomy* | |
| **Workload in Hours** | Independent Study Time 32, Study Time in Lecture 28 |
| **Credit points** | 2 |
| **Course achievement** | None |
| **Examination** | Presentation |
| **Examination duration and scale** | 6 x 10 min |
| **Assignment for the Following Curricula** | Engineering Science: Core Qualification: Compulsory<br>General Engineering Science (English program, 7 semester): Core Qualification: Compulsory |

### Course L2402: GES 101

| | |
|---|---|
| **Typ** | Seminar |
| **Hrs/wk** | 2 |
| **CP** | 2 |
| **Workload in Hours** | Independent Study Time 32, Study Time in Lecture 28 |
| **Lecturer** | Dr. Alexander Held |
| **Language** | EN |
| **Cycle** | WiSe |
| **Content** | |
| **Literature** | |

## Module M1081: Engineering Mechanics I (GES)

**Courses**

| Title | Typ | Hrs/wk | CP |
|---|---|---|---|
| Mechanics I (GES) (L1373) | Lecture | 2 | 3 |
| Mechanics I (GES) (L1374) | Recitation Section (large) | 3 | 3 |

| | |
|---|---|
| **Module Responsible** | Prof. Robert Seifried |
| **Admission Requirements** | None |
| **Recommended Previous Knowledge** | None |
| **Educational Objectives** | After taking part successfully, students have reached the following learning results |
| **Professional Competence** | |
| *Knowledge* | The primary purpose of the study of Statics is to develop the capacity to predict the effects of forces on rigid bodies, structural elements and simple structures, which are at rest (in equilibrium). Such a capacity is critical to the design of many structural or engineering systems. The particular objectives of this course are to:<br>1. Introduce the student to the basic principles required to analyse the effects of forces applied to rigid bodies, structural elements and simple structures in equilibrium;<br>2. Demonstrate sound techniques of constructing and solving idealised mathematical models of real engineering systems;<br>3. Promote the analytical and problem-solving skills required to solve a wide variety of real engineering problems effectively. |
| *Skills* | At the end of this course the student is able to:<br>1. Apply the properties of two- and three-dimensional force systems to the analysis of structural elements and simple structures in equilibrium.<br>2. Isolate a body in equilibrium by drawing its free-body diagram on which all forces acting on the body are represented.<br>3. Analyse the external effects of forces acting on a single body or a system of bodies in two- and three-dimensional equilibrium using the free-body diagram of the body or system.<br>4. Analyse the internal forces in trusses and beams.<br>5. Solve problems of equilibrium with account for dry friction.<br>6. Determine mass centres and centroids of lines, areas and volumes. |
| **Personal Competence** | |
| *Social Competence* | Students can: - work in groups and report on the findings, - develop joint solutions in mixed teams and present them to others, - assess the team collaboration and their own share in it. |
| *Autonomy* | Students are able to: - solve the problems independently with the help of hints, - assess their own strengths and weaknesses, e.g. with the aid of the mid-term test. |
| **Workload in Hours** | Independent Study Time 110, Study Time in Lecture 70 |
| **Credit points** | 6 |
| **Course achievement** | None |
| **Examination** | Written exam |
| **Examination duration and scale** | 1.5 hours Statics: force systems, equilibrium, mass center, friction, trusses, beams. |
| **Assignment for the Following Curricula** | Engineering Science: Core Qualification: Compulsory<br>General Engineering Science (English program, 7 semester): Core Qualification: Compulsory |

### Course L1373: Mechanics I (GES)

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|---|---|
| **Typ** | Lecture |
| **Hrs/wk** | 2 |
| **CP** | 3 |
| **Workload in Hours** | Independent Study Time 62, Study Time in Lecture 28 |
| **Lecturer** | Prof. Radoslaw Iwankiewicz |
| **Language** | EN |
| **Cycle** | WiSe |
| **Content** | 1. Two-dimensional (2D) force systems.: moment of a force about a point, reduction of a system of forces, resultant.<br>2. Three-dimensional (3D) force systems; moment of a force about a point and about an axis, reduction of a system of forces, resultant, wrench.<br>3. Supports and bearings, constraints, reactive forces, mechanical system isolation, free-body diagram. Systems with complete and incomplete fixity.<br>4. Equilibrium in two and three dimensions. Equations of equilibrium.<br>5. Plane trusses: forces in members, the method of joints and the method of sections. Space trusses.<br>6. Simple structures: frames and machines.<br>7. Mass centers and centroids of lines, areas and volumes.<br>8. Friction: dry friction, types of friction problems.<br>9. Beams: internal effects- internal forces. Internal forces in curved-in-plane members.<br>10. * Flexible cables.<br>11. * Virtual work principle.<br><br>* Denotes an additional topic. |
| **Literature** | 1. J.L. Meriam and L.G, Kraige, Engineering Mechanics, Vol. 1, Statics, John Wiley & Sons, SI Version, 4 th Edition.<br><br>2. R.C. Hibbeler, Engineering Mechanics, Statics, Pearson, Prentice Hall, SI, 3rd Edition. |

| Course L1374: Mechanics I (GES) | |
|---|---|
| **Typ** | Recitation Section (large) |
| **Hrs/wk** | 3 |
| **CP** | 3 |
| **Workload in Hours** | Independent Study Time 48, Study Time in Lecture 42 |
| **Lecturer** | Prof. Radoslaw Iwankiewicz |
| **Language** | EN |
| **Cycle** | WiSe |
| **Content** | 1. Two-dimensional (2D) force systems.: moment of a force about a point, reduction of a system of forces, resultant.<br>2. Three-dimensional (3D) force systems; moment of a force about a point and about an axis, reduction of a system of forces, resultant, wrench.<br>3. Supports and bearings, constraints, reactive forces, mechanical system isolation, free-body diagram. Systems with complete and incomplete fixity.<br>4. Equilibrium in two and three dimensions. Equations of equilibrium.<br>5. Plane trusses: forces in members, the method of joints and the method of sections. Space trusses.<br>6. Simple structures: frames and machines.<br>7. Mass centers and centroids of lines, areas and volumes.<br>8. Friction: dry friction, types of friction problems.<br>9. Beams: internal effects- internal forces. Internal forces in curved-in-plane members.<br>10. * Flexible cables.<br>11. * Virtual work principle.<br><br>* Denotes an additional topic. |
| **Literature** | 1. J.L. Meriam and L.G, Kraige, Engineering Mechanics, Vol. 1, Statics, John Wiley & Sons, SI Version, 4 th Edition.<br><br>2. R.C. Hibbeler, Engineering Mechanics, Statics, Pearson, Prentice Hall, SI, 3rd Edition. |

## Module M1139: Physics for Engineers (GES)

**Courses**

| Title | Typ | Hrs/wk | CP |
|---|---|---|---|
| Physics for Engineers (GES) (L0557) | Lecture | 2 | 3 |
| Physics for Engineers (GES) (L0560) | Recitation Section (small) | 1 | 1 |

| | |
|---|---|
| **Module Responsible** | Dr. Alexander Petrov |
| **Admission Requirements** | None |
| **Recommended Previous Knowledge** | • Calculus and linear algebra on high school level<br>• Physics on high school level |
| **Educational Objectives** | After taking part successfully, students have reached the following learning results |
| **Professional Competence** | |
| *Knowledge* | Students can explain fundamental topics and laws of physics such as in the areas of mechanics, oscillations, waves, and optics.<br><br>Students can relate physics topics to technical problems. |
| *Skills* | Students can describe physical problems mathematically and solve such problems within the framework of their acquired mathematical expertise. |
| **Personal Competence** | |
| *Social Competence* | Students can jointly solve subject related problems in groups. They can present their results effectively within the framework of the problem solving courses. |
| *Autonomy* | Students are capable to extract relevant information from the provided references and to relate this information to the content of the lecture. They can reflect their acquired level of expertise with the help of lecture accompanying measures such as exam typical exam questions. Students are able to connect their knowledge with that acquired from other lectures. |
| **Workload in Hours** | Independent Study Time 78, Study Time in Lecture 42 |
| **Credit points** | 4 |
| **Course achievement** | None |
| **Examination** | Written exam |
| **Examination duration and scale** | 120 Minutes, 10 tasks with parts a) and b) |
| **Assignment for the Following Curricula** | Engineering Science: Core Qualification: Compulsory<br>General Engineering Science (English program, 7 semester): Core Qualification: Compulsory |

### Course L0557: Physics for Engineers (GES)

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|---|---|
| **Typ** | Lecture |
| **Hrs/wk** | 2 |
| **CP** | 3 |
| **Workload in Hours** | Independent Study Time 62, Study Time in Lecture 28 |
| **Lecturer** | Dr. Alexander Petrov |
| **Language** | EN |
| **Cycle** | WiSe |
| **Content** | • Introduction<br>• Kinematics and dynamics<br>• Work, Energy, momentum<br>• Rotatory Motion, moments of inertia<br>• Gravitation<br>• Special Theory of Relativity<br>• Oscillations<br>• Waves<br>• Geometrical optics<br>• Wave optics<br>• Matter waves<br>• Fundamentals of quantum mechanics |
| **Literature** | • D. Halliday, R. Resnick and J. Walker (“HRW-7”), Fundamentals of Physics - Extended Edition, 7$^{th}$ ed., (Wiley 2005); available in the TUHH Library ‘Lehrbuchsammlung’.<br>• K. Cummings, P. Laws, E. Redish, and P. Cooney (“CLRC”), Understanding Physics, (Wiley 2004); available in the TUHH Library ‘Lehrbuchsammlung’.<br>• Other books that cover similar topics are, e.g., Physics by Fishbane, Gasiorowicz and Thornton and Physics by Tipler and Mosca. |

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

## Module M0577: Non-technical Courses for Bachelors

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|---|---|
| **Module Responsible** | Dagmar Richter |
| **Admission Requirements** | None |
| **Recommended Previous Knowledge** | None |
| **Educational Objectives** | After taking part successfully, students have reached the following learning results |
| **Professional Competence** | |
| *Knowledge* | **The Non-technical Academic Programms (NTA)**<br><br>imparts skills that, in view of the TUHH's training profile, professional engineering studies require but are not able to cover fully. Self-reliance, self-management, collaboration and professional and personnel management competences. The department implements these training objectives in its **teaching architecture**, in its **teaching and learning arrangements**, in **teaching areas** and by means of teaching offerings in which students can qualify by opting for **specific competences** and a **competence level** at the Bachelor's or Master's level. The teaching offerings are pooled in two different catalogues for nontechnical complementary courses.<br><br>**The Learning Architecture**<br><br>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.<br><br>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"<br><br>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.<br><br>**Teaching and Learning Arrangements**<br><br>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.<br><br>**Fields of Teaching**<br><br>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.<br><br>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.<br><br>**The Competence Level**<br><br>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.<br><br>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.<br><br>**Specialized Competence (Knowledge)**<br><br>Students can<br><br>• locate selected specialized areas with the relevant non-technical mother discipline,<br>• outline basic theories, categories, terminology, models, concepts or artistic techniques in the disciplines represented in the learning area,<br>• different specialist disciplines relate to their own discipline and differentiate it as well as make connections,<br>• 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,<br>• Can communicate in a foreign language in a manner appropriate to the subject. |
| *Skills* | **Professional Competence (Skills)**<br><br>In selected sub-areas students can<br><br>• apply basic methods of the said scientific disciplines,<br>• auestion a specific technical phenomena, models, theories from the viewpoint of another, aforementioned specialist discipline,<br>• to handle simple questions in aforementioned scientific disciplines in a sucsessful manner,<br>• justify their decisions on forms of organization and application in practical questions in contexts that go beyond the technical relationship to the subject. |
| **Personal Competence** | |
| *Social Competence* | **Personal Competences (Social Skills)**<br><br>Students will be able<br><br>• 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,<br>• 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),<br>• to explain nontechnical items to auditorium with technical background knowledge. |
| *Autonomy* | **Personal Competences (Self-reliance)**<br>Students are able in selected areas<br>• to reflect on their own profession and professionalism in the context of real-life fields of application<br>• to organize themselves and their own learning processes<br>• to reflect and decide questions in front of a broad education background<br>• to communicate a nontechnical item in a competent way in writen form or verbaly<br>• 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 M0701: Chemistry (GES)

**Courses**

| Title | Typ | Hrs/wk | CP |
|---|---|---|---|
| Chemistry (GES) I+II (L0467) | Lecture | 4 | 4 |
| Chemistry (GES) I+II (L0478) | Recitation Section (large) | 2 | 2 |

| | |
|---|---|
| **Module Responsible** | Dr. Dorothea Rechtenbach |
| **Admission Requirements** | None |
| **Recommended Previous Knowledge** | None |
| **Educational Objectives** | After taking part successfully, students have reached the following learning results |
| **Professional Competence** | |
| *Knowledge* | The students are able to name and to describe basic principles and applications of general chemistry (structure of matter, periodic table, chemical bonds), physical chemistry (aggregate states, separating processes, thermodynamics, kinetics), inorganic chemistry (acid/base, pH-value, salts, solubility, redox, metals) and organic chemistry (aliphatic hydrocarbons, functional groups, carbonyl compounds, aromates, reaction mechanisms, natural products, synthetic polymers). Furthermore students are able to explain basic chemical terms. |
| *Skills* | After successful completion of this module students are able to describe substance groups and chemical compounds. On this basis, they are capable of explaining, choosing and applying specific methods and various reaction mechanisms. |
| **Personal Competence** | |
| *Social Competence* | Students are able to take part in discussions on chemical issues and problems as a member of an interdisciplinary team. They can contribute to those discussion by their own statements. |
| *Autonomy* | After successful completion of this module students are able to solve chemical problems independently by defending proposed approaches with arguments. They can also document their approaches. |
| **Workload in Hours** | Independent Study Time 96, Study Time in Lecture 84 |
| **Credit points** | 6 |
| **Course achievement** | None |
| **Examination** | Written exam |
| **Examination duration and scale** | 120 min |
| **Assignment for the Following Curricula** | Engineering Science: Core Qualification: Compulsory<br>General Engineering Science (English program, 7 semester): Core Qualification: Compulsory |

| Course L0467: Chemistry (GES) I+II | |
|---|---|
| **Typ** | Lecture |
| **Hrs/wk** | 4 |
| **CP** | 4 |
| **Workload in Hours** | Independent Study Time 64, Study Time in Lecture 56 |
| **Lecturer** | Dr. Holger Gulyas |
| **Language** | EN |
| **Cycle** | WiSe |
| **Content** | Chemistry I:<br>- Structure of matter<br>- Periodic table<br>- Electronegativity<br>- Chemical bonds<br>- Solid compounds and solutions<br>- Chemistry of water<br>- Chemical reactions and equilibria<br>- Acid-base reactions<br>- Redox reactions<br>Chemistry II:<br>- Simple compounds of carbon, aliphatic hydrocarbons, aromatic hydrocarbons,<br>- Alkohols, phenols, ether, aldehydes, ketones, carbonic acids, ester, amines, amino acids, fats, sugars<br>- Reaction mechanisms, radical reactions, nucleophilic substitution, elimination reactions, addition reaction<br>- Practical apllications and examples |
| **Literature** | - Gallagher, Ingram: Complete Chemistry (Oxford University Press)<br>- Corwin: Introductory Chemistry (Pearson)<br>- Burrows, Parsons, Price,Holman: Chemistry3 (Oxford University Press) |

| Course L0478: Chemistry (GES) I+II | |
|---|---|
| **Typ** | Recitation Section (large) |
| **Hrs/wk** | 2 |
| **CP** | 2 |
| **Workload in Hours** | Independent Study Time 32, Study Time in Lecture 28 |
| **Lecturer** | Dr. Holger Gulyas |
| **Language** | EN |
| **Cycle** | WiSe |
| **Content** | See interlocking course |
| **Literature** | See interlocking course |

## Module M1575: Technical Thermodynamics I (GES)

**Courses**

| Title | Typ | Hrs/wk | CP |
|---|---|---|---|
| *** Technical Thermodynamics I (GES) (L2400) | Integrated Lecture | 3 | 5 |
| *** Technical Thermodynamics I (GES) (L2401) | Recitation Section (small) | 1 | 1 |

| | |
|---|---|
| **Module Responsible** | NN |
| **Admission Requirements** | None |
| **Recommended Previous Knowledge** | |
| **Educational Objectives** | After taking part successfully, students have reached the following learning results |
| **Professional Competence** | |
| *Knowledge* | |
| *Skills* | |
| **Personal Competence** | |
| *Social Competence* | |
| *Autonomy* | |
| **Workload in Hours** | Independent Study Time 124, Study Time in Lecture 56 |
| **Credit points** | 6 |
| **Course achievement** | None |
| **Examination** | Written exam |
| **Examination duration and scale** | 120 min |
| **Assignment for the Following Curricula** | Engineering Science: Core Qualification: Compulsory<br>General Engineering Science (English program, 7 semester): Core Qualification: Compulsory |

### Course L2400: *** Technical Thermodynamics I (GES)

| | |
|---|---|
| **Typ** | Integrated Lecture |
| **Hrs/wk** | 3 |
| **CP** | 5 |
| **Workload in Hours** | Independent Study Time 108, Study Time in Lecture 42 |
| **Lecturer** | NN |
| **Language** | EN |
| **Cycle** | SoSe |
| **Content** | 1.<br>1.<br>1. |
| **Literature** | |

### Course L2401: *** Technical Thermodynamics I (GES)

| | |
|---|---|
| **Typ** | Recitation Section (small) |
| **Hrs/wk** | 1 |
| **CP** | 1 |
| **Workload in Hours** | Independent Study Time 16, Study Time in Lecture 14 |
| **Lecturer** | NN |
| **Language** | EN |
| **Cycle** | SoSe |
| **Content** | See interlocking course |
| **Literature** | See interlocking course |

## Module M0772: Electrical Engineering II (GES)

**Courses**

| Title | Typ | Hrs/wk | CP |
|---|---|---|---|
| Electrical Engineering II (L0747) | Lecture | 3 | 5 |
| Electrical Engineering II (L0748) | Recitation Section (small) | 2 | 1 |

| | |
|---|---|
| **Module Responsible** | Prof. Manfred Kasper |
| **Admission Requirements** | None |
| **Recommended Previous Knowledge** | Content of the Lecture "Electrical Engineering I (Elektrotechnik I)" |
| **Educational Objectives** | After taking part successfully, students have reached the following learning results |
| **Professional Competence** | |
| *Knowledge* | The students know the basic theory, relations and methods of time dependent network theory and basic nonlinear circuit elements. This includes, in particular:<br>• transients,<br>• the use of complex numbers and phasors,<br>• the concept of impedance,<br>• steady state sinusoidal circuit analysis,<br>• complex power and 3-phase systems,<br>• transformers,<br>• transfer function and filters,<br>• the concept of resonance,<br>• diodes and rectifiers,<br>• bipolar transistors and operational amplifiers |
| *Skills* | The students are able to establish relations between time dependent currents and voltages in linear networks. The students know how to apply network theory to analyze 3-phase systems, transformers, filter-like structures, and resonating networks. The students know to include basic nonlinear circuit elements, such as diodes, bipolar transistors, and operational amplifiers, into the network analysis. |
| **Personal Competence** | |
| *Social Competence* | Students are able to solve specific problems, alone or in a group, and to present the results accordingly. Students can explain concepts and, on the basis of examples and exercises, verify and deepen their understanding. |
| *Autonomy* | Students are able to acquire particular knowledge using textbooks in a self-learning process, to integrate, present, and associate this knowledge with other fields. The students develop persistency to also solve more complicated problems. |
| **Workload in Hours** | Independent Study Time 110, Study Time in Lecture 70 |
| **Credit points** | 6 |
| **Course achievement** | None |
| **Examination** | Written exam |
| **Examination duration and scale** | 120 minutes |
| **Assignment for the Following Curricula** | Engineering Science: Core Qualification: Compulsory<br>General Engineering Science (English program, 7 semester): Core Qualification: Compulsory |

### Course L0747: Electrical Engineering II

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

| Course L0748: Electrical Engineering II | |
|---|---|
| **Typ** | Recitation Section (small) |
| **Hrs/wk** | 2 |
| **CP** | 1 |
| **Workload in Hours** | Independent Study Time 2, Study Time in Lecture 28 |
| **Lecturer** | Prof. Manfred Kasper |
| **Language** | EN |
| **Cycle** | SoSe |
| **Content** | See interlocking course |
| **Literature** | See interlocking course |

## Module M0737: Mathematical Analysis

**Courses**

| Title | Typ | Hrs/wk | CP |
|---|---|---|---|
| Mathematical Analysis (L0647) | Lecture | 4 | 4 |
| Mathematical Analysis (L0648) | Recitation Section (large) | 2 | 2 |
| Mathematical Analysis (L0649) | Recitation Section (small) | 2 | 2 |

| | |
|---|---|
| **Module Responsible** | Prof. Daniel Ruprecht |
| **Admission Requirements** | None |
| **Recommended Previous Knowledge** | None |
| **Educational Objectives** | After taking part successfully, students have reached the following learning results |
| **Professional Competence** | |
| *Knowledge* | • Students can name the basic concepts in analysis. They are able to explain them using appropriate examples.<br>• Students can discuss logical connections between these concepts. They are capable of illustrating these connections with the help of examples.<br>• They know proof strategies and can reproduce them. |
| *Skills* | • Students can model problems in analysis with the help of the concepts studied in this course. Moreover, they are capable of solving them by applying established methods.<br>• Students are able to discover and verify further logical connections between the concepts studied in the course.<br>• For a given problem, the students can develop and execute a suitable approach, and are able to critically evaluate the results. |
| **Personal Competence** | |
| *Social Competence* | - Students are able to work together (e.g. on their regular home work) in heterogeneously composed teams (i.e., teams from different study programs and background knowledge) and to present their results appropriately (e.g. during exercise class). |
| *Autonomy* | - Students are capable of checking their understanding of complex concepts on their own. They can specify open questions precisely and know where to get help in solving them.<br><br>- Students can put their knowledge in relation to the contents of other lectures.<br><br>- Students have developed sufficient persistence to be able to work for longer periods in a goal-oriented manner on hard problems. |
| **Workload in Hours** | Independent Study Time 128, Study Time in Lecture 112 |
| **Credit points** | 8 |
| **Course achievement** | None |
| **Examination** | Written exam |
| **Examination duration and scale** | 120 minutes |
| **Assignment for the Following Curricula** | Computer Science: Core Qualification: Compulsory<br>Data Science: Core Qualification: Compulsory<br>Engineering Science: Core Qualification: Compulsory<br>General Engineering Science (English program, 7 semester): Core Qualification: Compulsory |

