TUHH
Hamburg
University of
Technology

# Module Manual

Bachelor of Science (B.Sc.)

# Engineering and Management - Major in Logistics and Mobility

Cohort: Winter Term 2021

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# Program description

## Content

Economic development with its rapid change in products and processes has also led, among other things, to a considerable restructuring of the inter-company division of labor. Today, this division of labor is characterized by cross-company value chains in which complex production processes have to be planned, sustainably designed and controlled. Logistics and its basic functions, transport, handling and warehousing, play a central role in this. Mobility is understood in the sense of social participation and opportunities for movement. Successful, socially and ecologically compatible economic activity under such conditions is made possible by the interaction of innovative technical systems, information and communication technologies, and management strategies.

The bachelor's degree program "Engineering and Management - Major in Logistics and Mobility" prepares graduates for professional activities in this interdisciplinary field. Extensive, interdisciplinary basic knowledge from the natural and engineering sciences and from business administration is taught. The effects on society as a whole are always included. By working on a wide range of tasks from various application areas of logistics and mobility, students also learn how to deal with specific issues, thus acquiring a meaningful mix of practical and scientific skills.

## Career prospects

Graduates of the program can enter directly into professions in the field of logistics or transportation planning. The degree program prepares them for independent and joint activities in responsible positions.

Possible employers include, for example, companies in the logistics sector, trading companies, manufacturing companies, engineering and planning offices, transport companies, construction companies, infrastructure operators and the public sector.

At Hamburg University of Technology, graduates have the opportunity, among other things, to follow the bachelor's degree program in "Engineering and Management - Major in Logistics and Mobility" with a master's degree in "Logistics, Infrastructure, and Mobility" or in "International Management and Engineering".

## Learning target

The bachelor's degree program in "Engineering and Management - Major in Logistics and Mobility" prepares students both for a professional career and for a relevant master's degree program. The basic methodological knowledge required for this is acquired during the course of study. The learning outcomes of the program are achieved through an interplay of basic and advanced modules from the fields of logistics, engineering and business administration and can be specialized in one of three specializations. The learning objectives are divided below into the categories of knowledge, skills, social competence and independence.

**Knowledge**
Knowledge is constituted by facts, principles and theories and is acquired in the Bachelor's program "Engineering and Management - Major in Logistics and Mobility" in the following areas:

1. Graduates are able to explain the basic methods, procedures and interrelationships of engineering sciences, in particular mathematics, engineering mechanics and computer science.
2. Graduates will be able to explain the basic methods, procedures and interrelationships of economics, business administration and management.
3. Graduates will be able to explain the methods, procedures and interrelationships of logistics and transportation planning and provide an overview of their subject and the interrelationships between the sub-disciplines of logistics.
4. Graduates are able to place their subject in the overall societal, social and economic context.

**Skills**
The ability to apply acquired knowledge in order to solve specific problems is supported in many ways in the degree program "Engineering and Management - Major in Logistics and Mobility":

1. Graduates are able to solve technical problems, as well as design new technical systems of logistics and transportation systems.
2. Graduates are able to evaluate technical systems of logistics and transport systems economically and ecologically.
3. Graduates are able to analyze, plan, design and control the flow systems (goods, people, information, money) necessary for the production of goods or the provision of services and to apply their theoretical knowledge in practical problems. Due to their holistic and analytical thinking, graduates are also able to penetrate and optimize networked processes.

**Social competence**
Social competence comprises the individual ability and willingness to work together with others in a goal-oriented manner, to understand the interests of others, to communicate and to help shape the working and living environment.

1. Graduates can integrate themselves into professionally homogeneous teams, organize themselves in these teams, take on specific subtasks and reflect on their own contribution.
2. Graduates are able to integrate themselves into heterogeneous teams, to organize themselves in these teams, to take on specific subtasks and to reflect on their own contribution.
3. Graduates are able to communicate about the contents of logistics and mobility as well as the results of their own work in an appropriate manner with both experts and laypersons.
4. Graduates are able to classify the social and ecological effects of logistics and transport systems on society and the environment.

**Self-reliance**
Personal competencies include not only the competence to act independently, but also the system and solution competencies to represent general problems as specific sub-problems as well as the selection and mastery of suitable methods and procedures for problem solving.

1. Graduates are able to realistically assess their competencies and work on deficits independently.
2. Graduates have the ability to formulate their findings precisely in writing and orally.
3. Graduates are able to independently work on sub-projects in more complex logistics and transport planning projects on the basis of the knowledge and skills they have acquired during their studies.
4. Graduates can reliably apply methods of scientific work and are thus also qualified to work in research or to deepen their competencies in a more advanced course of study.