### Course L0647: Mathematical Analysis

| | |
|---|---|
| **Typ** | Lecture |
| **Hrs/wk** | 4 |
| **CP** | 4 |
| **Workload in Hours** | Independent Study Time 64, Study Time in Lecture 56 |
| **Lecturer** | Dr. Julian Großmann |
| **Language** | EN |
| **Cycle** | SoSe |
| **Content** | Convergence, sequences, and series<br><br>Continuity<br><br>Elementary functions<br><br>Differential calculus<br><br>Integral calculus<br><br>Sequences of functions |
| **Literature** | Königsberger: Analysis<br><br>Forster: Analysis |

| Course L0648: Mathematical Analysis | |
|---|---|
| **Typ** | Recitation Section (large) |
| **Hrs/wk** | 2 |
| **CP** | 2 |
| **Workload in Hours** | Independent Study Time 32, Study Time in Lecture 28 |
| **Lecturer** | Dr. Julian Großmann |
| **Language** | EN |
| **Cycle** | SoSe |
| **Content** | See interlocking course |
| **Literature** | See interlocking course |

| Course L0649: Mathematical Analysis | |
|---|---|
| **Typ** | Recitation Section (small) |
| **Hrs/wk** | 2 |
| **CP** | 2 |
| **Workload in Hours** | Independent Study Time 32, Study Time in Lecture 28 |
| **Lecturer** | Dr. Julian Großmann |
| **Language** | EN |
| **Cycle** | SoSe |
| **Content** | See interlocking course |
| **Literature** | See interlocking course |

## Module M1103: Engineering Mechanics II (GES)

**Courses**

| Title | Typ | Hrs/wk | CP |
|---|---|---|---|
| Mechanics II (GES) (L1417) | Lecture | 2 | 3 |
| Mechanics II (GES) (L1418) | Recitation Section (large) | 2 | 3 |

| | |
|---|---|
| **Module Responsible** | Prof. Robert Seifried |
| **Admission Requirements** | None |
| **Recommended Previous Knowledge** | None |
| **Educational Objectives** | After taking part successfully, students have reached the following learning results |
| **Professional Competence** | |
| *Knowledge* | The primary purpose of the study of Mechanics of Materials/Solids is to develop the capacity to predict the effects of forces on elastic bodies, structural elements and simple structures, which are at rest (in equilibrium). Such a capacity is critical to the design of many structural or engineering systems. The particular objectives of this course are to:<br>1. Introduce the student to the basic principles required to analyse the effects of forces applied to elastic bodies, structural elements and simple structures in equilibrium;<br>2. Demonstrate sound techniques of constructing and solving idealised mathematical models of real engineering systems;<br>3. Promote the analytical and problem-solving skills required to solve a wide variety of real engineering problems effectively. |
| *Skills* | At the end of this course the student should be able to:<br>1. Determine average normal and shear stresses.<br>2. Determine shear stresses and the angle of twist due to torsion of a circular shaft.<br>3. Determine thermal stresses in rods.<br>4. Analyse statically indeterminate rods and shafts..<br>5. Determine area moments of inertia as well as principal axes and moments of inertia.<br>6. Determine normal and shear stresses as well as deflections due to bending.<br>7. Analyse plane state of stress (stress transformation).<br>8. Analyse stability of equilibrium of simple systems and buckling of elastic columns.<br>9. Determine displacements and solve statically indeterminate problems with the aid of energy (Castigliano's) method. |
| **Personal Competence** | |
| *Social Competence* | Students can: -work in groups and report on the findings, - develop joint solutions in mixed teams and present them to others, - assess the team collaboration and their own share in it. |
| *Autonomy* | Students are able to; - solve the problems independently with the help of hints, - assess their own strengths and weaknesses, e.g. with the help of the mid-term test. |
| **Workload in Hours** | Independent Study Time 124, Study Time in Lecture 56 |
| **Credit points** | 6 |
| **Course achievement** | None |
| **Examination** | Written exam |
| **Examination duration and scale** | 1.5 hours Mechanics of Solids: stress and strain due to axial loading, torsion, bending, stress transformation, moments of inertia, buckling, energy methods. |
| **Assignment for the Following Curricula** | Engineering Science: Core Qualification: Compulsory<br>General Engineering Science (English program, 7 semester): Core Qualification: Compulsory |

| Course L1417: Mechanics II (GES) | |
|---|---|
| **Typ** | Lecture |
| **Hrs/wk** | 2 |
| **CP** | 3 |
| **Workload in Hours** | Independent Study Time 62, Study Time in Lecture 28 |
| **Lecturer** | Prof. Radoslaw Iwankiewicz |
| **Language** | EN |
| **Cycle** | SoSe |
| **Content** | COURSE CONTENTS:<br>1. Normal and shear stress, average normal and shear stress.<br>2. Normal and shear strain.<br>3. Axial loading: elastic deformation and statically indeterminate problems. Thermal stresses. Statically indeterminate axially loaded rods.<br>4. Area moments of inertia.<br>5. Torsion of a circular shaft: shear strain and stress, the angle of twist.<br>6. Bending. Pure and symmetric bending: normal strain and stress. Deflection of beams: elastic curve. Statically indeterminate beams.<br>7. Un-symmetric bending.<br>8. Bending with a transverse shear: shear stresses in beams. Shear flow in thin-walled members, shear center.<br>9. Plane-stress transformation.<br>10. Stability of equilibrium and buckling of elastic columns.<br>11. Elastic strain energy and energy methods: Castigliano's theorem - determination of displacements and statically indeterminate problems.<br>12. *Membrane theory of rotational shells: thin-walled pressure vessels.*<br>(*) denotes an additional topic. |
| **Literature** | 1. R.C. Hibbeler, Mechanics of Materials, Pearson, Prentice Hall, SI 2 nd Edition<br>2. R.C. Hibbeler, Engineering Mechanics, Statics, Pearson, Prentice Hall, SI 3rd Edition<br>3. J.L. Meriam and L.G, Kraige, Engineering Mechanics, Vol. 1, Statics, John Wiley & Sons, SI Version, 4 th Edition |

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

## Module M1348: Fundamentals of Mechanical Engineering Design (GES)

**Courses**

| Title | Typ | Hrs/wk | CP |
|---|---|---|---|
| Fundamentals of Mechanical Engineering (GES) (L1898) | Lecture | 2 | 3 |
| Fundamentals of Mechanical Engineering (GES) (L1899) | Recitation Section (small) | 2 | 3 |

| | |
|---|---|
| **Module Responsible** | Dr. Arthur Seibel |
| **Admission Requirements** | None |
| **Recommended Previous Knowledge** | • Basic knowledge about mechanics and production engineering<br>• Internship (Stage I Practical) |
| **Educational Objectives** | After taking part successfully, students have reached the following learning results |
| **Professional Competence** | |
| *Knowledge* | After passing the module, students are able to:<br>• explain basic working principles and functions of machine elements,<br>• explain requirements, selection criteria, application scenarios and practical examples of basic machine elements, indicate the background of dimensioning calculations. |
| *Skills* | After passing the module, students are able to:<br>• accomplish dimensioning calculations of covered machine elements,<br>• transfer knowledge learned in the module to new requirements and tasks (problem solving skills),<br>• recognize the content of technical drawings and schematic sketches,<br>• technically evaluate basic designs. |
| **Personal Competence** | |
| *Social Competence* | Students are able to discuss technical information in the lecture supported by activating methods. |
| *Autonomy* | • Students are able to independently deepen their acquired knowledge in exercises.<br>• Students are able to acquire additional knowledge and to recapitulate poorly understood content e.g. by using the video recordings of the lectures. |
| **Workload in Hours** | Independent Study Time 124, Study Time in Lecture 56 |
| **Credit points** | 6 |
| **Course achievement** | None |
| **Examination** | Written exam |
| **Examination duration and scale** | 120 min |
| **Assignment for the Following Curricula** | Engineering Science: Core Qualification: Compulsory<br>General Engineering Science (English program, 7 semester): Core Qualification: Compulsory |

### Course L1898: Fundamentals of Mechanical Engineering (GES)

| | |
|---|---|
| **Typ** | Lecture |
| **Hrs/wk** | 2 |
| **CP** | 3 |
| **Workload in Hours** | Independent Study Time 62, Study Time in Lecture 28 |
| **Lecturer** | NN |
| **Language** | EN |
| **Cycle** | SoSe |
| **Content** | **Lecture**<br>• Introduction to design<br>• Introduction to the following machine elements<br>  ◦ Screws<br>  ◦ Shaft-hub joints<br>  ◦ Rolling contact bearings<br>  ◦ Welding / adhesive / solder joints<br>  ◦ Springs<br>  ◦ Axes & shafts<br>• Presentation of technical objects (technical drawing)<br>**Exercise**<br>• Calculation methods for dimensioning the following machine elements:<br>  ◦ Screws<br>  ◦ Shaft-hub joints<br>  ◦ Rolling contact bearings<br>  ◦ Welding / adhesive / solder joints<br>  ◦ Springs<br>  ◦ Axis & shafts |
| **Literature** | |

| Course L1899: Fundamentals of Mechanical Engineering (GES) | |
|---|---|
| **Typ** | Recitation Section (small) |
| **Hrs/wk** | 2 |
| **CP** | 3 |
| **Workload in Hours** | Independent Study Time 62, Study Time in Lecture 28 |
| **Lecturer** | NN |
| **Language** | EN |
| **Cycle** | SoSe |
| **Content** | See interlocking course |
| **Literature** | See interlocking course |

## Module M1574: Fundamentals of Materials Science (EN)

**Courses**

| Title | Typ | Hrs/wk | CP |
|---|---|---|---|
| Fundamentals of Materials Science I (GES) (L2357) | Lecture | 2 | 2 |
| Fundamentals of Materials Science II (Advanced Ceramic Materials, Polymers and Composites) (GES) (L2358) | Lecture | 2 | 2 |
| Physical and Chemical Basics of Materials Science (GES) (L2359) | Lecture | 2 | 2 |

| | |
|---|---|
| **Module Responsible** | Prof. Robert Meißner |
| **Admission Requirements** | None |
| **Recommended Previous Knowledge** | |
| **Educational Objectives** | After taking part successfully, students have reached the following learning results |
| **Professional Competence** | |
| *Knowledge* | |
| *Skills* | |
| **Personal Competence** | |
| *Social Competence* | |
| *Autonomy* | |
| **Workload in Hours** | Independent Study Time 96, Study Time in Lecture 84 |
| **Credit points** | 6 |
| **Course achievement** | None |
| **Examination** | Written exam |
| **Examination duration and scale** | 180 min |
| **Assignment for the Following Curricula** | Engineering Science: Core Qualification: Compulsory<br>General Engineering Science (English program, 7 semester): Core Qualification: Compulsory |

### Course L2357: Fundamentals of Materials Science I (GES)

| | |
|---|---|
| **Typ** | Lecture |
| **Hrs/wk** | 2 |
| **CP** | 2 |
| **Workload in Hours** | Independent Study Time 32, Study Time in Lecture 28 |
| **Lecturer** | NN |
| **Language** | EN |
| **Cycle** | WiSe |
| **Content** | |
| **Literature** | |

### Course L2358: Fundamentals of Materials Science II (Advanced Ceramic Materials, Polymers and Composites) (GES)

| | |
|---|---|
| **Typ** | Lecture |
| **Hrs/wk** | 2 |
| **CP** | 2 |
| **Workload in Hours** | Independent Study Time 32, Study Time in Lecture 28 |
| **Lecturer** | Prof. Robert Meißner, Prof. Kaline Pagnan Furlan |
| **Language** | EN |
| **Cycle** | SoSe |
| **Content** | |
| **Literature** | |

### Course L2359: Physical and Chemical Basics of Materials Science (GES)

| | |
|---|---|
| **Typ** | Lecture |
| **Hrs/wk** | 2 |
| **CP** | 2 |
| **Workload in Hours** | Independent Study Time 32, Study Time in Lecture 28 |
| **Lecturer** | NN |
| **Language** | EN |
| **Cycle** | WiSe |
| **Content** | |
| **Literature** | |

## Module M1732: Mathematics III (EN)

**Courses**

| Title | Typ | Hrs/wk | CP |
|---|---|---|---|
| Analysis III (English) (L2790) | Lecture | 2 | 2 |
| Analysis III (English) (L2791) | Recitation Section (large) | 1 | 1 |
| Analysis III (English) (L2792) | Recitation Section (small) | 1 | 1 |
| Differential Equations 1 (Ordinary Differential Equations) (L2793) | Lecture | 2 | 2 |
| Differential Equations 1 (Ordinary Differential Equations) (L2794) | Recitation Section (large) | 1 | 1 |
| Differential Equations 1 (Ordinary Differential Equations) (L2795) | Recitation Section (small) | 1 | 1 |

| | |
|---|---|
| **Module Responsible** | Prof. Anusch Taraz |
| **Admission Requirements** | None |
| **Recommended Previous Knowledge** | |
| **Educational Objectives** | After taking part successfully, students have reached the following learning results |
| **Professional Competence**<br>*Knowledge*<br>*Skills*<br>**Personal Competence**<br>*Social Competence*<br>*Autonomy* | |
| **Workload in Hours** | Independent Study Time 128, Study Time in Lecture 112 |
| **Credit points** | 8 |
| **Course achievement** | None |
| **Examination** | Written exam |
| **Examination duration and scale** | 120 min |
| **Assignment for the Following Curricula** | Computer Science: Core Qualification: Compulsory<br>Data Science: Core Qualification: Compulsory<br>Engineering Science: Core Qualification: Compulsory |

### Course L2790: Analysis III (English)

| | |
|---|---|
| **Typ** | Lecture |
| **Hrs/wk** | 2 |
| **CP** | 2 |
| **Workload in Hours** | Independent Study Time 32, Study Time in Lecture 28 |
| **Lecturer** | Dozenten des Fachbereiches Mathematik der UHH |
| **Language** | EN |
| **Cycle** | WiSe |
| **Content** | |
| **Literature** | |

### Course L2791: Analysis III (English)

| | |
|---|---|
| **Typ** | Recitation Section (large) |
| **Hrs/wk** | 1 |
| **CP** | 1 |
| **Workload in Hours** | Independent Study Time 16, Study Time in Lecture 14 |
| **Lecturer** | Dozenten des Fachbereiches Mathematik der UHH |
| **Language** | EN |
| **Cycle** | WiSe |
| **Content** | See interlocking course |
| **Literature** | See interlocking course |

### Course L2792: Analysis III (English)

| | |
|---|---|
| **Typ** | Recitation Section (small) |
| **Hrs/wk** | 1 |
| **CP** | 1 |
| **Workload in Hours** | Independent Study Time 16, Study Time in Lecture 14 |
| **Lecturer** | Dozenten des Fachbereiches Mathematik der UHH |
| **Language** | EN |
| **Cycle** | WiSe |
| **Content** | See interlocking course |
| **Literature** | See interlocking course |

| Course L2793: Differential Equations 1 (Ordinary Differential Equations) | |
|---|---|
| **Typ** | Lecture |
| **Hrs/wk** | 2 |
| **CP** | 2 |
| **Workload in Hours** | Independent Study Time 32, Study Time in Lecture 28 |
| **Lecturer** | Dozenten des Fachbereiches Mathematik der UHH |
| **Language** | EN |
| **Cycle** | WiSe |
| **Content** | |
| **Literature** | |

| Course L2794: Differential Equations 1 (Ordinary Differential Equations) | |
|---|---|
| **Typ** | Recitation Section (large) |
| **Hrs/wk** | 1 |
| **CP** | 1 |
| **Workload in Hours** | Independent Study Time 16, Study Time in Lecture 14 |
| **Lecturer** | Dozenten des Fachbereiches Mathematik der UHH |
| **Language** | EN |
| **Cycle** | WiSe |
| **Content** | See interlocking course |
| **Literature** | See interlocking course |

| Course L2795: Differential Equations 1 (Ordinary Differential Equations) | |
|---|---|
| **Typ** | Recitation Section (small) |
| **Hrs/wk** | 1 |
| **CP** | 1 |
| **Workload in Hours** | Independent Study Time 16, Study Time in Lecture 14 |
| **Lecturer** | Dozenten des Fachbereiches Mathematik der UHH |
| **Language** | EN |
| **Cycle** | WiSe |
| **Content** | See interlocking course |
| **Literature** | See interlocking course |

## Module M1105: Engineering Mechanics III (EN)

**Courses**

| Title | Typ | Hrs/wk | CP |
|---|---|---|---|
| Mechanics III (EN) (L1421) | Lecture | 3 | 3 |
| Mechanics III (EN) (L1420) | Recitation Section (small) | 2 | 2 |
| Mechanics III (EN) (L1419) | Recitation Section (large) | 1 | 1 |

| | |
|---|---|
| **Module Responsible** | Prof. Robert Seifried |
| **Admission Requirements** | None |
| **Recommended Previous Knowledge** | None |
| **Educational Objectives** | After taking part successfully, students have reached the following learning results |
| **Professional Competence** | |
| *Knowledge* | The primary purpose of the study of Mechanics III (Fluid Statics, Kinematics and Kinetics) is to develop the capacity to predict the effects of forces and motions, necessary for the analysis and design of moving machine parts, different machinery, vehicles, aircraft, spacecraft, automatic control systems, etc.The particular objectives of this course are to:<br>1. Determine the hydrostatic forces acting on different objects.<br>2. Analyse stability of floating bodies.<br>3. Analyse the kinematics and kinetics of a particle in different reference systems,<br>4. Analyse the motion of the system of particles and forces acting on it,<br>5. Analyse the plane motion of a rigid body (simple mechanism) and forces acting on it.<br>6. Analyse the three-dimensional motion of a rigid body and forces acting on it. |
| *Skills* | At the end of this course the student should be able to:<br>1. Solve the equilibrium problems with account for hydrostatic pressure forces.<br>2. Analyse stability of simple floating bodies.<br>3. Calculate the velocity and acceleration of a particle in different reference systems.<br>• 4. Derive and solve the equation of motion of a particle in different reference systems.<br>5. Analyse the motion of the system of particles and forces acting on it with the aid of work-energy and impulse-momentum relationships,<br>6. Calculate the instantaneous linear and angular velocities and accelerations of the planar mechanisms.<br>7. Derive and solve the equations of a plane motion of a rigid body and find forces acting on it,<br>8. Apply work-energy and impulse-momentum relationships to analyse plane kinetics of a rigid body.<br>9. Calculate the instantaneous linear and angular velocities and accelerations of the three-dimensional motion of a rigid body.<br>10. Derive the equations of a motion of a three-dimensional motion of a rigid body.<br>11. Apply in three-dimensional kinematics and kinetics of rigid body both methods of vector algebra and matrix methods. |
| **Personal Competence** | |
| *Social Competence* | Students can: - work in groups and report on the findings, - develop joint solutions in mixed teams and present them to others, - assess the team collaboration and their share in it. |
| *Autonomy* | Students are able to: -solve the problems independently with the help of hints, - assess their own strengths and weaknesses, e.g. with the aid of the mid-term test. |
| **Workload in Hours** | Independent Study Time 96, Study Time in Lecture 84 |
| **Credit points** | 6 |
| **Course achievement** | None |
| **Examination** | Written exam |
| **Examination duration and scale** | 2 hours Fluid Statics: hydrostatic pressure, buoyancy, stability of floating vessels. Kinematics of particle, of plane and 3D rigid bod,y. Kinetics of particle, system of particles, of plane and 3D rigid body. Vector and matrix algebra formulation. |
| **Assignment for the Following Curricula** | Engineering Science: Core Qualification: Compulsory<br>General Engineering Science (English program, 7 semester): Core Qualification: Compulsory |

### Course L1421: Mechanics III (EN)

| | |
|---|---|
| **Typ** | Lecture |
| **Hrs/wk** | 3 |
| **CP** | 3 |
| **Workload in Hours** | Independent Study Time 48, Study Time in Lecture 42 |
| **Lecturer** | Prof. Radoslaw Iwankiewicz |
| **Language** | EN |
| **Cycle** | WiSe |
| **Content** | See interlocking course |
| **Literature** | See interlocking course |

| Course L1420: Mechanics III (EN) | |
|---|---|
| **Typ** | Recitation Section (small) |
| **Hrs/wk** | 2 |
| **CP** | 2 |
| **Workload in Hours** | Independent Study Time 32, Study Time in Lecture 28 |
| **Lecturer** | Prof. Radoslaw Iwankiewicz |
| **Language** | EN |
| **Cycle** | WiSe |
| **Content** | See interlocking course |
| **Literature** | See interlocking course |

| Course L1419: Mechanics III (EN) | |
|---|---|
| **Typ** | Recitation Section (large) |
| **Hrs/wk** | 1 |
| **CP** | 1 |
| **Workload in Hours** | Independent Study Time 16, Study Time in Lecture 14 |
| **Lecturer** | Prof. Radoslaw Iwankiewicz |
| **Language** | EN |
| **Cycle** | WiSe |
| **Content** | FLUID STATICS<br>1. Fluid pressure, hydrostatic pressure on flat and cylindrical surfaces.<br>2. Buoyancy force, buoyancy center, metacenter, stability of floating objects.<br>KINEMATICS<br>1. Kinematics of a particle. Plane curvilinear motion: rectangular coordinates, normal and tangential coordinates, polar coordinates. Space curvilinear motion.<br>2. Constrained motion of connected particles.<br>3. Plane kinematics of a rigid body.<br>4. Relative (compound) motion.<br>5. Three-dimensional kinematics of a rigid body.<br>KINETICS<br>1. Kinetics of a particle and of a system of particles.<br>2. Plane kinetics of a rigid body.<br>3. Three-dimensional kinetics of a rigid body. |
| **Literature** | 1. J.L. Meriam and L.G, Kraige, Engineering Mechanics, Vol. 2, Dynamics, John Wiley & Sons, SI Version, 4 th Edition<br>2 . R.C. Hibbeler, Engineering Mechanics, Dynamics, Pearson, Prentice Hall, SI 3 rd Edition |

## Module M1583: Computer Science for Engineers (EN)

**Courses**

| Title | Typ | Hrs/wk | CP |
|---|---|---|---|
| **** Computer Science for Engineers (GES) (L2388) | Lecture | 0 | 3 |
| **** Computer Science for Engineers (GES) (L2389) | Recitation Section (small) | 3 | 3 |

| | |
|---|---|
| **Module Responsible** | Prof. Görschwin Fey |
| **Admission Requirements** | None |
| **Recommended Previous Knowledge** | |
| **Educational Objectives** | After taking part successfully, students have reached the following learning results |
| **Professional Competence** | |
| *Knowledge* | |
| *Skills* | |
| **Personal Competence** | |
| *Social Competence* | |
| *Autonomy* | |
| **Workload in Hours** | Independent Study Time 138, Study Time in Lecture 42 |
| **Credit points** | 6 |
| **Course achievement** | None |
| **Examination** | Written exam |
| **Examination duration and scale** | 90 min |
| **Assignment for the Following Curricula** | Engineering Science: Core Qualification: Compulsory<br>General Engineering Science (English program, 7 semester): Core Qualification: Compulsory |

### Course L2388: **** Computer Science for Engineers (GES)

| | |
|---|---|
| **Typ** | Lecture |
| **Hrs/wk** | 0 |
| **CP** | 3 |
| **Workload in Hours** | Independent Study Time 90, Study Time in Lecture 0 |
| **Lecturer** | NN |
| **Language** | EN |
| **Cycle** | WiSe |
| **Content** | You are a student of 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. |
| **Literature** | Bjarne Stroustrup: Die C++-Programmiersprache: Aktuell zu C++11. Carl Hanser Verlag GmbH & Co. KG (7. April 2015).<br>Helmut Herold, Bruno Lurz, Jürgen Wohlrab, Matthias Hopf: Grundlagen der Informatik, 3. Auflage, 816 Seiten, Pearson Studium, 2017.<br><br>Bjarne Stroustrup, Einführung in die Programmierung mit C++, 479 Seiten, Pearson Studium, 2010.<br><br>Jürgen Wolf : Grundkurs C++: C++-Programmierung verständlich erklärt, Rheinwerk Computing, 3. Auflage, 2016. |

### Course L2389: **** Computer Science for Engineers (GES)

| | |
|---|---|
| **Typ** | Recitation Section (small) |
| **Hrs/wk** | 3 |
| **CP** | 3 |
| **Workload in Hours** | Independent Study Time 48, Study Time in Lecture 42 |
| **Lecturer** | NN |
| **Language** | EN |
| **Cycle** | WiSe |
| **Content** | See interlocking course |
| **Literature** | See interlocking course |

## Module M0598: Mechanical Engineering: Design

**Courses**

| Title | Typ | Hrs/wk | CP |
|---|---|---|---|
| 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 |

**Module Responsible**
Prof. Dieter Krause

**Admission Requirements**
None

**Recommended Previous Knowledge**

- Fundamentals of Mechanical Engineering Design
- Mechanics
- Fundamentals of Materials Science
- Production Engineering

**Educational Objectives**
After taking part successfully, students have reached the following learning results

**Professional Competence**

*Knowledge*
After passing the module, students are able to:

- explain design guidelines for machinery parts e.g. considering load situation, materials and manufacturing requirements,
- describe basics of 3D CAD,
- explain basics methods of engineering designing.

*Skills*
After passing the module, students are able to:

- independently create sketches, technical drawings and documentations e.g. using 3D CAD,
- design components based on design guidelines autonomously,
- dimension (calculate) used components,
- use methods to design and solve engineering design tasks systamtically and solution-oriented,
- apply creativity techniques in teams.

**Personal Competence**

*Social Competence*
After passing the module, students are able to:

- develop and evaluate solutions in groups including making and documenting decisions,
- moderate the use of scientific methods,
- present and discuss solutions and technical drawings within groups,
- reflect the own results in the work groups of the course.

*Autonomy*
Students are able

- to estimate their level of knowledge using activating methods within the lectures (e.g. with clickers),
- To solve engineering design tasks systematically.

**Workload in Hours**
Independent Study Time 40, Study Time in Lecture 140

**Credit points**
6

**Course achievement**

| Compulsory | Bonus | Form | Description |
|---|---|---|---|
| Yes | None | Written elaboration | Konstruktionsprojekt 1 |
| Yes | None | Written elaboration | Konstruktionsprojekt 2 |
| Yes | None | Written elaboration | 3D-CAD-Praktikum |
| Yes | None | Written elaboration | Teamprojekt Konstruktionsmethodik |

**Examination**
Written exam

**Examination duration and scale**
180

**Assignment for the Following Curricula**
General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering: Compulsory
General Engineering Science (German program, 7 semester): Specialisation Biomedical Engineering: Compulsory
General Engineering Science (German program, 7 semester): Specialisation Biomedical Engineering: Compulsory
Digital Mechanical Engineering: Core Qualification: Compulsory
Energy and Environmental Engineering: Core Qualification: Compulsory
Engineering Science: Core Qualification: Compulsory
General Engineering Science (English program, 7 semester): Specialisation Biomedical Engineering: Compulsory
Green Technologies: Energy, Water, Climate: Specialisation Energy Technology: Elective Compulsory
Mechanical Engineering: Core Qualification: Compulsory
Mechatronics: Core Qualification: Compulsory
Naval Architecture: Core Qualification: Compulsory

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

| Course L0695: Mechanical Design Project I | |
|---|---|
| **Typ** | Project-/problem-based Learning |
| **Hrs/wk** | 3 |
| **CP** | 2 |
| **Workload in Hours** | Independent Study Time 18, Study Time in Lecture 42 |
| **Lecturer** | Prof. Thorsten Schüppstuhl |
| **Language** | DE |
| **Cycle** | WiSe |
| **Content** | • Create a technical documentation of an existing mechanical model<br>• Consolidation of the following aspects of technical drawings:<br>  ◦ Presentation of technical objects and standardized parts<br>  (bearings, seals, shaft-hub joints, detachable connections, springs, axes and shafts)<br>  ◦ Sectional views<br>  ◦ Dimensioning<br>  ◦ Tolerances and surface specifications<br>  ◦ Creating a tally sheet |
| **Literature** | 1. Hoischen, H.; Hesser, W.: Technisches Zeichnen. Grundlagen, Normen, Beispiele, darstellende Geometrie, 33. Auflage. Berlin 2011.<br>2. Labisch, S.; Weber, C.: Technisches Zeichnen. Selbstständig lernen und effektiv üben, 4. Auflage. Wiesbaden 2008.<br>3. Fischer, U.: Tabellenbuch Metall, 43. Auflage. Haan-Gruiten 2005. |

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

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

## Module M1571: Computational Mechanics (EN)

**Courses**

| Title | Typ | Hrs/wk | CP |
|---|---|---|---|
| Computational Mechanics (ES) (L2398) | Integrated Lecture | 4 | 4 |
| Computational Mechanics (ES) (L2399) | Recitation Section (small) | 2 | 2 |

| | |
|---|---|
| **Module Responsible** | Dr. Alexander Held |
| **Admission Requirements** | None |
| **Recommended Previous Knowledge** | |
| **Educational Objectives** | After taking part successfully, students have reached the following learning results |
| **Professional Competence** | |
| *Knowledge* | |
| *Skills* | |
| **Personal Competence** | |
| *Social Competence* | |
| *Autonomy* | |
| **Workload in Hours** | Independent Study Time 96, Study Time in Lecture 84 |
| **Credit points** | 6 |
| **Course achievement** | None |
| **Examination** | Written exam |
| **Examination duration and scale** | 120 min |
| **Assignment for the Following Curricula** | Engineering Science: Core Qualification: Compulsory<br>General Engineering Science (English program, 7 semester): Core Qualification: Compulsory |

### Course L2398: Computational Mechanics (ES)

| | |
|---|---|
| **Typ** | Integrated Lecture |
| **Hrs/wk** | 4 |
| **CP** | 4 |
| **Workload in Hours** | Independent Study Time 64, Study Time in Lecture 56 |
| **Lecturer** | Dr. Alexander Held |
| **Language** | EN |
| **Cycle** | SoSe |
| **Content** | |
| **Literature** | |

### Course L2399: Computational Mechanics (ES)

| | |
|---|---|
| **Typ** | Recitation Section (small) |
| **Hrs/wk** | 2 |
| **CP** | 2 |
| **Workload in Hours** | Independent Study Time 32, Study Time in Lecture 28 |
| **Lecturer** | Dr. Alexander Held |
| **Language** | EN |
| **Cycle** | SoSe |
| **Content** | See interlocking course |
| **Literature** | See interlocking course |

## Module M1501: Electromagnetics for Engineers I: Time-Independent Fields

**Courses**

| Title | Typ | Hrs/wk | CP |
|---|---|---|---|
| Electromagnetics for Engineers I: Time-Independent Fields (L2281) | Lecture | 3 | 5 |
| Electromagnetics for Engineers I: Time-Independent Fields (L2282) | Recitation Section (small) | 2 | 1 |

| | |
|---|---|
| **Module Responsible** | Dr. Cheng Yang |
| **Admission Requirements** | None |
| **Recommended Previous Knowledge** | Basic principles of electrical engineering and advanced mathematics |
| **Educational Objectives** | After taking part successfully, students have reached the following learning results |
| **Professional Competence** | |
| *Knowledge* | Students can explain the fundamental formulas, relations, and methods of the theory of time-independent electromagnetic fields. They can explicate the principal behavior of electrostatic, magnetostatic, and current density fields with regard to respective sources. They can describe the properties of complex electromagnetic fields by means of superposition of solutions for simple fields. The students are aware of applications for the theory of time-independent electromagnetic fields and are able to explicate these. |
| *Skills* | Students can apply Maxwell's Equations in integral notation in order to solve highly symmetrical, time-independent, electromagnetic field problems. Furthermore, they are capable of applying a variety of methods that require solving Maxwell's Equations for more general problems. The students can assess the principal effects of given time-independent sources of fields and analyze these quantitatively. They can deduce meaningful quantities for the characterization of electrostatic, magnetostatic, and electrical flow fields (capacitances, inductances, resistances, etc.) from given fields and dimension them for practical applications. |
| **Personal Competence** | |
| *Social Competence* | Students are able to work together on subject related tasks in small groups. They are able to present their results effectively (e.g. during exercise sessions). |
| *Autonomy* | Students are capable to gather necessary information from provided references and relate this information to the lecture. They are able to continually reflect their knowledge by means of activities that accompany the lecture, such as short oral quizzes during the lectures and exercises that are related to the exam. Based on respective feedback, students are expected to adjust their individual learning process. They are able to draw connections between their knowledge obtained in this lecture and the content of other lectures (e.g. Electrical Engineering I, Linear Algebra, and Analysis). |
| **Workload in Hours** | Independent Study Time 110, Study Time in Lecture 70 |
| **Credit points** | 6 |
| **Course achievement** | None |
| **Examination** | Written exam |
| **Examination duration and scale** | 120 min |
| **Assignment for the Following Curricula** | Engineering Science: Core Qualification: Compulsory<br>General Engineering Science (English program, 7 semester): Core Qualification: Compulsory |

| Course L2281: Electromagnetics for Engineers I: Time-Independent Fields | |
|---|---|
| **Typ** | Lecture |
| **Hrs/wk** | 3 |
| **CP** | 5 |
| **Workload in Hours** | Independent Study Time 108, Study Time in Lecture 42 |
| **Lecturer** | Dr. Cheng Yang, Prof. Christian Schuster |
| **Language** | EN |
| **Cycle** | SoSe |
| **Content** | - Maxwell’s Equations in integral and differential notation<br>- Boundary conditions<br>- Laws of conservation for energy and charge<br>- Classification of electromagnetic field properties<br>- Integral characteristics of time-independent fields (R, L, C)<br>- Generic approaches to solving Poisson’s Equation<br>- Electrostatic fields and specific methods of solving<br>- Magnetostatic fields and specific methods of solving<br>- Fields of electrical current density and specific methods of solving<br>- Action of force within time-independent fields<br>- Numerical methods for solving time-independent problems<br>The practical application of numerical methods will be trained within specifically prepared lectures in an interactive manner using small MATLAB programs. |
| **Literature** | - G. Lehner, "Elektromagnetische Feldtheorie: Für Ingenieure und Physiker", Springer (2010)<br>- H. Henke, "Elektromagnetische Felder: Theorie und Anwendung", Springer (2011)<br>- W. Nolting, "Grundkurs Theoretische Physik 3: Elektrodynamik", Springer (2011)<br>- D. Griffiths, "Introduction to Electrodynamics", Pearson (2012)<br>- J. Edminister, " Schaum's Outline of Electromagnetics", Mcgraw-Hill (2013)<br>- Richard Feynman, "Feynman Lectures on Physics: Volume 2", Basic Books (2011) |

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

## Module M1581: Signals and Systems (EN)

**Courses**

| Title | Typ | Hrs/wk | CP |
|---|---|---|---|
| Signals and Systems (L0433) | Recitation Section (small) | 2 | 2 |
| Signals and Systems (GES) (L2385) | Lecture | 3 | 4 |

| | |
|---|---|
| **Module Responsible** | Prof. Gerhard Bauch |
| **Admission Requirements** | None |
| **Recommended Previous Knowledge** | Mathematics 1-3<br><br>The modul is an introduction to the theory of signals and systems. Good knowledge in maths as covered by the moduls Mathematik 1-3 is expected. Further experience with spectral transformations (Fourier series, Fourier transform, Laplace transform) is useful but not required. |
| **Educational Objectives** | After taking part successfully, students have reached the following learning results |
| **Professional Competence** | |
| *Knowledge* | The students are able to classify and describe signals and linear time-invariant (LTI) systems using methods of signal and system theory. They are able to apply the fundamental transformations of continuous-time and discrete-time signals and systems. They can describe and analyse deterministic signals and systems mathematically in both time and image domain. In particular, they understand the effects in time domain and image domain which are caused by the transition of a continuous-time signal to a discrete-time signal. |
| *Skills* | The students are able to describe and analyse deterministic signals and linear time-invariant systems using methods of signal and system theory. They can analyse and design basic systems regarding important properties such as magnitude and phase response, stability, linearity etc.. They can assess the impact of LTI systems on the signal properties in time and frequency domain. |
| **Personal Competence** | |
| *Social Competence* | he students can jointly solve specific problems. |
| *Autonomy* | The students are able to acquire relevant information from appropriate literature sources. They can control their level of knowledge during the lecture period by solving tutorial problems, software tools, clicker system. |
| **Workload in Hours** | Independent Study Time 110, Study Time in Lecture 70 |
| **Credit points** | 6 |
| **Course achievement** | None |
| **Examination** | Written exam |
| **Examination duration and scale** | 90 min |
| **Assignment for the Following Curricula** | Engineering Science: Core Qualification: Compulsory<br>General Engineering Science (English program, 7 semester): Core Qualification: Compulsory |

| Course L0433: Signals and Systems | |
|---|---|
| **Typ** | Recitation Section (small) |
| **Hrs/wk** | 2 |
| **CP** | 2 |
| **Workload in Hours** | Independent Study Time 32, Study Time in Lecture 28 |
| **Lecturer** | Prof. Gerhard Bauch |
| **Language** | DE/EN |
| **Cycle** | SoSe |
| **Content** | • Basic classification and description of continuous-time and discrete-time signals and systems<br>• Concvolution<br>• Power and energy of signals<br>• Correlation functions of deterministic signals<br>• Linear time-invariant (LTI) systems<br>• Signal transformations:<br>  ◦ Fourier-Series<br>  ◦ Fourier Transform<br>  ◦ Laplace Transform<br>  ◦ Discrete-time Fourier Transform<br>  ◦ Discrete Fourier Transform (DFT), Fast Fourier Transform (FFT)<br>  ◦ Z-Transform<br>• Analysis and design of LTI systems in time and frequency domain<br>• Basic filter types<br>• Sampling, sampling theorem<br>• Fundamentals of recursive and non-recursive discrete-time filters |
| **Literature** | • T. Frey , M. Bossert , Signal- und Systemtheorie, B.G. Teubner Verlag 2004<br>• K. Kammeyer, K. Kroschel, Digitale Signalverarbeitung, Teubner Verlag.<br>• B. Girod ,R. Rabensteiner , A. Stenger , Einführung in die Systemtheorie, B.G. Teubner, Stuttgart, 1997<br>• J.R. Ohm, H.D. Lüke , Signalübertragung, Springer-Verlag 8. Auflage, 2002<br>• S. Haykin, B. van Veen: Signals and systems. Wiley.<br>• Oppenheim, A.S. Willsky: Signals and Systems. Pearson.<br>• Oppenheim, R. W. Schafer: Discrete-time signal processing. Pearson. |

| Course L2385: Signals and Systems (GES) | |
|---|---|
| **Typ** | Lecture |
| **Hrs/wk** | 3 |
| **CP** | 4 |
| **Workload in Hours** | Independent Study Time 78, Study Time in Lecture 42 |
| **Lecturer** | Prof. Gerhard Bauch |
| **Language** | EN |
| **Cycle** | SoSe |
| **Content** | |
| **Literature** | |

## Module M1580: Introduction to Control Systems (EN)

**Courses**

| Title | Typ | Hrs/wk | CP |
|---|---|---|---|
| Introduction to Control Systems (EN) (L2382) | Lecture | 2 | 4 |
| Introduction to Control Systems (EN) (L3011) | Recitation Section (small) | 2 | 2 |

| | |
|---|---|
| **Module Responsible** | Prof. Dr. Annika Eichler |
| **Admission Requirements** | None |
| **Recommended Previous Knowledge** | Representation of signals and systems in time and frequency domain, Laplace transform |
| **Educational Objectives** | After taking part successfully, students have reached the following learning results |
| **Professional Competence** | |
| *Knowledge* | • Students can represent dynamic system behavior in time and frequency domain, and can in particular explain properties of first and second order systems<br>• They can explain the dynamics of simple control loops and interpret dynamic properties in terms of frequency response and root locus<br>• They can explain the Nyquist stability criterion and the stability margins derived from it.<br>• They can explain the role of the phase margin in analysis and synthesis of control loops<br>• They can explain the way a PID controller affects a control loop in terms of its frequency response<br>• They can explain issues arising when controllers designed in continuous time domain are implemented digitally |
| *Skills* | • Students can transform models of linear dynamic systems from time to frequency domain and vice versa<br>• They can simulate and assess the behavior of systems and control loops<br>• They can design PID controllers with the help of heuristic (Ziegler-Nichols) tuning rules<br>• They can analyze and synthesize simple control loops with the help of root locus and frequency response techniques<br>• They can calculate discrete-time approximations of controllers designed in continuous-time and use it for digital implementation<br>• They can use standard software tools (Matlab Control Toolbox, Simulink) for carrying out these tasks |
| **Personal Competence** | |
| *Social Competence* | Students can work in small groups to jointly solve technical problems, and experimentally validate their controller designs |
| *Autonomy* | Students can obtain information from provided sources (lecture notes, software documentation, experiment guides) and use it when solving given problems.<br><br>They can assess their knowledge in weekly on-line tests and thereby control their learning progress. |
| **Workload in Hours** | Independent Study Time 124, Study Time in Lecture 56 |
| **Credit points** | 6 |
| **Course achievement** | None |
| **Examination** | Written exam |
| **Examination duration and scale** | 120 min |
| **Assignment for the Following Curricula** | Engineering Science: Core Qualification: Compulsory |

| Course L2382: Introduction to Control Systems (EN) | |
|---|---|
| **Typ** | Lecture |
| **Hrs/wk** | 2 |
| **CP** | 4 |
| **Workload in Hours** | Independent Study Time 92, Study Time in Lecture 28 |
| **Lecturer** | Prof. Dr. Annika Eichler |
| **Language** | EN |
| **Cycle** | WiSe |
| **Content** | Signals and systems<br>• Linear systems, differential equations and transfer functions<br>• First and second order systems, poles and zeros, impulse and step response<br>• Stability<br>Feedback systems<br>• Principle of feedback, open-loop versus closed-loop control<br>• Reference tracking and disturbance rejection<br>• Types of feedback, PID control<br>• System type and steady-state error, error constants<br>• Internal model principle<br>Root locus techniques<br>• Root locus plots<br>• Root locus design of PID controllers<br>Frequency response techniques<br>• Bode diagram<br>• Minimum and non-minimum phase systems<br>• Nyquist plot, Nyquist stability criterion, phase and gain margin<br>• Loop shaping, lead lag compensation<br>• Frequency response interpretation of PID control<br>Time delay systems<br>• Root locus and frequency response of time delay systems<br>• Smith predictor<br>Digital control<br>• Sampled-data systems, difference equations<br>• Tustin approximation, digital implementation of PID controllers<br>Software tools<br>• Introduction to Matlab, Simulink, Control toolbox<br>• Computer-based exercises throughout the course |
| **Literature** | • Werner, H., Lecture Notes „Introduction to Control Systems“<br>• G.F. Franklin, J.D. Powell and A. Emami-Naeini "Feedback Control of Dynamic Systems", Addison Wesley, Reading, MA, 2009<br>• K. Ogata "Modern Control Engineering", Fourth Edition, Prentice Hall, Upper Saddle River, NJ, 2010<br>• R.C. Dorf and R.H. Bishop, "Modern Control Systems", Addison Wesley, Reading, MA 2010 |

| Course L3011: Introduction to Control Systems (EN) | |
|---|---|
| **Typ** | Recitation Section (small) |
| **Hrs/wk** | 2 |
| **CP** | 2 |
| **Workload in Hours** | Independent Study Time 32, Study Time in Lecture 28 |
| **Lecturer** | Prof. Dr. Annika Eichler |
| **Language** | EN |
| **Cycle** | WiSe |
| **Content** | See interlocking course |
| **Literature** | See interlocking course |