## Program structure

The curriculum of the Bachelor's degree program "Engineering and Management - Major in Logistics and Mobility" is structured as follows:

- Core qualification, 19 compulsory modules, 3 compulsory elective modules, 132 LP, 1st-5th semester.
- Consolidation, 3 compulsory modules, 3 compulsory elective modules, 36 LP, 4th semester onwards
- Bachelor thesis, 12 LP, 6th semester

This results in a total of 180 LP.

In the core qualification, students are taught the fundamentals of mathematics, engineering, business administration, logistics and mobility, primarily in the first four semesters. In addition, there is a compulsory elective module in applied business administration, a freely selectable technical and a freely selectable non-technical supplementary module. A student research project in the fifth semester prepares students for their final thesis.

Starting in the 4th semester, students choose one of the three specializations:

- Transport planning and systems
- Production management and processes
- Information Technology

A specialization consists of three compulsory modules and three elective modules.

The fifth semester is kept as free as possible due to the high number of elective modules. This makes it possible to complete the fifth semester abroad.

The sixth semester is devoted to writing the bachelor's thesis.

## Core Qualification

Students gain basic knowledge as well as deepend skills in mathematics and business administration.

### Module M0650: Introduction to Logistics and Mobility

**Courses**

| Title | Typ | Hrs/wk | CP |
|---|---|---|---|
| Introduction to Scientific Work (L0474) | Lecture | 1 | 2 |
| Freight Traffic and Logistics (L0390) | Lecture | 2 | 2 |
| Freight Traffic and Logistics (L0391) | Project-/problem-based Learning | 2 | 2 |

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|---|---|
| **Module Responsible** | Prof. Heike Flämig |
| **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...<br>• describe the historical development of logistics<br>• name the basic functions of logistics<br>• describe supply chain management, logistics concepts, mobility management and systems analysis<br>• describe the connection between logistics and traffic and spatial development<br>• estimate the environmental impact of logistical decisions |
| *Skills* | Students can...<br>• apply basic concepts and methods of logistics phase systems<br>• analyze logistical systems and select alternative logistics concepts to improve the sustainability of companies<br>• solve problems systematically |
| **Personal Competence** | |
| *Social Competence* | Students can...<br>• collaborate in groups to reach and record work outcomes<br>• give appropriate feedback and deal constructively with feedback on their work |
| *Autonomy* | Students can...<br>• assess their own learning progress<br>• conduct literature research and analyses independently and cite them properly<br>• organize and complete the work set independently in terms of both time and content<br>• produce written work independently |
| **Workload in Hours** | Independent Study Time 110, Study Time in Lecture 70 |
| **Credit points** | 6 |

**Course achievement**

| Compulsory | Bonus | Form | Description |
|---|---|---|---|
| No | 2.5 % | Presentation | |
| No | 2.5 % | Excercises | |
| No | 2.5 % | Written elaboration | |
| No | 2.5 % | Written elaboration | |

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| **Examination** | Written exam |
| **Examination duration and scale** | Written exam 60 minutes. 2.5% bonus points each: Excerpt (1 page), homework in group (approx. 20 pages), presentation homework in group (25 minutes), weekly participation in JiTT-questions (10 weeks) |
| **Assignment for the Following Curricula** | Logistics and Mobility: Core Qualification: Compulsory<br>Engineering and Management - Major in Logistics and Mobility: Core Qualification: Compulsory |