## Module M1579: Fluid Mechanics (EN)

**Courses**

| Title | Typ | Hrs/wk | CP |
|---|---|---|---|
| Fluid Mechanics (EN) (L2383) | Lecture | 3 | 4 |
| Fluid Mechanics (EN) (L2384) | Recitation Section (large) | 2 | 2 |

| | |
|---|---|
| **Module Responsible** | Prof. Thomas Rung |
| **Admission Requirements** | None |
| **Recommended Previous Knowledge** | Sound knowledge of engineering mathematics, engineering mechanics and thermodynamics. |
| **Educational Objectives** | After taking part successfully, students have reached the following learning results |
| **Professional Competence** | |
| *Knowledge* | Students will have the required sound knowledge to explain the general principles of fluid engineering and physics of fluids. Students can scientifically outline the rationale of flow physics using mathematical models and are familiar with methods for the performance analysis and the prediciton of fluid engineering devices. |
| *Skills* | Students are able to apply fluid-engineering principles and flow-physics models for the analysis of technical systems. The lecture enables the student to carry out all necessary theoretical calculations for the fluid dynamic design of engineering devices on a scientific level. |
| **Personal Competence** | |
| *Social Competence* | The students are able to discuss problems and jointly develop solution strategies. |
| *Autonomy* | The students are able to develop solution strategies for complex problems self-consistent and crtically analyse results. |
| **Workload in Hours** | Independent Study Time 110, Study Time in Lecture 70 |
| **Credit points** | 6 |
| **Course achievement** | None |
| **Examination** | Written exam |
| **Examination duration and scale** | 180 min |
| **Assignment for the Following Curricula** | General Engineering Science (German program, 7 semester): Specialisation Advanced Materials: Compulsory<br>Engineering Science: Core Qualification: Compulsory |

### Course L2383: Fluid Mechanics (EN)

| | |
|---|---|
| **Typ** | Lecture |
| **Hrs/wk** | 3 |
| **CP** | 4 |
| **Workload in Hours** | Independent Study Time 78, Study Time in Lecture 42 |
| **Lecturer** | NN |
| **Language** | EN |
| **Cycle** | WiSe |
| **Content** | • continuum physics definition of fluids, difference to solids/structures and material properties of fluids<br>• dimensional analysis and similitude<br>• fluid forces and fluid statics<br>• transport and conservation of mass, momentum & energy<br>• fluid kinematics<br>• technically relevant flow models for incompressible fluids<br>  ◦ control volume & stream tube analysis<br>  ◦ vortical flow models<br>  ◦ potential flows<br>  ◦ boundary layer flows<br>  ◦ different types of conservation equations and their realm (Navier-Stokes/Euler/Bernoulli equations)<br>  ◦ analytical solutions for Navier-Stokes systems<br>• Analysis of internal flows (channels, pipes, open channels) and external flows, fundamentals of wing aerodynamics<br>• turbulent flows<br>• fundamentals of gas dynamics (1D compressible flows) |
| **Literature** | • <br>• <br>• <br>• |

| Course L2384: Fluid Mechanics (EN) | |
|---|---|
| **Typ** | Recitation Section (large) |
| **Hrs/wk** | 2 |
| **CP** | 2 |
| **Workload in Hours** | Independent Study Time 32, Study Time in Lecture 28 |
| **Lecturer** | NN |
| **Language** | EN |
| **Cycle** | WiSe |
| **Content** | See interlocking course |
| **Literature** | See interlocking course |

## Module M0662: Numerical Mathematics I

**Courses**

| Title | Typ | Hrs/wk | CP |
|---|---|---|---|
| Numerical Mathematics I (L0417) | Lecture | 2 | 3 |
| Numerical Mathematics I (L0418) | Recitation Section (small) | 2 | 3 |

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

| Course L0417: Numerical Mathematics I | |
|---|---|
| **Typ** | Lecture |
| **Hrs/wk** | 2 |
| **CP** | 3 |
| **Workload in Hours** | Independent Study Time 62, Study Time in Lecture 28 |
| **Lecturer** | Prof. Sabine Le Borne |
| **Language** | EN |
| **Cycle** | WiSe |
| **Content** | 1. Finite precision arithmetic, error analysis, conditioning and stability<br>2. Linear systems of equations: LU and Cholesky factorization, condition<br>3. Interpolation: polynomial, spline and trigonometric interpolation<br>4. Nonlinear equations: fixed point iteration, root finding algorithms, Newton's method<br>5. Linear and nonlinear least squares problems: normal equations, Gram Schmidt and Householder orthogonalization, singular value decomposition, regularizatio, Gauss-Newton and Levenberg-Marquardt methods<br>6. Eigenvalue problems: power iteration, inverse iteration, QR algorithm<br>7. Numerical differentiation<br>8. Numerical integration: Newton-Cotes rules, error estimates, Gauss quadrature, adaptive quadrature |
| **Literature** | • Gander/Gander/Kwok: Scientific Computing: An introduction using Maple and MATLAB, Springer (2014)<br>• Stoer/Bulirsch: Numerische Mathematik 1, Springer<br>• Dahmen, Reusken: Numerik für Ingenieure und Naturwissenschaftler, Springer |

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

## 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 |

| | |
|---|---|
| **Module Responsible** | Prof. Hermann Lödding |
| **Admission Requirements** | None |
| **Recommended Previous Knowledge** | None |
| **Educational Objectives** | After taking part successfully, students have reached the following learning results |
| **Professional Competence** | |
| *Knowledge* | Students are able to explain the contents of the lecture of the module. |
| *Skills* | Students are able to apply the methods and models in the module to industrial problems. |
| **Personal Competence** | |
| *Social Competence* | - |
| *Autonomy* | - |
| **Workload in Hours** | Independent Study Time 124, Study Time in Lecture 56 |
| **Credit points** | 6 |
| **Course achievement** | None |
| **Examination** | Written exam |
| **Examination duration and scale** | 180 Minuten |
| **Assignment for the Following Curricula** | General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Aircraft Systems Engineering: Compulsory<br>General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Product Development and Production: Compulsory<br>General Engineering Science (German program, 7 semester): Specialisation Advanced Materials: Elective Compulsory<br>Engineering Science: Core Qualification: Compulsory<br>Engineering Science: Specialisation Mechatronics: Elective Compulsory<br>Engineering Science: Specialisation Mechanical Engineering: Elective Compulsory<br>Engineering Science: Specialisation Advanced Materials: Elective Compulsory<br>Logistics and Mobility: Specialisation Production Management and Processes: Compulsory<br>Logistics and Mobility: Specialisation Engineering Science: Elective Compulsory<br>Mechanical Engineering: Core Qualification: Elective Compulsory<br>Engineering and Management - Major in Logistics and Mobility: Specialisation Production Management and Processes: Compulsory |

### Course L0925: Production Process Organization

| | |
|---|---|
| **Typ** | Lecture |
| **Hrs/wk** | 2 |
| **CP** | 3 |
| **Workload in Hours** | Independent Study Time 62, Study Time in Lecture 28 |
| **Lecturer** | Prof. Hermann Lödding |
| **Language** | EN |
| **Cycle** | SoSe |
| **Content** | (A) Introduction<br>(B) Product planning<br>(C) Process planning<br>(D) Procurement<br>(E) Manufacturing<br>(F) Production planning and control (PPC)<br>(G) Distribution<br>(H) Cooperation |
| **Literature** | Wiendahl, H.-P.: Betriebsorganisation für Ingenieure<br>Vorlesungsskript |

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

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

**Courses**

| Title | Typ | Hrs/wk | CP |
|---|---|---|---|
| Modeling, Simulation and Optimization (EN) (L2446) | Integrated Lecture | 4 | 6 |

| | |
|---|---|
| **Module Responsible** | Prof. Benedikt Kriegesmann |
| **Admission Requirements** | None |
| **Recommended Previous Knowledge** | Sound knowledge of engineering mathematics, engineering mechanics and fluid mechanics |
| **Educational Objectives** | After taking part successfully, students have reached the following learning results |
| **Professional Competence** | |
| *Knowledge* | Students will have an overview of various technical problems and the differential equations, which describe them. Students will gave an overview of different solution approaches and for which kind of problems they can be used for. |
| *Skills* | Students are able to solve different technical problems with the introduced discretization methods. |
| **Personal Competence** | |
| *Social Competence* | The students are able to discuss problems and jointly develop solution strategies. |
| *Autonomy* | The students are able to develop solution strategies for complex problems self-consistent and critically analyse results. |
| **Workload in Hours** | Independent Study Time 124, Study Time in Lecture 56 |
| **Credit points** | 6 |
| **Course achievement** | None |
| **Examination** | Oral exam |
| **Examination duration and scale** | 30 min |
| **Assignment for the Following Curricula** | General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Theoretical Mechanical Engineering: Compulsory<br>General Engineering Science (German program, 7 semester): Specialisation Advanced Materials: Compulsory<br>General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Aircraft Systems Engineering: Elective Compulsory<br>Engineering Science: Core Qualification: Compulsory<br>Mechanical Engineering: Specialisation Theoretical Mechanical Engineering: Compulsory<br>Technomathematics: Specialisation III. Engineering Science: Elective Compulsory |

### Course L2446: Modeling, Simulation and Optimization (EN)

| | |
|---|---|
| **Typ** | Integrated Lecture |
| **Hrs/wk** | 4 |
| **CP** | 6 |
| **Workload in Hours** | Independent Study Time 124, Study Time in Lecture 56 |
| **Lecturer** | Prof. Benedikt Kriegesmann, Prof. Alexander Düster, Prof. Robert Seifried, Prof. Thomas Rung |
| **Language** | EN |
| **Cycle** | SoSe |
| **Content** | • Partial Differential Equations in technical problems<br>• Overview of modelling approaches<br>• Finite Approximation Methods - Finite Differences / Elements / Volumes<br>• Introduction to the Discrete Element Method<br>• Numerical methods for time dependent problems<br>• Gradient-based optimization |
| **Literature** | Michael Schäfer, Computational Engineering - Introduction to Numerical Methods, Springer. |

## Module M1585: Foundations of Management (EN)

**Courses**

| Title | Typ | Hrs/wk | CP |
|---|---|---|---|
| *** Introduction to Management (EN) (L2403) | Lecture | 3 | 3 |
| *** Introduction to Management (EN) (L2404) | Recitation Section (small) | 3 | 3 |

| | |
|---|---|
| **Module Responsible** | Prof. Tim Schweisfurth |
| **Admission Requirements** | None |
| **Recommended Previous Knowledge** | Basic Knowledge of Mathematics and Business |
| **Educational Objectives** | After taking part successfully, students have reached the following learning results |
| **Professional Competence** | |
| *Knowledge* | 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<br>• explain the differences between Economics and Management and the sub-disciplines in Management and to name important definitions from the field of Management<br>• explain the most important aspects of and goals in Management and name the most important aspects of entreprneurial projects<br>• describe and explain basic business functions as production, procurement and sourcing, supply chain management, organization and human ressource management, information management, innovation management and marketing<br>• 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<br>• state basics from accounting and costing and selected controlling methods. |
| *Skills* | |
| **Personal Competence** | |
| *Social Competence* | |
| *Autonomy* | |
| **Workload in Hours** | Independent Study Time 96, Study Time in Lecture 84 |
| **Credit points** | 6 |
| **Course achievement** | None |
| **Examination** | Subject theoretical and practical work |
| **Examination duration and scale** | several written exams during the semester |
| **Assignment for the Following Curricula** | Engineering Science: Core Qualification: Compulsory |

### Course L2403: *** Introduction to Management (EN)

| | |
|---|---|
| **Typ** | Lecture |
| **Hrs/wk** | 3 |
| **CP** | 3 |
| **Workload in Hours** | Independent Study Time 48, Study Time in Lecture 42 |
| **Lecturer** | Prof. Tim Schweisfurth |
| **Language** | EN |
| **Cycle** | SoSe |
| **Content** | • <br>• <br>• |
| **Literature** | |

### Course L2404: *** Introduction to Management (EN)

| | |
|---|---|
| **Typ** | Recitation Section (small) |
| **Hrs/wk** | 3 |
| **CP** | 3 |
| **Workload in Hours** | Independent Study Time 48, Study Time in Lecture 42 |
| **Lecturer** | Prof. Tim Schweisfurth |
| **Language** | EN |
| **Cycle** | SoSe |
| **Content** | See interlocking course |
| **Literature** | See interlocking course |

## Module M1273: Advanced Internship AIW/ ES

**Courses**

| Title | Typ | Hrs/wk | CP |
|---|---|---|---|
| Advanced Intenship AIW/ ES: Internship-accompanying Seminar (L2687) | Seminar | 1 | 0 |
| Advanced Internship AIW/ ES: Preparation (L2682) | Seminar | 1 | 0 |

| | |
|---|---|
| **Module Responsible** | Prof. Robert Seifried |
| **Admission Requirements** | None |
| **Recommended Previous Knowledge** | 150 Creditpoints in General Engineering Science |
| **Educational Objectives** | After taking part successfully, students have reached the following learning results |
| **Professional Competence** | |
| *Knowledge* | Students of the different specialisations get experiences in typical scope of duties of engineers, who are working in a development division, planning division or in the management of a company. In the framework of this environment the knowledge from university can used a first time for real engineering tasks. |
| *Skills* | Students of the different specialisations should be integrated in typical day's work. By this they are learning typical tasks and functions of engineers. They are able to structure and organize their working day and to finish tasks in a certain time. |
| **Personal Competence** | |
| *Social Competence* | Students are able to cooperate with co-workers in a company and to understand the language of engineers. |
| *Autonomy* | Students can finish own tasks. |
| **Workload in Hours** | Independent Study Time 512, Study Time in Lecture 28 |
| **Credit points** | 18 |
| **Course achievement** | None |
| **Examination** | Written elaboration (accord. to Internship Regulations) |
| **Examination duration and scale** | see Internship Regulations |
| **Assignment for the Following Curricula** | General Engineering Science (German program, 7 semester): Core Qualification: Compulsory<br>Engineering Science: Core Qualification: Compulsory |

### Course L2687: Advanced Intenship AIW/ ES: Internship-accompanying Seminar

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

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

## Specialization Advanced Materials

### Module M1348: Fundamentals of Mechanical Engineering Design (EN)

**Courses**

| Title | Typ | Hrs/wk | CP |
|---|---|---|---|
| Fundamentals of Mechanical Engineering (GES) (L1898) | Lecture | 2 | 3 |
| Fundamentals of Mechanical Engineering (GES) (L1899) | Recitation Section (small) | 2 | 3 |

| | |
|---|---|
| **Module Responsible** | Dr. Arthur Seibel |
| **Admission Requirements** | None |
| **Recommended Previous Knowledge** | • Basic knowledge about mechanics and production engineering<br>• Internship (Stage I Practical) |
| **Educational Objectives** | After taking part successfully, students have reached the following learning results |
| **Professional Competence** | |
| *Knowledge* | After passing the module, students are able to:<br>• explain basic working principles and functions of machine elements,<br>• explain requirements, selection criteria, application scenarios and practical examples of basic machine elements, indicate the background of dimensioning calculations. |
| *Skills* | After passing the module, students are able to:<br>• accomplish dimensioning calculations of covered machine elements,<br>• transfer knowledge learned in the module to new requirements and tasks (problem solving skills),<br>• recognize the content of technical drawings and schematic sketches,<br>• technically evaluate basic designs. |
| **Personal Competence** | |
| *Social Competence* | Students are able to discuss technical information in the lecture supported by activating methods. |
| *Autonomy* | • Students are able to independently deepen their acquired knowledge in exercises.<br>• Students are able to acquire additional knowledge and to recapitulate poorly understood content e.g. by using the video recordings of the lectures. |
| **Workload in Hours** | Independent Study Time 124, Study Time in Lecture 56 |
| **Credit points** | 6 |
| **Course achievement** | None |
| **Examination** | Written exam |
| **Examination duration and scale** | 120 min |
| **Assignment for the Following Curricula** | Engineering Science: Core Qualification: Compulsory<br>Engineering Science: Specialisation Mechanical Engineering: Compulsory<br>Engineering Science: Specialisation Mechatronics: Compulsory<br>Engineering Science: Specialisation Biomedical Engineering: Compulsory<br>Engineering Science: Specialisation Advanced Materials: Elective Compulsory |

| Course L1898: Fundamentals of Mechanical Engineering (GES) | |
|---|---|
| **Typ** | Lecture |
| **Hrs/wk** | 2 |
| **CP** | 3 |
| **Workload in Hours** | Independent Study Time 62, Study Time in Lecture 28 |
| **Lecturer** | NN |
| **Language** | EN |
| **Cycle** | SoSe |
| **Content** | **Lecture**<br>• Introduction to design<br>• Introduction to the following machine elements<br>  ◦ Screws<br>  ◦ Shaft-hub joints<br>  ◦ Rolling contact bearings<br>  ◦ Welding / adhesive / solder joints<br>  ◦ Springs<br>  ◦ Axes & shafts<br>• Presentation of technical objects (technical drawing)<br>**Exercise**<br>• Calculation methods for dimensioning the following machine elements:<br>  ◦ Screws<br>  ◦ Shaft-hub joints<br>  ◦ Rolling contact bearings<br>  ◦ Welding / adhesive / solder joints<br>  ◦ Springs<br>  ◦ Axis & shafts |
| **Literature** | |

| Course L1899: Fundamentals of Mechanical Engineering (GES) | |
|---|---|
| **Typ** | Recitation Section (small) |
| **Hrs/wk** | 2 |
| **CP** | 3 |
| **Workload in Hours** | Independent Study Time 62, Study Time in Lecture 28 |
| **Lecturer** | NN |
| **Language** | EN |
| **Cycle** | SoSe |
| **Content** | See interlocking course |
| **Literature** | See interlocking course |

# Specialization Electrical Engineering

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

Graduates will have

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

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

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

## Module M0760: Electronic Devices

**Courses**

| Title | Typ | Hrs/wk | CP |
|---|---|---|---|
| Electronic Devices (L0720) | Lecture | 3 | 4 |
| Electronic Devices (L0721) | Project-/problem-based Learning | 2 | 2 |

| | |
|---|---|
| **Module Responsible** | Prof. Hoc Khiem Trieu |
| **Admission Requirements** | None |
| **Recommended Previous Knowledge** | Atomic model and quantum theory, electrical currents in solid state materials, basics in solid-state physics<br><br>Successful participation of Physics for Engineers and Materials in Electrical Engineering or courses with equivalent contents |
| **Educational Objectives** | After taking part successfully, students have reached the following learning results |
| **Professional Competence**<br>*Knowledge* | Students are able<br>• to represent the basics of semiconductor physics,<br>• to explain the operating principle of important semiconductor devices,<br>• to outline device characteristics and equivalent circuits as well as to explain their derivation and<br>• to discuss the limitation of device models. |
| *Skills* | Students are capable<br>• to apply devices in basic circuits,<br>• to realize the physical context and to solve complex problems by oneself |
| **Personal Competence**<br>*Social Competence* | Students are able to prepare and perform their lab experiments in team work as well as to present and discuss the results in front of audience. |
| *Autonomy* | Students are capable to acquire knowledge based on literature in order to prepare their experiments. |
| **Workload in Hours** | Independent Study Time 110, Study Time in Lecture 70 |
| **Credit points** | 6 |
| **Course achievement** | **Compulsory** / **Bonus** / **Form** / **Description**<br>Yes / 10 % / Subject theoretical and practical work / Studierenden erarbeiten in Kleingruppen Wissen zu einem bestimmten Thema, demonstrieren dieses in Form eines Versuches mit Präsentation und Diskussion. Darüber hinaus betreut jede Gruppe eine Übungsaufgabe, die inhaltlich zu dem jeweiligen Versuch gehört. |
| **Examination** | Written exam |
| **Examination duration and scale** | 120 min |
| **Assignment for the Following Curricula** | General Engineering Science (German program, 7 semester): Specialisation Electrical Engineering: Compulsory<br>Electrical Engineering: Core Qualification: Compulsory<br>Engineering Science: Specialisation Electrical Engineering: Compulsory<br>General Engineering Science (English program, 7 semester): Specialisation Electrical Engineering: Compulsory<br>Computer Science in Engineering: Specialisation II. Mathematics & Engineering Science: Elective Compulsory |

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

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

## Module M0568: Theoretical Electrical Engineering II: Time-Dependent Fields

**Courses**

| Title | Typ | Hrs/wk | CP |
|---|---|---|---|
| Theoretical Electrical Engineering II: Time-Dependent Fields (L0182) | Lecture | 3 | 5 |
| Theoretical Electrical Engineering II: Time-Dependent Fields (L0183) | Recitation Section (small) | 2 | 1 |

| | |
|---|---|
| **Module Responsible** | Prof. Christian Schuster |
| **Admission Requirements** | None |
| **Recommended Previous Knowledge** | Electrical Engineering I, Electrical Engineering II, Theoretical Electrical Engineering I<br><br>Mathematics I, Mathematics II, Mathematics III, Mathematics IV |
| **Educational Objectives** | After taking part successfully, students have reached the following learning results |
| **Professional Competence** | |
| *Knowledge* | Students are able to explain fundamental formulas, relations, and methods related to the theory of time-dependent electromagnetic fields. They can assess the principal behavior and characteristics of quasistationary and fully dynamic fields with regard to respective sources. They can describe the properties of complex electromagnetic fields by means of superposition of solutions for simple fields. The students are aware of applications for the theory of time-dependent electromagnetic fields and are able to explicate these. |
| *Skills* | Students are able to apply a variety of procedures in order to solve the diffusion and the wave equation for general time-dependent field problems. They can assess the principal effects of given time-dependent sources of fields and analyze these quantitatively. They can deduce meaningful quantities for the characterization of fully dynamic fields (wave impedance, skin depth, Poynting-vector, radiation resistance, etc.) from given fields and interpret them with regard to practical applications. |
| **Personal Competence** | |
| *Social Competence* | Students are able to work together on subject related tasks in small groups. They are able to present their results effectively (e.g. during exercise sessions). |
| *Autonomy* | Students are capable to gather necessary information from provided references and relate this information to the lecture. They are able to continually reflect their knowledge by means of activities that accompany the lecture, such as short oral quizzes during the lectures and exercises that are related to the exam. Based on respective feedback, students are expected to adjust their individual learning process. They are able to draw connections between acquired knowledge and ongoing research at the Hamburg University of Technology (TUHH), e.g. in the area of high frequency engineering and optics. |
| **Workload in Hours** | Independent Study Time 110, Study Time in Lecture 70 |
| **Credit points** | 6 |
| **Course achievement** | None |
| **Examination** | Written exam |
| **Examination duration and scale** | 90-150 minutes |
| **Assignment for the Following Curricula** | General Engineering Science (German program, 7 semester): Specialisation Electrical Engineering: Compulsory<br>Electrical Engineering: Core Qualification: Compulsory<br>Engineering Science: Specialisation Electrical Engineering: Compulsory<br>Engineering Science: Specialisation Mechatronics: Elective Compulsory<br>Engineering Science: Specialisation Mechatronics: Elective Compulsory<br>Technomathematics: Specialisation III. Engineering Science: Elective Compulsory |

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

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

## Module M1730: Mathematics IV (EN)

**Courses**

| Title | Typ | Hrs/wk | CP |
|---|---|---|---|
| Differential Equations 2 (Partial Differential Equations) (EN) (L2783) | Lecture | 2 | 1 |
| Differential Equations 2 (Partial Differential Equations) (EN) (L2784) | Recitation Section (large) | 1 | 1 |
| Differential Equations 2 (Partial Differential Equations) (EN) (L2785) | Recitation Section (small) | 1 | 1 |
| Complex Functions (EN) (L2786) | Lecture | 2 | 1 |
| Complex Functions (EN) (L2787) | Recitation Section (large) | 1 | 1 |
| Complex Functions (EN) (L2788) | Recitation Section (small) | 1 | 1 |

| | |
|---|---|
| **Module Responsible** | Prof. Anusch Taraz |
| **Admission Requirements** | None |
| **Recommended Previous Knowledge** | Mathematics I - III (EN or DE) |
| **Educational Objectives** | After taking part successfully, students have reached the following learning results |
| **Professional Competence** | |
| *Knowledge* | • Students can name the basic concepts in Mathematics IV. They are able to explain them using appropriate examples.<br>• Students can discuss logical connections between these concepts. They are capable of illustrating these connections with the help of examples.<br>• They know proof strategies and can reproduce them. |
| *Skills* | • 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.<br>• Students are able to discover and verify further logical connections between the concepts studied in the course.<br>• For a given problem, the students can develop and execute a suitable approach, and are able to critically evaluate the results. |
| **Personal Competence** | |
| *Social Competence* | • Students are able to work together in teams. They are capable to use mathematics as a common language.<br>• 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. |
| *Autonomy* | • Students are capable of checking their understanding of complex concepts on their own. They can specify open questions precisely and know where to get help in solving them.<br>• Students have developed sufficient persistence to be able to work for longer periods in a goal-oriented manner on hard problems. |
| **Workload in Hours** | Independent Study Time 68, Study Time in Lecture 112 |
| **Credit points** | 6 |
| **Course achievement** | None |
| **Examination** | Written exam |
| **Examination duration and scale** | 120 min |
| **Assignment for the Following Curricula** | General Engineering Science (German program, 7 semester): Specialisation Advanced Materials: Compulsory<br>Computer Science: Specialisation II. Mathematics and Engineering Science: Elective Compulsory<br>Data Science: Core Qualification: Elective Compulsory<br>Data Science: Specialisation I. Mathematics/Computer Science: Elective Compulsory<br>Engineering Science: Specialisation Electrical Engineering: Compulsory<br>Engineering Science: Core Qualification: Compulsory<br>Engineering Science: Core Qualification: Compulsory<br>Engineering Science: Specialisation Mechatronics: Elective Compulsory |

| Course L2783: Differential Equations 2 (Partial Differential Equations) (EN) | |
|---|---|
| **Typ** | Lecture |
| **Hrs/wk** | 2 |
| **CP** | 1 |
| **Workload in Hours** | Independent Study Time 2, Study Time in Lecture 28 |
| **Lecturer** | Dozenten des Fachbereiches Mathematik der UHH |
| **Language** | EN |
| **Cycle** | SoSe |
| **Content** | Main features of the theory and numerical treatment of partial differential equations<br>• Examples of partial differential equations<br>• First order quasilinear differential equations<br>• Normal forms of second order differential equations<br>• Harmonic functions and maximum principle<br>• Maximum principle for the heat equation<br>• Wave equation<br>• Liouville's formula<br>• Special functions<br>• Difference methods<br>• Finite elements |
| **Literature** | http://www.math.uni-hamburg.de/teaching/export/tuhh/index.html |

| Course L2784: Differential Equations 2 (Partial Differential Equations) (EN) | |
|---|---|
| **Typ** | Recitation Section (large) |
| **Hrs/wk** | 1 |
| **CP** | 1 |
| **Workload in Hours** | Independent Study Time 16, Study Time in Lecture 14 |
| **Lecturer** | Dozenten des Fachbereiches Mathematik der UHH |
| **Language** | EN |
| **Cycle** | SoSe |
| **Content** | See interlocking course |
| **Literature** | See interlocking course |

| Course L2785: Differential Equations 2 (Partial Differential Equations) (EN) | |
|---|---|
| **Typ** | Recitation Section (small) |
| **Hrs/wk** | 1 |
| **CP** | 1 |
| **Workload in Hours** | Independent Study Time 16, Study Time in Lecture 14 |
| **Lecturer** | Dozenten des Fachbereiches Mathematik der UHH |
| **Language** | EN |
| **Cycle** | SoSe |
| **Content** | See interlocking course |
| **Literature** | See interlocking course |

| Course L2786: Complex Functions (EN) | |
|---|---|
| **Typ** | Lecture |
| **Hrs/wk** | 2 |
| **CP** | 1 |
| **Workload in Hours** | Independent Study Time 2, Study Time in Lecture 28 |
| **Lecturer** | Dozenten des Fachbereiches Mathematik der UHH |
| **Language** | EN |
| **Cycle** | SoSe |
| **Content** | Main features of complex analysis<br>• Functions of one complex variable<br>• Complex differentiation<br>• Conformal mappings<br>• Complex integration<br>• Cauchy's integral theorem<br>• Cauchy's integral formula<br>• Taylor and Laurent series expansion<br>• Singularities and residuals<br>• Integral transformations: Fourier and Laplace transformation |
| **Literature** | http://www.math.uni-hamburg.de/teaching/export/tuhh/index.html |

| Course L2787: Complex Functions (EN) | |
|---|---|
| **Typ** | Recitation Section (large) |
| **Hrs/wk** | 1 |
| **CP** | 1 |
| **Workload in Hours** | Independent Study Time 16, Study Time in Lecture 14 |
| **Lecturer** | Dozenten des Fachbereiches Mathematik der UHH |
| **Language** | EN |
| **Cycle** | SoSe |
| **Content** | See interlocking course |
| **Literature** | See interlocking course |

| Course L2788: Complex Functions (EN) | |
|---|---|
| **Typ** | Recitation Section (small) |
| **Hrs/wk** | 1 |
| **CP** | 1 |
| **Workload in Hours** | Independent Study Time 16, Study Time in Lecture 14 |
| **Lecturer** | Dozenten des Fachbereiches Mathematik der UHH |
| **Language** | EN |
| **Cycle** | SoSe |
| **Content** | See interlocking course |
| **Literature** | See interlocking course |

## Module M0777: Semiconductor Circuit Design

**Courses**

| Title | Typ | Hrs/wk | CP |
|---|---|---|---|
| Semiconductor Circuit Design (L0763) | Lecture | 3 | 4 |
| Semiconductor Circuit Design (L0864) | Recitation Section (small) | 1 | 2 |

| | |
|---|---|
| **Module Responsible** | Prof. Matthias Kuhl |
| **Admission Requirements** | None |
| **Recommended Previous Knowledge** | Fundamentals of electrical engineering<br><br>Basics of physics, especially semiconductor physics |
| **Educational Objectives** | After taking part successfully, students have reached the following learning results |
| **Professional Competence** | |
| *Knowledge* | • Students are able to explain the functionality of different MOS devices in electronic circuits.<br>• Students are able to explain how analog circuits functions and where they are applied.<br>• Students are able to explain the functionality of fundamental operational amplifiers and their specifications.<br>• Students know the fundamental digital logic circuits and can discuss their advantages and disadvantages.<br>• Students have knowledge about memory circuits and can explain their functionality and specifications.<br>• Students know the appropriate fields for the use of bipolar transistors. |
| *Skills* | • Students can calculate the specifications of different MOS devices and can define the parameters of electronic circuits.<br>• Students are able to develop different logic circuits and can design different types of logic circuits.<br>• Students can use MOS devices, operational amplifiers and bipolar transistors for specific applications. |
| **Personal Competence** | |
| *Social Competence* | • Students are able work efficiently in heterogeneous teams.<br>• Students working together in small groups can solve problems and answer professional questions. |
| *Autonomy* | • Students are able to assess their level of knowledge. |
| **Workload in Hours** | Independent Study Time 124, Study Time in Lecture 56 |
| **Credit points** | 6 |
| **Course achievement** | None |
| **Examination** | Written exam |
| **Examination duration and scale** | 120 min |
| **Assignment for the Following Curricula** | General Engineering Science (German program, 7 semester): Specialisation Electrical Engineering: Compulsory<br>General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Mechatronics: Compulsory<br>Data Science: Core Qualification: Elective Compulsory<br>Electrical Engineering: Core Qualification: Compulsory<br>Engineering Science: Specialisation Electrical Engineering: Compulsory<br>Engineering Science: Specialisation Mechatronics: Compulsory<br>General Engineering Science (English program, 7 semester): Specialisation Electrical Engineering: Compulsory<br>General Engineering Science (English program, 7 semester): Specialisation Mechatronics: Compulsory<br>Computer Science in Engineering: Specialisation II. Mathematics & Engineering Science: Elective Compulsory<br>Mechanical Engineering: Specialisation Mechatronics: Compulsory<br>Mechatronics: Core Qualification: Compulsory<br>Technomathematics: Specialisation III. Engineering Science: Elective Compulsory |

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

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

# Specialization Mechanical Engineering

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

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

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

3) In-depth knowledge in Engineering applications, especially in the selected subject area of focus (product development and manufacturing, material science, aircrafts, energy Engineering, mechatronics, medical engineering, theoretical mechanical engineering). They have in particular the necessary methodological knowledge and its application to engineering problems, taking into account technical specifications and economic and social parameters.
4) The ability to work scientifically and to expand their specialized knowledge independently.
Graduates are able to work responsibly and competently as mechanical engineers, especially in occupations related to the selected subject area of focus.

## 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 |

| | |
|---|---|
| **Module Responsible** | Prof. Wolfgang Hintze |
| **Admission Requirements** | None |
| **Recommended Previous Knowledge** | no course assessments required<br><br>internship recommended |
| **Educational Objectives** | After taking part successfully, students have reached the following learning results |
| **Professional Competence** | |
| *Knowledge* | Students are able to ...<br><br>• name basic criteria for the selection of manufacturing processes.<br>• name the main groups of Manufacturing Technology.<br>• name the application areas of different manufacturing processes.<br>• name boundaries, advantages and disadvantages of the different manufacturing process.<br>• describe elements, geometric properties and kinematic variables and requirements for tools, workpiece and process.<br>• explain the essential models of manufacturing technology. |
| *Skills* | Students are able to...<br><br>• select manufacturing processes in accordance with the requirements.<br>• design manufacturing processes for simple tasks to meet the required tolerances of the component to be produced.<br>• assess components in terms of their production-oriented construction. |
| **Personal Competence** | |
| *Social Competence* | Students are able to ...<br><br>• develop solutions in a production environment with qualified personnel at technical level and represent decisions. |
| *Autonomy* | Students are able to ..<br><br>• interpret independently the manufacturing process.<br>• assess own strengths and weaknesses in general.<br>• assess their learning progress and define gaps to be improved.<br>• assess possible consequences of their actions. |
| **Workload in Hours** | Independent Study Time 96, Study Time in Lecture 84 |
| **Credit points** | 6 |
| **Course achievement** | None |
| **Examination** | Written exam |
| **Examination duration and scale** | 120 min |
| **Assignment for the Following Curricula** | General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Product Development and Production: Compulsory<br>General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Theoretical Mechanical Engineering: Elective Compulsory<br>Digital Mechanical Engineering: Core Qualification: Compulsory<br>Engineering Science: Specialisation Mechanical Engineering: Compulsory<br>General Engineering Science (English program, 7 semester): Specialisation Mechanical Engineering: Compulsory |

| | |
|---|---|
| | Green Technologies: Energy, Water, Climate: Specialisation Energy Technology: Elective Compulsory<br>Logistics and Mobility: Specialisation Production Management and Processes: Compulsory<br>Logistics and Mobility: Specialisation Engineering Science: Elective Compulsory<br>Mechanical Engineering: Core Qualification: Compulsory<br>Mechatronics: Core Qualification: Compulsory<br>Engineering and Management - Major in Logistics and Mobility: Specialisation Production Management and Processes: Compulsory |

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

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

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

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

## 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 |

| | |
|---|---|
| **Module Responsible** | Prof. Dieter Krause |
| **Admission Requirements** | None |
| **Recommended Previous Knowledge** | • Fundamentals of Mechanical Engineering Design<br>• Mechanics<br>• Fundamentals of Materials Science<br>• Production Engineering |
| **Educational Objectives** | After taking part successfully, students have reached the following learning results |
| **Professional Competence** | |
| *Knowledge* | After passing the module, students are able to:<br>• explain complex working principles and functions of machine elements and of basic elements of fluidics,<br>• explain requirements, selection criteria, application scenarios and practical examples of complex machine elements,<br>• indicate the background of dimensioning calculations. |
| *Skills* | After passing the module, students are able to:<br>• accomplish dimensioning calculations of covered machine elements,<br>• transfer knowledge learned in the module to new requirements and tasks (problem solving skills),<br>• recognize the content of technical drawings and schematic sketches,<br>• evaluate complex designs, technically. |
| **Personal Competence** | |
| *Social Competence* | • Students are able to discuss technical information in the lecture supported by activating methods. |
| *Autonomy* | • Students are able to independently deepen their acquired knowledge in exercises.<br>• Students are able to acquire additional knowledge and to recapitulate poorly understood content e.g. by using the video recordings of the lectures. |
| **Workload in Hours** | Independent Study Time 68, Study Time in Lecture 112 |
| **Credit points** | 6 |
| **Course achievement** | None |
| **Examination** | Written exam |
| **Examination duration and scale** | 120 |
| **Assignment for the Following Curricula** | General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering: Compulsory<br>Energy and Environmental Engineering: Core Qualification: Elective Compulsory<br>Energy Systems: Technical Complementary Course Core Studies: Elective Compulsory<br>Engineering Science: Specialisation Mechanical Engineering: Compulsory<br>General Engineering Science (English program, 7 semester): Specialisation Mechanical Engineering: Compulsory<br>Mechanical Engineering: Core Qualification: Compulsory<br>Naval Architecture: Core Qualification: Compulsory |

| Course L0264: Advanced Mechanical Engineering Design II | |
|---|---|
| **Typ** | Lecture |
| **Hrs/wk** | 2 |
| **CP** | 2 |
| **Workload in Hours** | Independent Study Time 32, Study Time in Lecture 28 |
| **Lecturer** | Prof. Dieter Krause, Prof. Dr. Nikola Bursac |
| **Language** | DE |
| **Cycle** | SoSe |
| **Content** | **Advanced Mechanical Engineering Design I & II**<br><br>**Lecture**<br><br>• Fundamentals of the following machine elements:<br>  ◦ Linear rolling bearings<br>  ◦ Axes & shafts<br>  ◦ Seals<br>  ◦ Clutches & brakes<br>  ◦ Belt & chain drives<br>  ◦ Gear drives<br>  ◦ Epicyclic gears<br>  ◦ Crank drives<br>  ◦ Sliding bearings<br>• Elements of fluidics<br><br>**Exercise**<br><br>• Calculation methods of the following machine elements:<br>  ◦ Linear rolling bearings<br>  ◦ Axes & shafts<br>  ◦ Clutches & brakes<br>  ◦ Belt & chain drives<br>  ◦ Gear drives<br>  ◦ Epicyclic gears<br>  ◦ Crank gears<br>  ◦ Sliding bearings<br>• Calculations of hydrostatic systems (fluidics) |
| **Literature** | • Dubbel, Taschenbuch für den Maschinenbau; Grote, K.-H., Feldhusen, J.(Hrsg.); Springer-Verlag, aktuelle Auflage.<br>• Maschinenelemente, Band I-III; Niemann, G., Springer-Verlag, aktuelle Auflage.<br>• Maschinen- und Konstruktionselemente; Steinhilper, W., Röper, R., Springer Verlag, aktuelle Auflage.<br>• Einführung in die DIN-Normen; Klein, M., Teubner-Verlag.<br>• Konstruktionslehre, Pahl, G.; Beitz, W., Springer-Verlag, aktuelle Auflage.<br>• Maschinenelemente 1-2; Schlecht, B., Pearson Verlag, aktuelle Auflage.<br>• Maschinenelemente - Gestaltung, Berechnung, Anwendung; Haberhauer, H., Bodenstein, F., Springer-Verlag, aktuelle Auflage.<br>• Roloff/Matek Maschinenelemente; Wittel, H., Muhs, D., Jannasch, D., Voßiek, J., Springer Vieweg, aktuelle Auflage.<br><br>Sowie weitere Bücher zu speziellen Themen |

| Course L0265: Advanced Mechanical Engineering Design II | |
|---|---|
| **Typ** | Recitation Section (large) |
| **Hrs/wk** | 2 |
| **CP** | 1 |
| **Workload in Hours** | Independent Study Time 2, Study Time in Lecture 28 |
| **Lecturer** | Prof. Dieter Krause, Prof. Dr. Nikola Bursac |
| **Language** | DE |
| **Cycle** | SoSe |
| **Content** | See interlocking course |
| **Literature** | See interlocking course |

| Course L0262: Advanced Mechanical Engineering Design I | |
|---|---|
| **Typ** | Lecture |
| **Hrs/wk** | 2 |
| **CP** | 2 |
| **Workload in Hours** | Independent Study Time 32, Study Time in Lecture 28 |
| **Lecturer** | Prof. Dieter Krause, Prof. Otto von Estorff |
| **Language** | DE |
| **Cycle** | WiSe |
| **Content** | **Advanced Mechanical Engineering Design I & II**<br><br>**Lecture**<br><br>• Fundamentals of the following machine elements:<br>  ◦ Linear rolling bearings<br>  ◦ Axes & shafts<br>  ◦ Seals<br>  ◦ Clutches & brakes<br>  ◦ Belt & chain drives<br>  ◦ Gear drives<br>  ◦ Epicyclic gears<br>  ◦ Crank drives<br>  ◦ Sliding bearings<br>• Elements of fluidics<br><br>**Exercise**<br><br>• Calculation methods of the following machine elements:<br>  ◦ Linear rolling bearings<br>  ◦ Axes & shafts<br>  ◦ Clutches & brakes<br>  ◦ Belt & chain drives<br>  ◦ Gear drives<br>  ◦ Epicyclic gears<br>  ◦ Crank gears<br>  ◦ Sliding bearings<br>• Calculations of hydrostatic systems (fluidics) |
| **Literature** | • Dubbel, Taschenbuch für den Maschinenbau; Grote, K.-H., Feldhusen, J.(Hrsg.); Springer-Verlag, aktuelle Auflage.<br>• Maschinenelemente, Band I-III; Niemann, G., Springer-Verlag, aktuelle Auflage.<br>• Maschinen- und Konstruktionselemente; Steinhilper, W., Röper, R., Springer Verlag, aktuelle Auflage.<br>• Einführung in die DIN-Normen; Klein, M., Teubner-Verlag.<br>• Konstruktionslehre, Pahl, G.; Beitz, W., Springer-Verlag, aktuelle Auflage.<br>• Maschinenelemente 1-2; Schlecht, B., Pearson Verlag, aktuelle Auflage.<br>• Maschinenelemente - Gestaltung, Berechnung, Anwendung; Haberhauer, H., Bodenstein, F., Springer-Verlag, aktuelle Auflage.<br>• Roloff/Matek Maschinenelemente; Wittel, H., Muhs, D., Jannasch, D., Voßiek, J., Springer Vieweg, aktuelle Auflage.<br><br>Sowie weitere Bücher zu speziellen Themen |

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

## Module M0956: Measurement Technology for Mechanical Engineers

**Courses**

| Title | Typ | Hrs/wk | CP |
|---|---|---|---|
| Practical Course: Measurement and Control Systems (L1119) | Practical Course | 2 | 2 |
| Measurement Technology for Mechanical Engineering (L1116) | Lecture | 2 | 3 |
| Measurement Technology for Mechanical Engineering (L1118) | Recitation Section (large) | 1 | 1 |