| Course L0474: Introduction to Scientific Work | |
|---|---|
| **Typ** | Lecture |
| **Hrs/wk** | 1 |
| **CP** | 2 |
| **Workload in Hours** | Independent Study Time 46, Study Time in Lecture 14 |
| **Lecturer** | Dr. Meike Schröder |
| **Language** | DE |
| **Cycle** | WiSe |
| **Content** | • Introduction to research and science<br>• Finding a topic<br>• Literature review (finding, organizing and analyzing literature, databanks)<br>• Correct citing (adequate behavior with regard to literature, plagiarism, citation types, citation programs)<br>• Structuring a scientific work (organizing material, research questions, exposée, arguments, structure)<br>• Formating and layout (grouping, foot notes, formating in word)<br>• Writing of an excerpt for the term paper and written exam<br>• Discussing possible questions of the exam |
| **Literature** | • Beinke, Christiane; Brinkschulte, Melanie; Bunn, Lothar; Thürmer, Stefan (2011): Die Seminararbeit. Schreiben für den Leser. 2., völlig überarb. Aufl. Konstanz: UVK-Verlagsgesellschaft.<br>• Bitterlich, Axel; Bünting, Karl-Dieter; Pospiech, Ulrike (2007): Schreiben im Studium: mit Erfolg. Ein Leitfaden. 7. Aufl. Berlin: Cornelsen Scriptor.<br>• Boeglin, Martha (2011): Wissenschaftlich arbeiten Schritt für Schritt. Gelassen und effektiv studieren. 2., Aufl. Paderborn, Paderborn: UTB; Fink, Wilhelm.<br>• Brink, Alfred (2013): Anfertigung wissenschaftlicher Arbeiten. Wiesbaden: Springer Fachmedien Wiesbaden.<br>• Hirsch-Weber, Andreas; Scherer, Stefan (2016): Wissenschaftliches Schreiben und Abschlussarbeit in Naturwissenschaften und Ingenieurwissenschaften. Grundlagen - Praxisbeispiele - Übungen. Stuttgart: Verlag Eugen Ulmer.<br>• Kollmann, Tobias; Kuckertz, Andreas; Stöckmann, Christoph (2016): Das 1 x 1 des Wissenschaftlichen Arbeitens. Wiesbaden: Springer Fachmedien Wiesbaden.<br>• Niederhauser, Jürg (2015): Die schriftliche Arbeit kompakt. Von der Ideenfindung bis zur fertigen Arbeit. Für Schule, Hochschule und Universität. 2., aktualisierte und überarb. Aufl. Berlin: Dudenverlag.<br>• Oehlrich, Marcus (2015): Wissenschaftliches Arbeiten und Schreiben. Berlin, Heidelberg: Springer Berlin Heidelberg.<br>• Rost, Friedrich (2012): Lern- und Arbeitstechniken für das Studium. Wiesbaden: VS Verlag für Sozialwissenschaften.<br>• Sesink, Werner (2012): Einführung in das wissenschaftliche Arbeiten. Inklusive E-Learning, Web-Recherche, digitale Präsentation u.a. 9., aktualisierte Aufl. München: Oldenbourg.<br>• Sommer, Roy (2006): Schreibkompetenzen. Erfolgreich wissenschaftlich schreiben. Stuttgart: Klett Lernen und Wissen.<br>• Spoun, Sascha (2011): Erfolgreich studieren. 2., aktualisierte Aufl. München: Pearson Studium.<br>• Theisen, Manuel René (2013): Wissenschaftliches Arbeiten: Erfolgreich bei Bachelor- und Masterarbeit. 16., vollständig überarbeitete Auflage. München: Vahlen.<br>• Voss, Rödiger (2016): Wissenschaftliches Arbeiten ... leicht verständlich. Mit zahlreichen Abbildungen und Übersichten. 4., überarbeitete Auflage. Konstanz, München: UVK Verlagsgesellschaft mbH; UVK/Lucius. |

| Course L0390: Freight Traffic and Logistics | |
|---|---|
| **Typ** | Lecture |
| **Hrs/wk** | 2 |
| **CP** | 2 |
| **Workload in Hours** | Independent Study Time 32, Study Time in Lecture 28 |
| **Lecturer** | Prof. Heike Flämig |
| **Language** | DE |
| **Cycle** | WiSe |
| **Content** | The course gives an introductory overview of the basics of supply chain management and logistics and their interaction with freight traffic and thus the significance of traffic planning for business activities. In addition, examples of ecologically and economically sustainable best practice are discussed. The following subject areas are covered:<br>• Historical development of logistics<br>• Systemic thinking in logistics<br>• Concepts, trends and strategies in the field of<br>  ◦ Procurement logistics<br>  ◦ Production logistics<br>  ◦ Distribution logistics<br>  ◦ Reverse logistics<br>  ◦ Storage logistics<br>  ◦ Transport logistics<br>  ◦ Handling logistics<br>• Basics of the connection between logistical decisions and traffic<br>• Introduction to traffic policy<br>• Scope for design of (sustainable) freight traffic and logistics<br>The course contents will be consolidated by means of online surveys, Wiki entries by students and special practice sessions and illustrated by means of excursions. |
| **Literature** | ARNOLD, D., ISERMANN, H., KUHN, A., TEMPELMEIER, H. (Hrsg.) (2008): Handbuch Logistik. Berlin, Heidelberg, Springer-Verlag Berlin 3. neu bearb. Auflage.<br>IHDE, G. B. (2001): Transport, Verkehr, Logistik, Gesamtwirtschafliche Aspekte und einzelwirtschaftliche Handhabung. München, Verlag Franz Vahlen, 3. völlig überarbeitete und erweiterte Auflage.<br>PFOHL, H.-C. (2010): Logistiksysteme - Betriebswirtschaftliche Grundlagen. Berlin, Heidelberg, New York, Springer-Verlag, 8. neu bearb. Und aktualisierte Auflage. |