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

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

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

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

## Module M0688: Technical Thermodynamics II

**Courses**

| Title | Typ | Hrs/wk | CP |
|---|---|---|---|
| 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 |

| | |
|---|---|
| **Module Responsible** | Prof. Arne Speerforck |
| **Admission Requirements** | None |
| **Recommended Previous Knowledge** | Elementary knowledge in Mathematics, Mechanics and Technical Thermodynamics I |
| **Educational Objectives** | After taking part successfully, students have reached the following learning results |
| **Professional Competence** | |
| *Knowledge* | Students are familiar with different cycle processes like Joule, Otto, Diesel, Stirling, Seiliger and Clausius-Rankine. They are able to derive energetic and exergetic efficiencies and know the influence different factors. They know the difference between anti clockwise and clockwise cycles (heat-power cycle, cooling cycle). They have increased knowledge of steam cycles and are able to draw the different cycles 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. |
| *Skills* | Students are able to use thermodynamic laws for the design of technical processes. Especially they are able to formulate energy, exergy- and entropy balances and by this to optimise technical processes. They are able to perform simple safety calculations in regard to an outflowing gas from a tank. They are able to transform a verbal formulated message into an abstract formal procedure. |
| **Personal Competence** | |
| *Social Competence* | The students are able to discuss in small groups and develop an approach. You can answer comprehension questions about the content that are provided in the lecture with the ClickerOnline tool "TurningPoint" after discussions with other students. |
| *Autonomy* | Students can physically understand and explain the complex problems (cycle processes, air conditioning processes, combustion processes) set in tasks. They are able to select the methods taught in the lecture and exercise to solve complex problems and apply them independently to different types of tasks. |
| **Workload in Hours** | Independent Study Time 124, Study Time in Lecture 56 |
| **Credit points** | 6 |
| **Course achievement** | None |
| **Examination** | Written exam |
| **Examination duration and scale** | 90 min |
| **Assignment for the Following Curricula** | General Engineering Science (German program, 7 semester): Core Qualification: Compulsory<br>Bioprocess Engineering: Core Qualification: Compulsory<br>Chemical and Bioprocess Engineering: Core Qualification: Compulsory<br>Energy Systems: Technical Complementary Course Core Studies: Elective Compulsory<br>Engineering Science: Specialisation Mechanical Engineering: Elective Compulsory<br>General Engineering Science (English program, 7 semester): Specialisation Mechanical Engineering: Elective Compulsory<br>Green Technologies: Energy, Water, Climate: Core Qualification: Compulsory<br>Integrated Building Technology: Core Qualification: Compulsory<br>Mechanical Engineering: Core Qualification: Compulsory<br>Mechatronics: Core Qualification: Compulsory<br>Technomathematics: Specialisation III. Engineering Science: Elective Compulsory<br>Process Engineering: Core Qualification: Compulsory |

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

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

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

## 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 |

| | |
|---|---|
| **Module Responsible** | Prof. Dieter Krause |
| **Admission Requirements** | None |
| **Recommended Previous Knowledge** | Advanced Knowledge about engineering design:<br>Fundamentals of Mechanical Engineering Design<br>Mechanical Engineering: Design<br>Advanced Mechanical Engineering Design |
| **Educational Objectives** | After taking part successfully, students have reached the following learning results |
| **Professional Competence** | |
| *Knowledge* | After completing the module, students are capable of:<br>• explaining the functional principle of 3D-CAD-Systems, PDM- and FEM-Systems<br>• describing the interaction of the different CAE-Systems in the product development process |
| *Skills* | After completing the module, students are able to:<br>• evaluate different CAD- and PDM-Systems with regards to the desired requirements such as classification schemes and product structuring<br>• design an exemplary product using CAD-,PDM- and/or FEM-Systems with shared workload |
| **Personal Competence** | |
| *Social Competence* | After completing the module, students are able to:<br>• To develop a project plan and allocate work appropriate work packages in the framework of group discussions<br>• Present project results as a team for instance in a presentation |
| *Autonomy* | Students are capable of:<br>• independently adapt to a CAE-Tool and complete a given practical task with it |
| **Workload in Hours** | Independent Study Time 96, Study Time in Lecture 84 |
| **Credit points** | 6 |
| **Course achievement** | Compulsory: Yes; Bonus: 20 %; Form: Subject theoretical and practical work; Description: CAE-Teamprojekt inkl. Vortrag und Ausarbeitung |
| **Examination** | Written exam |
| **Examination duration and scale** | 90 |
| **Assignment for the Following Curricula** | General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Aircraft Systems Engineering: Compulsory<br>General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Product Development and Production: Compulsory<br>Engineering Science: Specialisation Mechanical Engineering: Elective Compulsory<br>General Engineering Science (English program, 7 semester): Specialisation Mechanical Engineering: Elective Compulsory<br>Mechanical Engineering: Specialisation Product Development and Production: Compulsory<br>Mechanical Engineering: Specialisation Aircraft Systems Engineering: Compulsory<br>Product Development, Materials and Production: Technical Complementary Course Core Studies: Elective Compulsory |

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

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

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

## Module M1595: Machine Learning I

**Courses**

| Title | Typ | Hrs/wk | CP |
|---|---|---|---|
| Machine Learning I (L2432) | Lecture | 2 | 3 |
| Machine Learning I (L2433) | Recitation Section (small) | 2 | 3 |

| | |
|---|---|
| **Module Responsible** | Prof. Nihat Ay |
| **Admission Requirements** | None |
| **Recommended Previous Knowledge** | Linear Algebra, Analysis, Basic Programming Course |
| **Educational Objectives** | After taking part successfully, students have reached the following learning results |
| **Professional Competence** | |
| *Knowledge* | The students know<br>• general principles of machine learning learning: supervised/unsupervised learning, generative/descriptive learning, parametric/non-parametric learning<br>• different learning methods: neural networks, support vector machines, clustering, dimensionality reduction, kernel methods<br>• fundamentals of statistical learning theory<br>• advanced techniques such as transfer learning, reinforcement learning, generative adversarial networks and adaptive control |
| *Skills* | The students can<br>• apply machine learning methods to concrete problems<br>• select and evaluate suitable methods for specific problems<br>• evaluate the quality of a trained data-driven model<br>• work with known software frameworks for machine learning<br>• adapt the architecture and cost function of neural networks to specific problems<br>• show the limits of machine learning methods |
| **Personal Competence** | |
| *Social Competence* | Students can work on complex problems both independently and in teams. They can exchange ideas with each other and use their individual strengths to solve the problem. |
| *Autonomy* | Students are able to independently investigate a complex problem and assess which competencies are required to solve it. |
| **Workload in Hours** | Independent Study Time 124, Study Time in Lecture 56 |
| **Credit points** | 6 |
| **Course achievement** | **Compulsory** / **Bonus** / **Form** / **Description**<br>No / 20 % / Excercises |
| **Examination** | Written exam |
| **Examination duration and scale** | 90 min |
| **Assignment for the Following Curricula** | General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Theoretical Mechanical Engineering: Elective Compulsory<br>Computer Science: Specialisation I. Computer and Software Engineering: Elective Compulsory<br>Data Science: Core Qualification: Compulsory<br>Engineering Science: Specialisation Advanced Materials: Elective Compulsory<br>Engineering Science: Specialisation Mechanical Engineering: Elective Compulsory<br>Engineering Science: Specialisation Mechatronics: Elective Compulsory<br>Logistics and Mobility: Specialisation Information Technology: Elective Compulsory<br>Mechanical Engineering: Specialisation Theoretical Mechanical Engineering: Elective Compulsory<br>Technomathematics: Specialisation II. Informatics: Elective Compulsory<br>Technomathematics: Specialisation II. Informatics: Elective Compulsory<br>Engineering and Management - Major in Logistics and Mobility: Specialisation Information Technology: Elective Compulsory |

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

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

## Module M1746: Materials Engineering: Materials Selection, Processing and Modelling

**Courses**

| Title | Typ | Hrs/wk | CP |
|---|---|---|---|
| Materials and Process Modeling (L2862) | Lecture | 3 | 3 |
| Materials Selection and Processing (L2861) | Lecture | 3 | 3 |

| | |
|---|---|
| **Module Responsible** | Prof. Norbert Huber |
| **Admission Requirements** | None |
| **Recommended Previous Knowledge** | Fundamentals of mathematics (differential equations, integration), materials science (classes of materials, structure, properties, tensile test) and engineering mechanics (stress, strain, elasticity, deformation). |
| **Educational Objectives** | After taking part successfully, students have reached the following learning results |
| **Professional Competence** | |
| *Knowledge* | The module deals with the production and properties of engineering materials. Particular attention is paid to material selection, material processing, the associated microstructure and the achievable mechanical properties. In conjunction with the costs, these are decisive for the applicability and economic efficiency. Metallic materials are in the foreground. Ceramics and polymers are also covered in the sense of a broad range of available materials.<br><br>In parallel to the material-technological consideration, the modeling of material behavior by means of phenomenological material laws for plasticity under monotonic and cyclic loading is worked out. In addition to the evaluation of component behavior, plasticity also plays a major role in manufacturing processes and thus provides the basis for process simulation. Process models and simulation methods for selected manufacturing processes, such as rolling or forming, are presented for this topic area. |
| *Skills* | Students are able to<br>• analyze the material behavior of metallic materials for general load histories with respect to elasticity and plasticity as well as the associated velocity-dependent material behavior and describe it with corresponding material laws<br>• to relate the deformation behavior to the underlying microstructural mechanisms<br>• to assess how processing procedures affect the chain microstructure - process - properties<br>• understand how the mechanical properties of metallic materials can be tailored by the processing due to microstructural design |
| **Personal Competence** | |
| *Social Competence* | Students are able to<br>• actively enrich and shape the course by contributing to the discussion.<br>• develop solutions to given problems and explain them in English in the plenum and discuss them with their fellow students. |
| *Autonomy* | Students are able to,<br>• assess their own strengths and weaknesses<br>• concretely assess their respective learning status and define further work steps on this basis<br>• abstract given tasks and then apply them to new problems by transferring the taught material. |
| **Workload in Hours** | Independent Study Time 96, Study Time in Lecture 84 |
| **Credit points** | 6 |

**Course achievement**

| Compulsory | Bonus | Form | Description |
|---|---|---|---|
| Yes | 20 % | Excercises | Wir stellen Übungsaufgaben (ÜA), die während des Semesters erbracht und in den wöchentlichen Übungen vorgestellt werden. Diese können im Umfang von bis zu 20% bei der Prüfung berücksichtigt werden. |

| | |
|---|---|
| **Examination** | Written exam |
| **Examination duration and scale** | 120 min |
| **Assignment for the Following Curricula** | General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Materials in Engineering Sciences: Compulsory<br>General Engineering Science (German program, 7 semester): Specialisation Advanced Materials: Compulsory<br>Engineering Science: Specialisation Mechanical Engineering: Elective Compulsory<br>Engineering Science: Specialisation Advanced Materials: Compulsory<br>Engineering Science: Specialisation Advanced Materials: Compulsory<br>Mechanical Engineering: Specialisation Materials in Engineering Sciences: Compulsory |

| Course L2862: Materials and Process Modeling | |
|---|---|
| **Typ** | Lecture |
| **Hrs/wk** | 3 |
| **CP** | 3 |
| **Workload in Hours** | Independent Study Time 48, Study Time in Lecture 42 |
| **Lecturer** | Prof. Norbert Huber |
| **Language** | EN |
| **Cycle** | SoSe |
| **Content** | 1. Relevance of plasticity in materials processing and operation<br>2. Fundamentals of plasticity in metals and alloys<br>3. Modellierung von Materialverhalten<br>4. Plasticity in cyclic loading<br>5. Rate dependency, recristallization<br>6. Rolling, forming, and solid state joining processes<br>7. Residual stress design |
| **Literature** | • Hull and Bacon: Introduction to Dislocations (1984)<br>• G. Gottstein: Physik. Grundlagen der Materialk. (2001)<br>• P. Haupt: Cont. Mechanics and Theory of Materials (2002)<br>• N. Huber: Vorlesungsskript „Grundlagen der mechanischen Eigenschaften von Werkstoffen“, TUHH |

| Course L2861: Materials Selection and Processing | |
|---|---|
| **Typ** | Lecture |
| **Hrs/wk** | 3 |
| **CP** | 3 |
| **Workload in Hours** | Independent Study Time 48, Study Time in Lecture 42 |
| **Lecturer** | Prof. Kaline Pagnan Furlan |
| **Language** | EN |
| **Cycle** | SoSe |
| **Content** | 1. Introduction<br>2. Overview of fabrication processes<br>3. Shape considerations: macrostructural aspects<br>4. Material properties: microstructural aspects<br>5. Materials engineering: microstructure, shape and processing relation<br>6. Materials engineering: function and costs relation |
| **Literature** | • M.F. Ashby,Materials Selection in Mechanical Design, 4thedition,Butterworth-Heinemann(2011)<br>• W.F. Gale and T.C. Totemeier, Smithells Metals Reference Book, 8thedition, Butterworth-Heinemann(2004)<br>• J. Beddoes and M. Bibby, Principles of Metal Manufacturing Processes, Butterworth-Heinemann(1999) |

## Specialization Mechatronics

### Module M0956: Measurement Technology for Mechanical Engineers

**Courses**

| Title | Typ | Hrs/wk | CP |
|---|---|---|---|
| Practical Course: Measurement and Control Systems (L1119) | Practical Course | 2 | 2 |
| Measurement Technology for Mechanical Engineering (L1116) | Lecture | 2 | 3 |
| Measurement Technology for Mechanical Engineering (L1118) | Recitation Section (large) | 1 | 1 |

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

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

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

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

## Module M0731: Functional Programming

**Courses**

| Title | Typ | Hrs/wk | CP |
|---|---|---|---|
| Functional Programming (L0624) | Lecture | 2 | 2 |
| Functional Programming (L0625) | Recitation Section (large) | 2 | 2 |
| Functional Programming (L0626) | Recitation Section (small) | 2 | 2 |

| | |
|---|---|
| **Module Responsible** | Prof. Sibylle Schupp |
| **Admission Requirements** | None |
| **Recommended Previous Knowledge** | Discrete mathematics at high-school level |
| **Educational Objectives** | After taking part successfully, students have reached the following learning results |
| **Professional Competence** | |
| *Knowledge* | Students apply the principles, constructs, and simple design techniques of functional programming. They demonstrate their ability to read Haskell programs and to explain Haskell syntax as well as Haskell's read-eval-print loop. They interpret warnings and find errors in programs. They apply the fundamental data structures, data types, and type constructors. They employ strategies for unit tests of functions and simple proof techniques for partial and total correctness. They distinguish laziness from other evaluation strategies. |
| *Skills* | Students break a natural-language description down in parts amenable to a formal specification and develop a functional program in a structured way. They assess different language constructs, make conscious selections both at specification and implementations level, and justify their choice. They analyze given programs and rewrite them in a controlled way. They design and implement unit tests and can assess the quality of their tests. They argue for the correctness of their program. |
| **Personal Competence** | |
| *Social Competence* | Students practice peer programming with varying peers. They explain problems and solutions to their peer. They defend their programs orally. They communicate in English. |
| *Autonomy* | In programming labs, students learn under supervision (a.k.a. "Betreutes Programmieren") the mechanics of programming. In exercises, they develop solutions individually and independently, and receive feedback. |
| **Workload in Hours** | Independent Study Time 96, Study Time in Lecture 84 |
| **Credit points** | 6 |
| **Course achievement** | **Compulsory** / **Bonus** / **Form** / **Description**: Yes / 15 % / Excercises |
| **Examination** | Written exam |
| **Examination duration and scale** | 90 min |
| **Assignment for the Following Curricula** | General Engineering Science (German program, 7 semester): Specialisation Computer Science: Elective Compulsory<br>Computer Science: Core Qualification: Compulsory<br>Data Science: Core Qualification: Elective Compulsory<br>Data Science: Specialisation I. Mathematics/Computer Science: Elective Compulsory<br>Engineering Science: Specialisation Mechatronics: Elective Compulsory<br>General Engineering Science (English program, 7 semester): Specialisation Mechatronics: Elective Compulsory<br>Computer Science in Engineering: Specialisation I. Computer Science: Elective Compulsory<br>Technomathematics: Specialisation II. Informatics: Elective Compulsory |

### Course L0624: Functional Programming

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

| Course L0625: Functional Programming | |
|---|---|
| **Typ** | Recitation Section (large) |
| **Hrs/wk** | 2 |
| **CP** | 2 |
| **Workload in Hours** | Independent Study Time 32, Study Time in Lecture 28 |
| **Lecturer** | Prof. Sibylle Schupp |
| **Language** | EN |
| **Cycle** | WiSe |
| **Content** | • Functions, Currying, Recursive Functions, Polymorphic Functions, Higher-Order Functions<br>• Conditional Expressions, Guarded Expressions, Pattern Matching, Lambda Expressions<br>• Types (simple, composite), Type Classes, Recursive Types, Algebraic Data Type<br>• Type Constructors: Tuples, Lists, Trees, Associative Lists (Dictionaries, Maps)<br>• Modules<br>• Interactive Programming<br>• Lazy Evaluation, Call-by-Value, Strictness<br>• Design Recipes<br>• Testing (axiom-based, invariant-based, against reference implementation)<br>• Reasoning about Programs (equation-based, inductive)<br>• Idioms of Functional Programming<br>• Haskell Syntax and Semantics |
| **Literature** | Graham Hutton, Programming in Haskell, Cambridge University Press 2007. |

| Course L0626: Functional Programming | |
|---|---|
| **Typ** | Recitation Section (small) |
| **Hrs/wk** | 2 |
| **CP** | 2 |
| **Workload in Hours** | Independent Study Time 32, Study Time in Lecture 28 |
| **Lecturer** | Prof. Sibylle Schupp |
| **Language** | EN |
| **Cycle** | WiSe |
| **Content** | • Functions, Currying, Recursive Functions, Polymorphic Functions, Higher-Order Functions<br>• Conditional Expressions, Guarded Expressions, Pattern Matching, Lambda Expressions<br>• Types (simple, composite), Type Classes, Recursive Types, Algebraic Data Type<br>• Type Constructors: Tuples, Lists, Trees, Associative Lists (Dictionaries, Maps)<br>• Modules<br>• Interactive Programming<br>• Lazy Evaluation, Call-by-Value, Strictness<br>• Design Recipes<br>• Testing (axiom-based, invariant-based, against reference implementation)<br>• Reasoning about Programs (equation-based, inductive)<br>• Idioms of Functional Programming<br>• Haskell Syntax and Semantics |
| **Literature** | Graham Hutton, Programming in Haskell, Cambridge University Press 2007. |

## Module M0834: Computernetworks and Internet Security

**Courses**

| Title | Typ | Hrs/wk | CP |
|---|---|---|---|
| Computer Networks and Internet Security (L1098) | Lecture | 3 | 5 |
| Computer Networks and Internet Security (L1099) | Recitation Section (small) | 1 | 1 |

| | |
|---|---|
| **Module Responsible** | Prof. Andreas Timm-Giel |
| **Admission Requirements** | None |
| **Recommended Previous Knowledge** | Basics of Computer Science |
| **Educational Objectives** | After taking part successfully, students have reached the following learning results |
| **Professional Competence** | |
| *Knowledge* | Students are able to explain important and common Internet protocols in detail and classify them, in order to be able to analyse and develop networked systems in further studies and job. |
| *Skills* | Students are able to analyse common Internet protocols and evaluate the use of them in different domains. |
| **Personal Competence** | |
| *Social Competence* | |
| *Autonomy* | Students can select relevant parts out of high amount of professional knowledge and can independently learn and understand it. |
| **Workload in Hours** | Independent Study Time 124, Study Time in Lecture 56 |
| **Credit points** | 6 |
| **Course achievement** | None |
| **Examination** | Written exam |
| **Examination duration and scale** | 120 min |
| **Assignment for the Following Curricula** | General Engineering Science (German program, 7 semester): Specialisation Computer Science: Elective Compulsory<br>Computer Science: Core Qualification: Compulsory<br>Data Science: Specialisation I. Mathematics/Computer Science: Elective Compulsory<br>Data Science: Core Qualification: Elective Compulsory<br>Electrical Engineering: Core Qualification: Elective Compulsory<br>Engineering Science: Specialisation Electrical Engineering: Elective Compulsory<br>Engineering Science: Specialisation Mechatronics: Elective Compulsory<br>Engineering Science: Specialisation Mechatronics: Elective Compulsory<br>General Engineering Science (English program, 7 semester): Specialisation Mechatronics: Elective Compulsory<br>Computer Science in Engineering: Core Qualification: Compulsory<br>Technomathematics: Specialisation II. Informatics: Elective Compulsory |

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

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

## Module M0568: Theoretical Electrical Engineering II: Time-Dependent Fields

**Courses**

| Title | Typ | Hrs/wk | CP |
|---|---|---|---|
| Theoretical Electrical Engineering II: Time-Dependent Fields (L0182) | Lecture | 3 | 5 |
| Theoretical Electrical Engineering II: Time-Dependent Fields (L0183) | Recitation Section (small) | 2 | 1 |

| | |
|---|---|
| **Module Responsible** | Prof. Christian Schuster |
| **Admission Requirements** | None |
| **Recommended Previous Knowledge** | Electrical Engineering I, Electrical Engineering II, Theoretical Electrical Engineering I<br><br>Mathematics I, Mathematics II, Mathematics III, Mathematics IV |
| **Educational Objectives** | After taking part successfully, students have reached the following learning results |
| **Professional Competence** | |
| *Knowledge* | Students are able to explain fundamental formulas, relations, and methods related to the theory of time-dependent electromagnetic fields. They can assess the principal behavior and characteristics of quasistationary and fully dynamic fields with regard to respective sources. They can describe the properties of complex electromagnetic fields by means of superposition of solutions for simple fields. The students are aware of applications for the theory of time-dependent electromagnetic fields and are able to explicate these. |
| *Skills* | Students are able to apply a variety of procedures in order to solve the diffusion and the wave equation for general time-dependent field problems. They can assess the principal effects of given time-dependent sources of fields and analyze these quantitatively. They can deduce meaningful quantities for the characterization of fully dynamic fields (wave impedance, skin depth, Poynting-vector, radiation resistance, etc.) from given fields and interpret them with regard to practical applications. |
| **Personal Competence** | |
| *Social Competence* | Students are able to work together on subject related tasks in small groups. They are able to present their results effectively (e.g. during exercise sessions). |
| *Autonomy* | Students are capable to gather necessary information from provided references and relate this information to the lecture. They are able to continually reflect their knowledge by means of activities that accompany the lecture, such as short oral quizzes during the lectures and exercises that are related to the exam. Based on respective feedback, students are expected to adjust their individual learning process. They are able to draw connections between acquired knowledge and ongoing research at the Hamburg University of Technology (TUHH), e.g. in the area of high frequency engineering and optics. |
| **Workload in Hours** | Independent Study Time 110, Study Time in Lecture 70 |
| **Credit points** | 6 |
| **Course achievement** | None |
| **Examination** | Written exam |
| **Examination duration and scale** | 90-150 minutes |
| **Assignment for the Following Curricula** | General Engineering Science (German program, 7 semester): Specialisation Electrical Engineering: Compulsory<br>Electrical Engineering: Core Qualification: Compulsory<br>Engineering Science: Specialisation Electrical Engineering: Compulsory<br>Engineering Science: Specialisation Mechatronics: Elective Compulsory<br>Engineering Science: Specialisation Mechatronics: Elective Compulsory<br>Technomathematics: Specialisation III. Engineering Science: Elective Compulsory |