| Course L0391: Freight Traffic and Logistics | |
|---|---|
| **Typ** | Project-/problem-based Learning |
| **Hrs/wk** | 2 |
| **CP** | 2 |
| **Workload in Hours** | Independent Study Time 32, Study Time in Lecture 28 |
| **Lecturer** | Prof. Heike Flämig |
| **Language** | DE |
| **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, |

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

## Module M0829: Foundations of Management

**Courses**

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

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| **Module Responsible** | Prof. Christoph Ihl |
| **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* | Students are able to analyse business units with respect to different criteria (organization, objectives, strategies etc.) and to carry out an Entrepreneurship project in a team. In particular, they are able to<br>• analyse Management goals and structure them appropriately<br>• analyse organisational and staff structures of companies<br>• apply methods for decision making under multiple objectives, under uncertainty and under risk<br>• analyse production and procurement systems and Business information systems<br>• analyse and apply basic methods of marketing<br>• select and apply basic methods from mathematical finance to predefined problems<br>• apply basic methods from accounting, costing and controlling to predefined problems |
| **Personal Competence** | |
| *Social Competence* | Students are able to<br>• work successfully in a team of students<br>• to apply their knowledge from the lecture to an entrepreneurship project and write a coherent report on the project<br>• to communicate appropriately and<br>• to cooperate respectfully with their fellow students. |
| *Autonomy* | Students are able to<br>• work in a team and to organize the team themselves<br>• to write a report on their project. |
| **Workload in Hours** | Independent Study Time 110, Study Time in Lecture 70 |
| **Credit points** | 6 |
| **Course achievement** | None |
| **Examination** | Subject theoretical and practical work |
| **Examination duration and scale** | several written exams during the semester |
| **Assignment for the Following Curricula** | General Engineering Science (German program, 7 semester): Core Qualification: Compulsory<br>Civil- and Environmental Engineering: Specialisation Civil Engineering: Elective Compulsory<br>Civil- and Environmental Engineering: Specialisation Water and Environment: Elective Compulsory<br>Civil- and Environmental Engineering: Specialisation Traffic and Mobility: Elective Compulsory<br>Bioprocess Engineering: Core Qualification: Compulsory<br>Computer Science: Core Qualification: Compulsory<br>Data Science: Core Qualification: Compulsory<br>Electrical Engineering: Core Qualification: Compulsory<br>Energy and Environmental Engineering: Core Qualification: Compulsory<br>General Engineering Science (English program, 7 semester): Specialisation Electrical Engineering: Compulsory<br>General Engineering Science (English program, 7 semester): Specialisation Civil Engineering: Compulsory<br>General Engineering Science (English program, 7 semester): Specialisation Bioprocess Engineering: Compulsory<br>General Engineering Science (English program, 7 semester): Specialisation Energy and Enviromental Engineering: Compulsory<br>General Engineering Science (English program, 7 semester): Specialisation Computer Science: Compulsory<br>General Engineering Science (English program, 7 semester): Specialisation Mechanical Engineering, Focus Biomechanics: Compulsory<br>General Engineering Science (English program, 7 semester): Specialisation Mechanical Engineering, Focus Energy Systems: Compulsory<br>General Engineering Science (English program, 7 semester): Specialisation Mechanical Engineering, Focus Aircraft Systems Engineering: Compulsory |

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

| **Course L0882: Management Tutorial** | |
|---|---|
| **Typ** | Recitation Section (small) |
| **Hrs/wk** | 2 |
| **CP** | 3 |
| **Workload in Hours** | Independent Study Time 62, Study Time in Lecture 28 |
| **Lecturer** | Prof. Christoph Ihl, Katharina Roedelius |
| **Language** | DE |
| **Cycle** | WiSe/SoSe |
| **Content** | In the management tutorial, the contents of the lecture will be deepened by practical examples and the application of the discussed tools.<br><br>If there is adequate demand, a problem-oriented tutorial will be offered in parallel, which students can choose alternatively. Here, students work in groups on se selected projects that focus on the elaboration of an innovative business idea from the point of view of an established company or a startup. Again, the busin knowledge from the lecture should come to practical use. The group projects are guided by a mentor. |
| **Literature** | Relevante Literatur aus der korrespondierenden Vorlesung. |

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

## Module M0850: Mathematics I

**Courses**

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

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| **Module Responsible** | Prof. Anusch Taraz |
| **Admission Requirements** | None |
| **Recommended Previous Knowledge** | School mathematics |
| **Educational Objectives** | After taking part successfully, students have reached the following learning results |
| **Professional Competence** | |
| *Knowledge* | • Students can name the basic concepts in analysis and 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 analysis and linear algebra with the help of the concepts studied in this course. Moreover, they are capable of solving them by applying established methods.<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 128, Study Time in Lecture 112 |
| **Credit points** | 8 |
| **Course achievement** | None |
| **Examination** | Written exam |
| **Examination duration and scale** | 60 min (Analysis I) + 60 min (Linear Algebra I) |
| **Assignment for the Following Curricula** | General Engineering Science (German program, 7 semester): Core Qualification: Compulsory<br>Civil- and Environmental Engineering: Core Qualification: Compulsory<br>Bioprocess Engineering: Core Qualification: Compulsory<br>Digital Mechanical Engineering: Core Qualification: Compulsory<br>Electrical Engineering: Core Qualification: Compulsory<br>Green Technologies: Energy, Water, Climate: Core Qualification: Compulsory<br>Computational Science and Engineering: Core Qualification: Compulsory<br>Logistics and Mobility: Core Qualification: Compulsory<br>Mechanical Engineering: Core Qualification: Compulsory<br>Mechatronics: Core Qualification: Compulsory<br>Orientation Studies: Core Qualification: Elective Compulsory<br>Naval Architecture: Core Qualification: Compulsory<br>Process Engineering: Core Qualification: Compulsory<br>Engineering and Management - Major in Logistics and Mobility: Core Qualification: Compulsory |

| Course L1010: Analysis I | |
|---|---|
| **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** | DE |
| **Cycle** | WiSe |
| **Content** | Foundations of differential and integrational calculus of one variable<br>• statements, sets and functions<br>• natural and real numbers<br>• convergence of sequences and series<br>• continuous and differentiable functions<br>• mean value theorems<br>• Taylor series<br>• calculus<br>• error analysis<br>• fixpoint iteration |
| **Literature** | • http://www.math.uni-hamburg.de/teaching/export/tuhh/index.html |

| Course L1012: Analysis I | |
|---|---|
| **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** | DE |
| **Cycle** | WiSe |
| **Content** | See interlocking course |
| **Literature** | See interlocking course |

| Course L1013: Analysis I | |
|---|---|
| **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, Dr. Simon Campese |
| **Language** | DE |
| **Cycle** | WiSe |
| **Content** | See interlocking course |
| **Literature** | See interlocking course |

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

| Course L0913: Linear Algebra I | |
|---|---|
| **Typ** | Recitation Section (small) |
| **Hrs/wk** | 1 |
| **CP** | 1 |
| **Workload in Hours** | Independent Study Time 16, Study Time in Lecture 14 |
| **Lecturer** | Prof. Anusch Taraz, Dr. Dennis Clemens, Prof. Marko Lindner |
| **Language** | DE |
| **Cycle** | WiSe |
| **Content** | • vectors: intuition, rules, inner and cross product, lines and planes<br>• general vector spaces: subspaces, Euclidean vector spaces<br>• systems of linear equations: Gauß-elimination, matrix product, inverse matrices, transformations, LR-decomposition, block matrices, determinants |
| **Literature** | • T. Arens u.a. : Mathematik, Spektrum Akademischer Verlag, Heidelberg 2009<br>• W. Mackens, H. Voß: Mathematik I für Studierende der Ingenieurwissenschaften, HECO-Verlag, Alsdorf 1994<br>• W. Mackens, H. Voß: Aufgaben und Lösungen zur Mathematik I für Studierende der Ingenieurwissenschaften, HECO-Verlag, Alsdorf 1994 |