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

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

## Module M0777: Semiconductor Circuit Design

**Courses**

| Title | Typ | Hrs/wk | CP |
|---|---|---|---|
| Semiconductor Circuit Design (L0763) | Lecture | 3 | 4 |
| Semiconductor Circuit Design (L0864) | Recitation Section (small) | 1 | 2 |

| | |
|---|---|
| **Module Responsible** | Prof. Matthias Kuhl |
| **Admission Requirements** | None |
| **Recommended Previous Knowledge** | Fundamentals of electrical engineering<br><br>Basics of physics, especially semiconductor physics |
| **Educational Objectives** | After taking part successfully, students have reached the following learning results |
| **Professional Competence** | |
| *Knowledge* | • Students are able to explain the functionality of different MOS devices in electronic circuits.<br>• Students are able to explain how analog circuits functions and where they are applied.<br>• Students are able to explain the functionality of fundamental operational amplifiers and their specifications.<br>• Students know the fundamental digital logic circuits and can discuss their advantages and disadvantages.<br>• Students have knowledge about memory circuits and can explain their functionality and specifications.<br>• Students know the appropriate fields for the use of bipolar transistors. |
| *Skills* | • Students can calculate the specifications of different MOS devices and can define the parameters of electronic circuits.<br>• Students are able to develop different logic circuits and can design different types of logic circuits.<br>• Students can use MOS devices, operational amplifiers and bipolar transistors for specific applications. |
| **Personal Competence** | |
| *Social Competence* | • Students are able work efficiently in heterogeneous teams.<br>• Students working together in small groups can solve problems and answer professional questions. |
| *Autonomy* | • Students are able to assess their level of knowledge. |
| **Workload in Hours** | Independent Study Time 124, Study Time in Lecture 56 |
| **Credit points** | 6 |
| **Course achievement** | None |
| **Examination** | Written exam |
| **Examination duration and scale** | 120 min |
| **Assignment for the Following Curricula** | General Engineering Science (German program, 7 semester): Specialisation Electrical Engineering: Compulsory<br>General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Mechatronics: Compulsory<br>Data Science: Core Qualification: Elective Compulsory<br>Electrical Engineering: Core Qualification: Compulsory<br>Engineering Science: Specialisation Electrical Engineering: Compulsory<br>Engineering Science: Specialisation Mechatronics: Compulsory<br>General Engineering Science (English program, 7 semester): Specialisation Electrical Engineering: Compulsory<br>General Engineering Science (English program, 7 semester): Specialisation Mechatronics: Compulsory<br>Computer Science in Engineering: Specialisation II. Mathematics & Engineering Science: Elective Compulsory<br>Mechanical Engineering: Specialisation Mechatronics: Compulsory<br>Mechatronics: Core Qualification: Compulsory<br>Technomathematics: Specialisation III. Engineering Science: Elective Compulsory |

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

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

## Module M0803: Embedded Systems

**Courses**

| Title | Typ | Hrs/wk | CP |
|---|---|---|---|
| Embedded Systems (L0805) | Lecture | 3 | 3 |
| Embedded Systems (L2938) | Project-/problem-based Learning | 1 | 1 |
| Embedded Systems (L0806) | Recitation Section (small) | 1 | 2 |

| | |
|---|---|
| **Module Responsible** | Prof. Heiko Falk |
| **Admission Requirements** | None |
| **Recommended Previous Knowledge** | Computer Engineering |
| **Educational Objectives** | After taking part successfully, students have reached the following learning results |
| **Professional Competence** | |
| *Knowledge* | Embedded systems can be defined as information processing systems embedded into enclosing products. This course teaches the foundations of such systems. In particular, it deals with an introduction into these systems (notions, common characteristics) and their specification languages (models of computation, hierarchical automata, specification of distributed systems, task graphs, specification of real-time applications, translations between different models).<br><br>Another part covers the hardware of embedded systems: Sonsors, A/D and D/A converters, real-time capable communication hardware, embedded processors, memories, energy dissipation, reconfigurable logic and actuators. The course also features an introduction into real-time operating systems, middleware and real-time scheduling. Finally, the implementation of embedded systems using hardware/software co-design (hardware/software partitioning, high-level transformations of specifications, energy-efficient realizations, compilers for embedded processors) is covered. |
| *Skills* | After having attended the course, students shall be able to realize simple embedded systems. The students shall realize which relevant parts of technological competences to use in order to obtain a functional embedded systems. In particular, they shall be able to compare different models of computations and feasible techniques for system-level design. They shall be able to judge in which areas of embedded system design specific risks exist. |
| **Personal Competence** | |
| *Social Competence* | Students are able to solve similar problems alone or in a group and to present the results accordingly. |
| *Autonomy* | Students are able to acquire new knowledge from specific literature and to associate this knowledge with other classes. |
| **Workload in Hours** | Independent Study Time 110, Study Time in Lecture 70 |
| **Credit points** | 6 |
| **Course achievement** | **Compulsory** Yes; **Bonus** 10 %; **Form** Subject theoretical and practical work; **Description** |
| **Examination** | Written exam |
| **Examination duration and scale** | 90 minutes, contents of course and labs |
| **Assignment for the Following Curricula** | General Engineering Science (German program, 7 semester): Specialisation Computer Science: Compulsory<br>Computer Science: Specialisation I. Computer and Software Engineering: Elective Compulsory<br>Electrical Engineering: Core Qualification: Elective Compulsory<br>Engineering Science: Specialisation Mechatronics: Elective Compulsory<br>Engineering Science: Specialisation Electrical Engineering: Elective Compulsory<br>Aircraft Systems Engineering: Core Qualification: Elective Compulsory<br>General Engineering Science (English program, 7 semester): Specialisation Mechatronics: Elective Compulsory<br>Computer Science in Engineering: Core Qualification: Compulsory<br>Mechatronics: Specialisation System Design: Elective Compulsory<br>Mechatronics: Specialisation Intelligent Systems and Robotics: Elective Compulsory<br>Microelectronics and Microsystems: Specialisation Embedded Systems: Elective Compulsory |

### Course L0805: Embedded Systems

| | |
|---|---|
| **Typ** | Lecture |
| **Hrs/wk** | 3 |
| **CP** | 3 |
| **Workload in Hours** | Independent Study Time 48, Study Time in Lecture 42 |
| **Lecturer** | Prof. Heiko Falk |
| **Language** | EN |
| **Cycle** | SoSe |
| **Content** | • Introduction<br>• Specifications and Modeling<br>• Embedded/Cyber-Physical Systems Hardware<br>• System Software<br>• Evaluation and Validation<br>• Mapping of Applications to Execution Platforms<br>• Optimization |
| **Literature** | • Peter Marwedel. Embedded System Design - Embedded Systems Foundations of Cyber-Physical Systems. 2 nd Edition, Springer, 2012., Springer, 2012. |

| Course L2938: Embedded Systems | |
|---|---|
| **Typ** | Project-/problem-based Learning |
| **Hrs/wk** | 1 |
| **CP** | 1 |
| **Workload in Hours** | Independent Study Time 16, Study Time in Lecture 14 |
| **Lecturer** | Prof. Heiko Falk |
| **Language** | EN |
| **Cycle** | SoSe |
| **Content** | • Introduction<br>• Specifications and Modeling<br>• Embedded/Cyber-Physical Systems Hardware<br>• System Software<br>• Evaluation and Validation<br>• Mapping of Applications to Execution Platforms<br>• Optimization |
| **Literature** | • Peter Marwedel. Embedded System Design - Embedded Systems Foundations of Cyber-Physical Systems. 2 nd Edition, Springer, 2012., Springer, 2012. |

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

## Module M1595: Machine Learning I

**Courses**

| Title | Typ | Hrs/wk | CP |
|---|---|---|---|
| Machine Learning I (L2432) | Lecture | 2 | 3 |
| Machine Learning I (L2433) | Recitation Section (small) | 2 | 3 |

| | |
|---|---|
| **Module Responsible** | Prof. Nihat Ay |
| **Admission Requirements** | None |
| **Recommended Previous Knowledge** | Linear Algebra, Analysis, Basic Programming Course |
| **Educational Objectives** | After taking part successfully, students have reached the following learning results |
| **Professional Competence** | |
| *Knowledge* | The students know<br>• general principles of machine learning learning: supervised/unsupervised learning, generative/descriptive learning, parametric/non-parametric learning<br>• different learning methods: neural networks, support vector machines, clustering, dimensionality reduction, kernel methods<br>• fundamentals of statistical learning theory<br>• advanced techniques such as transfer learning, reinforcement learning, generative adversarial networks and adaptive control |
| *Skills* | The students can<br>• apply machine learning methods to concrete problems<br>• select and evaluate suitable methods for specific problems<br>• evaluate the quality of a trained data-driven model<br>• work with known software frameworks for machine learning<br>• adapt the architecture and cost function of neural networks to specific problems<br>• show the limits of machine learning methods |
| **Personal Competence** | |
| *Social Competence* | Students can work on complex problems both independently and in teams. They can exchange ideas with each other and use their individual strengths to solve the problem. |
| *Autonomy* | Students are able to independently investigate a complex problem and assess which competencies are required to solve it. |
| **Workload in Hours** | Independent Study Time 124, Study Time in Lecture 56 |
| **Credit points** | 6 |
| **Course achievement** | **Compulsory** / **Bonus** / **Form** / **Description**<br>No / 20 % / Excercises |
| **Examination** | Written exam |
| **Examination duration and scale** | 90 min |
| **Assignment for the Following Curricula** | General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Theoretical Mechanical Engineering: Elective Compulsory<br>Computer Science: Specialisation I. Computer and Software Engineering: Elective Compulsory<br>Data Science: Core Qualification: Compulsory<br>Engineering Science: Specialisation Advanced Materials: Elective Compulsory<br>Engineering Science: Specialisation Mechanical Engineering: Elective Compulsory<br>Engineering Science: Specialisation Mechatronics: Elective Compulsory<br>Logistics and Mobility: Specialisation Information Technology: Elective Compulsory<br>Mechanical Engineering: Specialisation Theoretical Mechanical Engineering: Elective Compulsory<br>Technomathematics: Specialisation II. Informatics: Elective Compulsory<br>Technomathematics: Specialisation II. Informatics: Elective Compulsory<br>Engineering and Management - Major in Logistics and Mobility: Specialisation Information Technology: Elective Compulsory |

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

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

## Module M1730: Mathematics IV (EN)

**Courses**

| Title | Typ | Hrs/wk | CP |
|---|---|---|---|
| Differential Equations 2 (Partial Differential Equations) (EN) (L2783) | Lecture | 2 | 1 |
| Differential Equations 2 (Partial Differential Equations) (EN) (L2784) | Recitation Section (large) | 1 | 1 |
| Differential Equations 2 (Partial Differential Equations) (EN) (L2785) | Recitation Section (small) | 1 | 1 |
| Complex Functions (EN) (L2786) | Lecture | 2 | 1 |
| Complex Functions (EN) (L2787) | Recitation Section (large) | 1 | 1 |
| Complex Functions (EN) (L2788) | Recitation Section (small) | 1 | 1 |

| | |
|---|---|
| **Module Responsible** | Prof. Anusch Taraz |
| **Admission Requirements** | None |
| **Recommended Previous Knowledge** | Mathematics I - III (EN or DE) |
| **Educational Objectives** | After taking part successfully, students have reached the following learning results |
| **Professional Competence** | |
| *Knowledge* | • Students can name the basic concepts in Mathematics IV. They are able to explain them using appropriate examples.<br>• Students can discuss logical connections between these concepts. They are capable of illustrating these connections with the help of examples.<br>• They know proof strategies and can reproduce them. |
| *Skills* | • 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.<br>• Students are able to discover and verify further logical connections between the concepts studied in the course.<br>• For a given problem, the students can develop and execute a suitable approach, and are able to critically evaluate the results. |
| **Personal Competence** | |
| *Social Competence* | • Students are able to work together in teams. They are capable to use mathematics as a common language.<br>• 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. |
| *Autonomy* | • Students are capable of checking their understanding of complex concepts on their own. They can specify open questions precisely and know where to get help in solving them.<br>• Students have developed sufficient persistence to be able to work for longer periods in a goal-oriented manner on hard problems. |
| **Workload in Hours** | Independent Study Time 68, Study Time in Lecture 112 |
| **Credit points** | 6 |
| **Course achievement** | None |
| **Examination** | Written exam |
| **Examination duration and scale** | 120 min |
| **Assignment for the Following Curricula** | General Engineering Science (German program, 7 semester): Specialisation Advanced Materials: Compulsory<br>Computer Science: Specialisation II. Mathematics and Engineering Science: Elective Compulsory<br>Data Science: Core Qualification: Elective Compulsory<br>Data Science: Specialisation I. Mathematics/Computer Science: Elective Compulsory<br>Engineering Science: Specialisation Electrical Engineering: Compulsory<br>Engineering Science: Core Qualification: Compulsory<br>Engineering Science: Core Qualification: Compulsory<br>Engineering Science: Specialisation Mechatronics: Elective Compulsory |

| Course L2783: Differential Equations 2 (Partial Differential Equations) (EN) | |
|---|---|
| **Typ** | Lecture |
| **Hrs/wk** | 2 |
| **CP** | 1 |
| **Workload in Hours** | Independent Study Time 2, Study Time in Lecture 28 |
| **Lecturer** | Dozenten des Fachbereiches Mathematik der UHH |
| **Language** | EN |
| **Cycle** | SoSe |
| **Content** | Main features of the theory and numerical treatment of partial differential equations<br>• Examples of partial differential equations<br>• First order quasilinear differential equations<br>• Normal forms of second order differential equations<br>• Harmonic functions and maximum principle<br>• Maximum principle for the heat equation<br>• Wave equation<br>• Liouville's formula<br>• Special functions<br>• Difference methods<br>• Finite elements |
| **Literature** | http://www.math.uni-hamburg.de/teaching/export/tuhh/index.html |

| Course L2784: Differential Equations 2 (Partial Differential Equations) (EN) | |
|---|---|
| **Typ** | Recitation Section (large) |
| **Hrs/wk** | 1 |
| **CP** | 1 |
| **Workload in Hours** | Independent Study Time 16, Study Time in Lecture 14 |
| **Lecturer** | Dozenten des Fachbereiches Mathematik der UHH |
| **Language** | EN |
| **Cycle** | SoSe |
| **Content** | See interlocking course |
| **Literature** | See interlocking course |

| Course L2785: Differential Equations 2 (Partial Differential Equations) (EN) | |
|---|---|
| **Typ** | Recitation Section (small) |
| **Hrs/wk** | 1 |
| **CP** | 1 |
| **Workload in Hours** | Independent Study Time 16, Study Time in Lecture 14 |
| **Lecturer** | Dozenten des Fachbereiches Mathematik der UHH |
| **Language** | EN |
| **Cycle** | SoSe |
| **Content** | See interlocking course |
| **Literature** | See interlocking course |

| Course L2786: Complex Functions (EN) | |
|---|---|
| **Typ** | Lecture |
| **Hrs/wk** | 2 |
| **CP** | 1 |
| **Workload in Hours** | Independent Study Time 2, Study Time in Lecture 28 |
| **Lecturer** | Dozenten des Fachbereiches Mathematik der UHH |
| **Language** | EN |
| **Cycle** | SoSe |
| **Content** | Main features of complex analysis<br>• Functions of one complex variable<br>• Complex differentiation<br>• Conformal mappings<br>• Complex integration<br>• Cauchy's integral theorem<br>• Cauchy's integral formula<br>• Taylor and Laurent series expansion<br>• Singularities and residuals<br>• Integral transformations: Fourier and Laplace transformation |
| **Literature** | http://www.math.uni-hamburg.de/teaching/export/tuhh/index.html |

| Course L2787: Complex Functions (EN) | |
|---|---|
| **Typ** | Recitation Section (large) |
| **Hrs/wk** | 1 |
| **CP** | 1 |
| **Workload in Hours** | Independent Study Time 16, Study Time in Lecture 14 |
| **Lecturer** | Dozenten des Fachbereiches Mathematik der UHH |
| **Language** | EN |
| **Cycle** | SoSe |
| **Content** | See interlocking course |
| **Literature** | See interlocking course |

| Course L2788: Complex Functions (EN) | |
|---|---|
| **Typ** | Recitation Section (small) |
| **Hrs/wk** | 1 |
| **CP** | 1 |
| **Workload in Hours** | Independent Study Time 16, Study Time in Lecture 14 |
| **Lecturer** | Dozenten des Fachbereiches Mathematik der UHH |
| **Language** | EN |
| **Cycle** | SoSe |
| **Content** | See interlocking course |
| **Literature** | See interlocking course |

## Module M0624: Automata Theory and Formal Languages

**Courses**

| Title | Typ | Hrs/wk | CP |
|---|---|---|---|
| Automata Theory and Formal Languages (L0332) | Lecture | 2 | 4 |
| Automata Theory and Formal Languages (L0507) | Recitation Section (small) | 2 | 2 |

| | |
|---|---|
| **Module Responsible** | Prof. Matthias Mnich |
| **Admission Requirements** | None |
| **Recommended Previous Knowledge** | Participating students should be able to<br>- specify algorithms for simple data structures (such as, e.g., arrays) to solve computational problems<br>- apply propositional logic and predicate logic for specifying and understanding mathematical proofs<br>- apply the knowledge and skills taught in the module Discrete Algebraic Structures |
| **Educational Objectives** | After taking part successfully, students have reached the following learning results |
| **Professional Competence** | |
| *Knowledge* | Students can explain syntax, semantics, and decision problems of propositional logic, and they are able to give algorithms for solving decision problems. Students can show correspondences to Boolean algebra. Students can describe which application problems are hard to represent with propositional logic, and therefore, the students can motivate predicate logic, and define syntax, semantics, and decision problems for this representation formalism. Students can explain unification and resolution for solving the predicate logic SAT decision problem. Students can also describe syntax, semantics, and decision problems for various kinds of temporal logic, and identify their application areas. The participants of the course can define various kinds of finite automata and can identify relationships to logic and formal grammars. The spectrum that students can explain ranges from deterministic and nondeterministic finite automata and pushdown automata to Turing machines. Students can name those formalism for which nondeterminism is more expressive than determinism. They are also able to demonstrate which decision problems require which expressivity, and, in addition, students can transform decision problems w.r.t. one formalism into decision problems w.r.t. other formalisms. They understand that some formalisms easily induce algorithms whereas others are best suited for specifying systems and their properties. Students can describe the relationships between formalisms such as logic, automata, or grammars. |
| *Skills* | Students can apply propositional logic as well as predicate logic resolution to a given set of formulas. Students analyze application problems in order to derive propositional logic, predicate logic, or temporal logic formulas to represent them. They can evaluate which formalism is best suited for a particular application problem, and they can demonstrate the application of algorithms for decision problems to specific formulas. Students can also transform nondeterministic automata into deterministic ones, or derive grammars from automata and vice versa. They can show how parsers work, and they can apply algorithms for the language emptiness problem in case of infinite words. |
| **Personal Competence** | |
| *Social Competence* | • Students are able to work together in teams. They are capable to use mathematics as a common language.<br>• 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. |
| *Autonomy* | • Students are capable of checking their understanding of complex concepts on their own. They can specify open questions precisely and know where to get help in solving them.<br>• Students have developed sufficient persistence to be able to work for longer periods in a goal-oriented manner on hard problems. |
| **Workload in Hours** | Independent Study Time 124, Study Time in Lecture 56 |
| **Credit points** | 6 |
| **Course achievement** | None |
| **Examination** | Written exam |
| **Examination duration and scale** | 90 min |
| **Assignment for the Following Curricula** | General Engineering Science (German program, 7 semester): Specialisation Computer Science: Compulsory<br>Computer Science: Core Qualification: Compulsory<br>Data Science: Core Qualification: Compulsory<br>Engineering Science: Specialisation Mechatronics: Elective Compulsory<br>Engineering Science: Specialisation Mechatronics: Elective Compulsory<br>General Engineering Science (English program, 7 semester): Specialisation Mechatronics: Elective Compulsory<br>Computer Science in Engineering: Core Qualification: Compulsory<br>Orientation Studies: Core Qualification: Elective Compulsory<br>Technomathematics: Specialisation II. Informatics: Elective Compulsory |

| Course L0332: Automata Theory and Formal Languages | |
|---|---|
| **Typ** | Lecture |
| **Hrs/wk** | 2 |
| **CP** | 4 |
| **Workload in Hours** | Independent Study Time 92, Study Time in Lecture 28 |
| **Lecturer** | Prof. Matthias Mnich |
| **Language** | EN |
| **Cycle** | SoSe |
| **Content** | 1. Propositional logic, Boolean algebra, propositional resolution, SAT-2KNF<br>2. Predicate logic, unification, predicate logic resolution<br>3. Temporal Logics (LTL, CTL)<br>4. Deterministic finite automata, definition and construction<br>5. Regular languages, closure properties, word problem, string matching<br>6. Nondeterministic automata:<br>Rabin-Scott transformation of nondeterministic into deterministic automata<br>7. Epsilon automata, minimization of automata,<br>elimination of e-edges, uniqueness of the minimal automaton (modulo renaming of states)<br>8. Myhill-Nerode Theorem:<br>Correctness of the minimization procedure, equivalence classes of strings induced by automata<br>9. Pumping Lemma for regular languages:<br>provision of a tool which, in some cases, can be used to show that a finite automaton principally cannot be expressive enough to solve a word problem for some given language<br>10. Regular expressions vs. finite automata:<br>Equivalence of formalisms, systematic transformation of representations, reductions<br>11. Pushdown automata and context-free grammars:<br>Definition of pushdown automata, definition of context-free grammars, derivations, parse trees, ambiguities, pumping lemma for context-free grammars, transformation of formalisms (from pushdown automata to context-free grammars and back)<br>12. Chomsky normal form<br>13. CYK algorithm for deciding the word problem for context-free grammrs<br>14. Deterministic pushdown automata<br>15. Deterministic vs. nondeterministic pushdown automata:<br>Application for parsing, LL(k) or LR(k) grammars and parsers vs. deterministic pushdown automata, compiler compiler<br>16. Regular grammars<br>17. Outlook: Turing machines and linear bounded automata vs general and context-sensitive grammars<br>18. Chomsky hierarchy<br>19. Mealy- and Moore automata:<br>Automata with output (w/o accepting states), infinite state sequences, automata networks<br>20. Omega automata: Automata for infinite input words, Büchi automata, representation of state transition systems, verification w.r.t. temporal logic specifications (in particular LTL)<br>21. LTL safety conditions and model checking with Büchi automata, relationships between automata and logic<br>22. Fixed points, propositional mu-calculus<br>23. Characterization of regular languages by monadic second-order logic (MSO) |
| **Literature** | 1. Logik für Informatiker Uwe Schöning, Spektrum, 5. Aufl.<br>2. Logik für Informatiker Martin Kreuzer, Stefan Kühling, Pearson Studium, 2006<br>3. Grundkurs Theoretische Informatik, Gottfried Vossen, Kurt-Ulrich Witt, Vieweg-Verlag, 2010.<br>4. Principles of Model Checking, Christel Baier, Joost-Pieter Katoen, The MIT Press, 2007 |