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

## Module M0889: Mechanics I (Statics)

**Courses**

| Title | Typ | Hrs/wk | CP |
|---|---|---|---|
| Mechanics I (Statics) (L1001) | Lecture | 2 | 3 |
| Mechanics I (Statics) (L1002) | Recitation Section (small) | 2 | 2 |
| Mechanics I (Statics) (L1003) | Recitation Section (large) | 1 | 1 |

| | |
|---|---|
| **Module Responsible** | Prof. Robert Seifried |
| **Admission Requirements** | None |
| **Recommended Previous Knowledge** | Solid school knowledge in mathematics and physics. |
| **Educational Objectives** | After taking part successfully, students have reached the following learning results |
| **Professional Competence** | |
| *Knowledge* | The students can<br>• describe the axiomatic procedure used in mechanical contexts;<br>• explain important steps in model design;<br>• present technical knowledge in stereostatics. |
| *Skills* | The students can<br>• explain the important elements of mathematical / mechanical analysis and model formation, and apply it to the context of their own problems;<br>• apply basic statical methods to engineering problems;<br>• estimate the reach and boundaries of statical methods and extend them to be applicable to wider problem sets. |
| **Personal Competence** | |
| *Social Competence* | The students can work in groups and support each other to overcome difficulties. |
| *Autonomy* | Students are capable of determining their own strengths and weaknesses and to organize their time and learning based on those. |
| **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** | General Engineering Science (German program, 7 semester): Core Qualification: Compulsory<br>Civil- and Environmental Engineering: Core Qualification: Compulsory<br>Bioprocess Engineering: Core Qualification: Compulsory<br>Data Science: Specialisation Mechanics: Compulsory<br>Digital Mechanical Engineering: Core Qualification: Compulsory<br>Electrical Engineering: Core Qualification: Elective Compulsory<br>Green Technologies: Energy, Water, Climate: Core Qualification: Compulsory<br>Computational Science and Engineering: Specialisation II. Mathematics & Engineering Science: Elective Compulsory<br>Logistics and Mobility: Core Qualification: Compulsory<br>Mechanical Engineering: Core Qualification: Compulsory<br>Mechatronics: Core Qualification: Compulsory<br>Orientation Studies: Core Qualification: Elective Compulsory<br>Naval Architecture: Core Qualification: Compulsory<br>Technomathematics: Core Qualification: Compulsory<br>Process Engineering: Core Qualification: Compulsory<br>Engineering and Management - Major in Logistics and Mobility: Core Qualification: Compulsory |

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

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

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

## Module M1004: Logistics Management

**Courses**

| Title | Typ | Hrs/wk | CP |
|---|---|---|---|
| Introduction into Production Logistics (L1222) | Lecture | 2 | 2 |
| Logistics Economics (L1221) | Project-/problem-based Learning | 3 | 4 |

| | |
|---|---|
| **Module Responsible** | Prof. Wolfgang Kersten |
| **Admission Requirements** | None |
| **Recommended Previous Knowledge** | Introduction to Business and Management |
| **Educational Objectives** | After taking part successfully, students have reached the following learning results |
| **Professional Competence** | |
| *Knowledge* | Students will be able<br>• to differentiate between production logistics and logistics services,<br>• to describe internal and external areas of production and logistics management,<br>• understand the difference between the different roles in a supply chain,<br>• to describe and explain the actual challenges of production and Logistics management |
| *Skills* | Based on the acquired knowledge students are capable of<br>• Analysing logistics problems and influence factors in companies,<br>• Selecting appropriate methods for solving practical problems,<br>• Applying methods and tools of logistics management for standardized problems. |
| **Personal Competence** | |
| *Social Competence* | Students can<br>• actively participate in discussions and team sessions,<br>• arrive at work results in groups and document them,<br>• develop joint solutions in mixed teams and present them to others. |
| *Autonomy* | Students are able to<br>- perform work steps for solving problems of business logistics independently with the aid of pointers<br>- assess their own state of learning in specific terms and to define further work steps on this basis guided by teachers. |
| **Workload in Hours** | Independent Study Time 110, Study Time in Lecture 70 |
| **Credit points** | 6 |
| **Course achievement** | **Compulsory** **Bonus** **Form** **Description**<br>No 20 % Subject theoretical and practical work |
| **Examination** | Written exam |
| **Examination duration and scale** | 120 min |
| **Assignment for the Following Curricula** | Data Science: Specialisation Logistics: Compulsory<br>Logistics and Mobility: Core Qualification: Compulsory<br>Orientation Studies: Core Qualification: Elective Compulsory<br>Engineering and Management - Major in Logistics and Mobility: Core Qualification: Compulsory |