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

# Specialization Biomedical Engineering

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

## Module 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 |

| | |
|---|---|
| **Module Responsible** | Prof. Hans-Jürgen Kreienkamp |
| **Admission Requirements** | None |
| **Recommended Previous Knowledge** | None |
| **Educational Objectives** | After taking part successfully, students have reached the following learning results |
| **Professional Competence** | |
| *Knowledge* | The students can<br>• describe basic biomolecules;<br>• explain how genetic information is coded in the DNA;<br>• explain the connection between DNA and proteins; |
| *Skills* | The students can<br>• recognize the importance of molecular parameters for the course of a disease;<br>• describe selected molecular-diagnostic procedures;<br>• explain the relevance of these procedures for some diseases |
| **Personal Competence** | |
| *Social Competence* | The students can participate in discussions in research and medicine on a technical level.<br>Students will have an improved understanding of current medical problems (e.g. Corona pandemic)and will be able to explain these issues to others. |
| *Autonomy* | The students can develop an understanding of topics from the course, using technical literature, by themselves.<br>Students will be better equipped to recognize fake news in the media regarding medical research topics. |
| **Workload in Hours** | Independent Study Time 62, Study Time in Lecture 28 |
| **Credit points** | 3 |
| **Course achievement** | None |
| **Examination** | Written exam |
| **Examination duration and scale** | 60 minutes |
| **Assignment for the Following Curricula** | General Engineering Science (German program, 7 semester): Specialisation Biomedical Engineering: Compulsory<br>General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Biomechanics: Compulsory<br>Electrical Engineering: Specialisation Medical Technology: Elective Compulsory<br>Engineering Science: Specialisation Biomedical Engineering: Compulsory<br>General Engineering Science (English program, 7 semester): Specialisation Biomedical Engineering: Compulsory<br>Mechanical Engineering: Specialisation Biomechanics: Compulsory<br>Biomedical Engineering: Specialisation Management and Business Administration: Elective Compulsory<br>Biomedical Engineering: Specialisation Artificial Organs and Regenerative Medicine: Elective Compulsory<br>Biomedical Engineering: Specialisation Medical Technology and Control Theory: Elective Compulsory<br>Biomedical Engineering: Specialisation Implants and Endoprostheses: Elective Compulsory<br>Technomathematics: Specialisation III. Engineering Science: Elective Compulsory |

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

## Module M1333: BIO I: Implants and Fracture Healing

**Courses**

| Title | Typ | Hrs/wk | CP |
|---|---|---|---|
| Implants and Fracture Healing (L0376) | Lecture | 2 | 3 |

| | |
|---|---|
| **Module Responsible** | Prof. Michael Morlock |
| **Admission Requirements** | None |
| **Recommended Previous Knowledge** | It is recommended to participate in "Introduction into Anatomie" before attending "Implants and Fracture Healing". |
| **Educational Objectives** | After taking part successfully, students have reached the following learning results |
| **Professional Competence** | |
| *Knowledge* | The students can describe the different ways how bones heal, and the requirements for their existence.<br>The students can name different treatments for the spine and hollow bones under given fracture morphologies. |
| *Skills* | The students can determine the forces acting within the human body under quasi-static situations under specific assumptions. |
| **Personal Competence** | |
| *Social Competence* | The students can, in groups, solve basic numerical modeling tasks for the calculation of internal forces. |
| *Autonomy* | The students can, in groups, solve basic numerical modeling tasks for the calculation of internal forces. |
| **Workload in Hours** | Independent Study Time 62, Study Time in Lecture 28 |
| **Credit points** | 3 |
| **Course achievement** | None |
| **Examination** | Written exam |
| **Examination duration and scale** | 90 min |
| **Assignment for the Following Curricula** | General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Biomechanics: Compulsory<br>General Engineering Science (German program, 7 semester): Specialisation Biomedical Engineering: Compulsory<br>Engineering Science: Specialisation Biomedical Engineering: Compulsory<br>General Engineering Science (English program, 7 semester): Specialisation Biomedical Engineering: Compulsory<br>Mechanical Engineering: Specialisation Biomechanics: Compulsory<br>Biomedical Engineering: Specialisation Implants and Endoprostheses: Elective Compulsory<br>Biomedical Engineering: Specialisation Artificial Organs and Regenerative Medicine: Elective Compulsory<br>Biomedical Engineering: Specialisation Management and Business Administration: Elective Compulsory<br>Biomedical Engineering: Specialisation Medical Technology and Control Theory: Elective Compulsory<br>Orientation Studies: Core Qualification: Elective Compulsory<br>Technomathematics: Specialisation III. Engineering Science: Elective Compulsory |

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

## Module M0956: Measurement Technology for Mechanical Engineers

**Courses**

| Title | Typ | Hrs/wk | CP |
|---|---|---|---|
| Practical Course: Measurement and Control Systems (L1119) | Practical Course | 2 | 2 |
| Measurement Technology for Mechanical Engineering (L1116) | Lecture | 2 | 3 |
| Measurement Technology for Mechanical Engineering (L1118) | Recitation Section (large) | 1 | 1 |

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

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

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

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

## Module M0634: Introduction into Medical Technology and Systems

**Courses**

| Title | Typ | Hrs/wk | CP |
|---|---|---|---|
| Introduction into Medical Technology and Systems (L0342) | Lecture | 2 | 3 |
| Introduction into Medical Technology and Systems (L0343) | Project Seminar | 2 | 2 |
| Introduction into Medical Technology and Systems (L1876) | Recitation Section (large) | 1 | 1 |

| | |
|---|---|
| **Module Responsible** | Prof. Alexander Schlaefer |
| **Admission Requirements** | None |
| **Recommended Previous Knowledge** | principles of math (algebra, analysis/calculus)<br>principles of stochastics<br>principles of programming, R/Matlab |
| **Educational Objectives** | After taking part successfully, students have reached the following learning results |
| **Professional Competence** | |
| *Knowledge* | The students can explain principles of medical technology, including imaging systems, computer aided surgery, and medical information systems. They are able to give an overview of regulatory affairs and standards in medical technology. |
| *Skills* | The students are able to evaluate systems and medical devices in the context of clinical applications. |
| **Personal Competence** | |
| *Social Competence* | The students describe a problem in medical technology as a project, and define tasks that are solved in a joint effort.<br>The students can critically reflect on the results of other groups and make constructive suggestions for improvement. |
| *Autonomy* | The students can assess their level of knowledge and document their work results. They can critically evaluate the results achieved and present them in an appropriate manner. |
| **Workload in Hours** | Independent Study Time 110, Study Time in Lecture 70 |
| **Credit points** | 6 |
| **Course achievement** | Compulsory: Yes; Bonus: 10 %; Form: Presentation<br>Compulsory: Yes; Bonus: 10 %; Form: Written elaboration |
| **Examination** | Written exam |
| **Examination duration and scale** | 90 minutes |
| **Assignment for the Following Curricula** | General Engineering Science (German program, 7 semester): Specialisation Biomedical Engineering: Compulsory<br>Computer Science: Specialisation II. Mathematics and Engineering Science: Elective Compulsory<br>Data Science: Specialisation II. Application: Elective Compulsory<br>Data Science: Core Qualification: Elective Compulsory<br>Electrical Engineering: Core Qualification: Elective Compulsory<br>Engineering Science: Specialisation Biomedical Engineering: Compulsory<br>General Engineering Science (English program, 7 semester): Specialisation Biomedical Engineering: Compulsory<br>Computer Science in Engineering: Specialisation II. Mathematics & Engineering Science: Elective Compulsory<br>Biomedical Engineering: Specialisation Artificial Organs and Regenerative Medicine: Elective Compulsory<br>Biomedical Engineering: Specialisation Implants and Endoprostheses: Elective Compulsory<br>Biomedical Engineering: Specialisation Medical Technology and Control Theory: Elective Compulsory<br>Biomedical Engineering: Specialisation Management and Business Administration: Elective Compulsory<br>Technomathematics: Specialisation III. Engineering Science: Elective Compulsory |

| Course L0342: Introduction into Medical Technology and Systems | |
|---|---|
| **Typ** | Lecture |
| **Hrs/wk** | 2 |
| **CP** | 3 |
| **Workload in Hours** | Independent Study Time 62, Study Time in Lecture 28 |
| **Lecturer** | Prof. Alexander Schlaefer |
| **Language** | DE |
| **Cycle** | SoSe |
| **Content** | - imaging systems<br>- computer aided surgery<br>- medical sensor systems<br>- medical information systems<br>- regulatory affairs<br>- standard in medical technology<br>The students will work in groups to apply the methods introduced during the lecture using problem based learning. |
| **Literature** | Bernhard Priem, "Visual Computing for Medicine", 2014<br>Heinz Handels, "Medizinische Bildverarbeitung", 2009 (https://katalog.tub.tuhh.de/Record/745558097)<br>Valery Tuchin, "Tissue Optics - Light Scattering Methods and Instruments for Medical Diagnosis", 2015<br>Olaf Drössel, "Biomedizinische Technik - Medizinische Bildgebung", 2014<br>H. Gross, "Handbook of Optical Systems", 2008 (https://katalog.tub.tuhh.de/Record/856571687)<br>Wolfgang Drexler, "Optical Coherence Tomography", 2008<br>Kramme, "Medizintechnik", 2011<br>Thorsten M. Buzug, "Computed Tomography", 2008<br>Otmar Scherzer, "Handbook of Mathematical Methods in Imaging", 2015<br>Weishaupt, "Wie funktioniert MRI?", 2014<br>Paul Suetens, "Fundamentals of Medical Imaging", 2009<br>Vorlesungsunterlagen |

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

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

## Module M1280: MED II: Introduction to Physiology

**Courses**

| Title | Typ | Hrs/wk | CP |
|---|---|---|---|
| Introduction to Physiology (L0385) | Lecture | 2 | 3 |

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

### Course L0385: Introduction to Physiology

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

## 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 |

| | |
|---|---|
| **Module Responsible** | Prof. Ulrich Carl |
| **Admission Requirements** | None |
| **Recommended Previous Knowledge** | None |
| **Educational Objectives** | After taking part successfully, students have reached the following learning results |
| **Professional Competence** | |
| *Knowledge* | **Therapy**<br>The students can distinguish different types of currently used equipment with respect to its use in radiation therapy.<br>The students can explain treatment plans used in radiation therapy in interdisciplinary contexts (e.g. surgery, internal medicine).<br>**The students can describe the patients' passage from their initial admittance through to follow-up care.**<br>**Diagnostics**<br>The students can illustrate the technical base concepts of projection radiography, including angiography and mammography, as well as sectional imaging techniques (CT, MRT, US).<br>The students can explain the diagnostic as well as therapeutic use of imaging techniques, as well as the technical basis for those techniques.<br>The students can choose the right treatment method depending on the patient's clinical history and needs.<br>The student can explain the influence of technical errors on the imaging techniques.<br>The student can draw the right conclusions based on the images' diagnostic findings or the error protocol. |
| *Skills* | **Therapy**<br>The students can distinguish curative and palliative situations and motivate why they came to that conclusion.<br>The students can develop adequate therapy concepts and relate it to the radiation biological aspects.<br>The students can use the therapeutic principle (effects vs adverse effects)<br>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).<br>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).<br>**Diagnostics**<br>The students can suggest solutions for repairs of imaging instrumentation after having done error analyses.<br>The students can classify results of imaging techniques according to different groups of diseases based on their knowledge of anatomy, pathology and pathophysiology. |
| **Personal Competence** | |
| *Social Competence* | The students can assess the special social situation of tumor patients and interact with them in a professional way.<br>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. |
| *Autonomy* | The students can apply their new knowledge and skills to a concrete therapy case.<br>The students can introduce younger students to the clinical daily routine.<br>The students are able to access anatomical knowledge by themselves, can participate competently in conversations on the topic and acquire the relevant knowledge themselves. |
| **Workload in Hours** | Independent Study Time 62, Study Time in Lecture 28 |
| **Credit points** | 3 |
| **Course achievement** | None |
| **Examination** | Written exam |
| **Examination duration and scale** | 90 minutes |
| **Assignment for the Following Curricula** | General Engineering Science (German program, 7 semester): Specialisation Biomedical Engineering: Compulsory<br>General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Biomechanics: Compulsory<br>Data Science: Specialisation II. Application: Elective Compulsory<br>Electrical Engineering: Specialisation Medical Technology: Elective Compulsory<br>Engineering Science: Specialisation Biomedical Engineering: Compulsory<br>General Engineering Science (English program, 7 semester): Specialisation Biomedical Engineering: Compulsory<br>Mechanical Engineering: Specialisation Biomechanics: Compulsory<br>Biomedical Engineering: Specialisation Medical Technology and Control Theory: Elective Compulsory<br>Biomedical Engineering: Specialisation Management and Business Administration: Elective Compulsory<br>Biomedical Engineering: Specialisation Artificial Organs and Regenerative Medicine: Elective Compulsory<br>Biomedical Engineering: Specialisation Implants and Endoprostheses: Elective Compulsory |

| | |
|---|---|
| | Technomathematics: Specialisation III. Engineering Science: Elective Compulsory |

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

## Module M1332: BIO I: Experimental Methods in Biomechanics

**Courses**

| Title | Typ | Hrs/wk | CP |
|---|---|---|---|
| Experimental Methods in Biomechanics (L0377) | Lecture | 2 | 3 |

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

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

## Module M1277: MED I: Introduction to Anatomy

**Courses**

| Title | Typ | Hrs/wk | CP |
|---|---|---|---|
| Introduction to Anatomy (L0384) | Lecture | 2 | 3 |

| | |
|---|---|
| **Module Responsible** | Prof. Udo Schumacher |
| **Admission Requirements** | None |
| **Recommended Previous Knowledge** | Students can listen to the lectures without any prior knowledge. Basic school knowledge of biology, chemistry / biochemistry, physics and Latin can be useful. |
| **Educational Objectives** | After taking part successfully, students have reached the following learning results |
| **Professional Competence** | |
| *Knowledge* | The lectures are about microscopic anatomy, describing the microscopic structure of tissues and organs, and about macroscopic anatomy which is about organs and organ systems. The lectures also contain an introduction to cell biology, human development and to the central nervous system. The fundamentals of radiologic imaging are described as well, using projectional x-ray and cross-sectional images. The Latin terms are introduced. |
| *Skills* | At the end of the lecture series the students are able to describe the microscopic as well as the macroscopic assembly and functions of the human body. The Latin terms are the prerequisite to understand medical literature. This knowledge is needed to understand und further develop medical devices.<br><br>These insights in human anatomy are the fundamentals to explain the role of structure and function for the development of common diseases and their impact on the human body. |
| **Personal Competence** | |
| *Social Competence* | The students can participate in current discussions in biomedical research and medicine on a professional level. The Latin terms are prerequisite for communication with physicians on a professional level. |
| *Autonomy* | The lectures are an introduction to the basics of anatomy and should encourage students to improve their knowledge by themselves. Advice is given as to which further literature is suitable for this purpose. Likewise, the lecture series encourages students to recognize and think critically about biomedical problems. |
| **Workload in Hours** | Independent Study Time 62, Study Time in Lecture 28 |
| **Credit points** | 3 |
| **Course achievement** | None |
| **Examination** | Written exam |
| **Examination duration and scale** | 90 minutes |
| **Assignment for the Following Curricula** | General Engineering Science (German program, 7 semester): Specialisation Biomedical Engineering: Compulsory<br>General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Biomechanics: Compulsory<br>Data Science: Specialisation II. Application: Elective Compulsory<br>Electrical Engineering: Specialisation Medical Technology: Elective Compulsory<br>Engineering Science: Specialisation Biomedical Engineering: Compulsory<br>General Engineering Science (English program, 7 semester): Specialisation Biomedical Engineering: Compulsory<br>Mechanical Engineering: Specialisation Biomechanics: Compulsory<br>Biomedical Engineering: Specialisation Medical Technology and Control Theory: Elective Compulsory<br>Biomedical Engineering: Specialisation Management and Business Administration: Elective Compulsory<br>Biomedical Engineering: Specialisation Artificial Organs and Regenerative Medicine: Elective Compulsory<br>Biomedical Engineering: Specialisation Implants and Endoprostheses: Elective Compulsory<br>Technomathematics: Specialisation III. Engineering Science: Elective Compulsory |

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

# Thesis

## Module M-001: Bachelor Thesis

**Courses**

| Title | Typ | Hrs/wk | CP |
|---|---|---|---|

| | |
|---|---|
| **Module Responsible** | Professoren der TUHH |
| **Admission Requirements** | • According to General Regulations §21 (1):<br>At least 126 ECTS credit points have to be achieved in study programme. The examinations board decides on exceptions. |
| **Recommended Previous Knowledge** | |
| **Educational Objectives** | After taking part successfully, students have reached the following learning results |
| **Professional Competence** | |
| *Knowledge* | • The students can select, outline and, if need be, critically discuss the most important scientific fundamentals of their course of study (facts, theories, and methods).<br>• 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.<br>• The students are able to outline the state of research on a selected issue in their subject area. |
| *Skills* | • The students can make targeted use of the basic knowledge of their subject that they have acquired in their studies to solve subject-related problems.<br>• 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.<br>• The students can take up a critical position on the findings of their own research work from a specialized perspective. |
| **Personal Competence** | |
| *Social Competence* | • Both in writing and orally the students can outline a scientific issue for an expert audience accurately, understandably and in a structured way.<br>• The students can deal with issues in an expert discussion and answer them in a manner that is appropriate to the addressees. In doing so they can uphold their own assessments and viewpoints convincingly. |
| *Autonomy* | • The students are capable of structuring an extensive work process in terms of time and of dealing with an issue within a specified time frame.<br>• The students are able to identify, open up, and connect knowledge and material necessary for working on a scientific problem.<br>• The students can apply the essential techniques of scientific work to research of their own. |
| **Workload in Hours** | Independent Study Time 360, Study Time in Lecture 0 |
| **Credit points** | 12 |
| **Course achievement** | None |
| **Examination** | Thesis |
| **Examination duration and scale** | According to General Regulations |
| **Assignment for the Following Curricula** | General Engineering Science (German program): Thesis: Compulsory<br>General Engineering Science (German program, 7 semester): Thesis: Compulsory<br>Civil- and Environmental Engineering: Thesis: Compulsory<br>Bioprocess Engineering: Thesis: Compulsory<br>Chemical and Bioprocess Engineering: Thesis: Compulsory<br>Computer Science: Thesis: Compulsory<br>Data Science: Thesis: Compulsory<br>Digital Mechanical Engineering: Thesis: Compulsory<br>Electrical Engineering: Thesis: Compulsory<br>Engineering Science: Thesis: Compulsory<br>General Engineering Science (English program): Thesis: Compulsory<br>General Engineering Science (English program, 7 semester): Thesis: Compulsory<br>Green Technologies: Energy, Water, Climate: Thesis: Compulsory<br>Computer Science in Engineering: Thesis: Compulsory<br>Integrated Building Technology: Thesis: Compulsory<br>Logistics and Mobility: Thesis: Compulsory<br>Mechanical Engineering: Thesis: Compulsory<br>Mechatronics: Thesis: Compulsory<br>Naval Architecture: Thesis: Compulsory<br>Technomathematics: Thesis: Compulsory<br>Teilstudiengang Lehramt Metalltechnik: Thesis: Compulsory<br>Process Engineering: Thesis: Compulsory<br>Engineering and Management - Major in Logistics and Mobility: Thesis: Compulsory |