| **Course L1222: Introduction into Production Logistics** | |
|---|---|
| **Typ** | Lecture |
| **Hrs/wk** | 2 |
| **CP** | 2 |
| **Workload in Hours** | Independent Study Time 32, Study Time in Lecture 28 |
| **Lecturer** | Dr. Yong Lee |
| **Language** | DE |
| **Cycle** | SoSe |
| **Content** | In the era of time-competition production and logistics need to be considered as a combined strategic competitive advantage.<br><br>"Introduction in to production logistics" gives an overview over the different disciplinces of production logistics:<br><br>- Development from cost-, quality to time-competitiion,<br>- fundamentals of production and logistics,<br>- phase-oriented and functional subsystems of production logistics,<br>- planning and steering,<br>- analysis and optimization (focus: Lean Management),<br>- production logistics controlling and supply-chain management in production network<br><br>Theory is complented by case studies and guest presentations. |
| **Literature** | • Der Vorlesung zugrunde liegende Literatur (Auswahl):<br><br>- Beer, Stafford (1988): Diagnosing the system for organizations. John Wiley & Sons. Chichester, New York, Brisbane, Toronto 1988.<br>- Ferdows, Kasra; De Meyer, Arnoud (1990): Lasting Improvements in Manufacturing Performance In Search of a New Theory. In: Journal of Operations Management, Vol. 9 (2), 1990, S. 365-384.<br>- Gudehus, Timm (2010): Logistik. Grundlagen - Strategien - Anwendungen. 4. aktual. Aufl. Springer Verlag. Heidelberg/Berlin 2010.<br>- Günther, Hans-Otto/Tempelmeier, Horst (2012): Produktion und Logistik. 9., akt. u. erw. Aufl. Springer Verlag. Berlin/Heidelberg 2012.<br>- Hayes, Robert H.; Schmenner, Roger (1978): How Should You Organize Ma-nufacturing?. In: Harvard Business Review, Vol. 56 (1), 1978, S. 105-118.<br>- Krafcik, John F. (1988): Triumph of the lean production system. In: Sloan Management Review, Vol. 30 (1), S. 41-52.<br>- Maskell, Brian H. (1989a): Performance Measurement for World Class Manufacturing. Part I. Manufacturing Systems, Vol. 7, 1989, S. 62-64.<br>- Pawellek, Günther (2007): Produktionslogistik - Planung - Steuerung - Controlling. Carl Hanser Verlag. München 2007.<br>- Nyhuis, Peter (2008): Beiträge zu einer Theorie der Logistik. Springer Verlag. Berlin/Heidelberg 2008.<br>- Pfohl, Hans-Christian (2010): Logistiksysteme. Betriebswirtschaftliche Grundlagen. 8., neu bearb. u. aktual. Aufl. Springer Verlag. Berlin/Heidelberg 2010.<br>- Schuh, Günther (1988): Gestaltung und Bewertung von Produktvarianten. Ein Beitrag zur systematischen Planung von Serienprodukten. Dissertation. RWTH Aachen 1988.<br>- Takeda, Hitoshi (2012): Das synchrone Produktionssystem. Just-in-time für das ganze Unternehmen. 7. Aufl. Verlag Franz Vahlen. München 2012.<br>- Ten Hompel, Michael/Sadowsky, Volker/Beck, Maria (2011): Kommissionierung. Materialflusssysteme 2 - Planung und Berechnung der Kommissionierung in der Logistik. Springer Verlag. Berlin/Heidelberg 2011.<br>- Wannenwetsch, Helmut (2007): Integrierte Materialwirtschaft und Logistik. Beschaffung, Logistik, Materialwirtschaft und Produktion.3., akt. Aufl. Springer Verlag. Berlin/Heidelberg 2007.<br>- Wiendahl, Hans-Peter/Reichardt, Jürgen/Nyhuis, Peter (2014): Handbuch Fabrikplanung. Konzept, Gestaltung und Umsetzung wandlungsfähiger Produktionsstätten. 2., überarb. u. erw. Aufl. Carl Hanser Verlag. München/Wien 2014.<br>- Wildemann, Horst (1997): Fertigungsstrategien - Reorganisation für eine schlanke Produktion und Zulieferung. 3. Aufl. TCW Transfer-Centrum-Verlag. München 1997.<br>- Wildemann, Horst (2008): Produktionssysteme. Leitfaden zur methoden-gestützten Reorganisation der Produktion. 6. Aufl. 2008, TCW München.<br>- Wildemann, Horst (2009): Logistik Prozeßmanagement. 4. Aufl. TCW Transfer-Centrum-Verlag. München 2009.<br>- Zäpfel, Günther (2001): Grundzüge des Produktions- und Logistikmanagement. 2., unwesentlich veränd. Aufl. R. Oldenbourg Verlag. München/Wien 2001. |

| **Course L1221: Logistics Economics** | |
|---|---|
| **Typ** | Project-/problem-based Learning |
| **Hrs/wk** | 3 |
| **CP** | 4 |
| **Workload in Hours** | Independent Study Time 78, Study Time in Lecture 42 |
| **Lecturer** | Dr. Meike Schröder |
| **Language** | DE |
| **Cycle** | SoSe |
| **Content** | • Explanation of basic concepts of logistics and outline of the scope of the logistics business, identification of global logistics networks and relationships<br>• Stakeholder: Introduction to the different kinds of logistics service providers, characterization of services of consulting firms for logistics companies<br>• Strategy: Influence of the business strategies on business logistics<br>• Outsourcing: Decision processes, possibilities and risks of outsourcing of logistics services<br>• Market: Logistics in Germany, relevance of logistics for the city of Hamburg<br>• Research: Outlook on current issues in academic research, as well as an outline of supplementary management methods for logistics |
| **Literature** | • Arnold, D.; Isermann, H.; Kuhn, A.; Tempelmeier, H. (2008): Handbuch Logistik, Berlin: Springer, 2008, ISBN: 3-540-72928-3<br>• Ballou, R. H. (2004): Business logistics, supply chain management: planning, organizing, and controlling the supply chain, 5. ed., internat. ed., Upper Saddle River, NJ: Pearson Prentice Hall, 2004, ISBN: 0-13-123010-7<br>• Bretzke, W.-R. (2008): Logistische Netzwerke, Springer, Berlin, 2008<br>• Gleißner, H.; Femerling, C. (2008): Logistik - Grundlagen, Übungen, Fallbeispiele, Wiesbaden: Gabler, 2008, ISBN: 978-3-8349-0296-2<br>• Kersten, W.; Hohrath, P.; Koch, J. (2007): Innovative logistics services : Advantage and Disadvantages of Outsourcing Complex Service Bundles, in: Key Factors for Successful Logistics, Berlin: Erich Schmidt Verlag GmbH & Co. KG, 2007<br>• Kersten, W.; Koch, J. (2007): Motive für das Outsourcing komplexer Logistikdienstleistungen, in: Handbuch Kontraktlogistik : Management komplexer Logistikdienstleistungen, Weinheim<br>• Schulte, C. (2009): Logistik: Wege zur Optimierung der Supply Chain, 5. überarb. und erw. Aufl., München: Vahlen, 2009, ISBN: 3-8006-3516-X<br>• Wildemann, H. (1997): Logistik Prozessmanagement - Organisation und Methoden, München: TCW Transfer-Centrum Verlag, 1997, ISBN: 3-931511-17-0 |

## Module M1681: Technical drawing and CAD

**Courses**

| Title | Typ | Hrs/wk | CP |
|---|---|---|---|
| Introduction to CAD (L2808) | Recitation Section (small) | 2 | 3 |
| Fundamentals of Technical Drawing (L1741) | Lecture | 1 | 1 |
| Fundamentals of Technical Drawing (L1742) | Recitation Section (large) | 1 | 2 |

| | |
|---|---|
| **Module Responsible** | Dr. Marko Hoffmann |
| **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** | Compulsory: No; Bonus: 10 %; Form: Subject theoretical and practical work; Description: |
| | Compulsory: No; Bonus: 5 %; Form: Excercises; Description: |
| **Examination** | Written exam |
| **Examination duration and scale** | 120 min |
| **Assignment for the Following Curricula** | Logistics and Mobility: Core Qualification: Compulsory<br>Engineering and Management - Major in Logistics and Mobility: Core Qualification: Compulsory |

### Course L2808: Introduction to CAD

| | |
|---|---|
| **Typ** | Recitation Section (small) |
| **Hrs/wk** | 2 |
| **CP** | 3 |
| **Workload in Hours** | Independent Study Time 62, Study Time in Lecture 28 |
| **Lecturer** | Dr. Marko Hoffmann |
| **Language** | DE |
| **Cycle** | WiSe |
| **Content** | • Introduction and terminology<br>• Basic materials for process engineering<br>• Examples of apparatuses and their elements<br>• Construction conforming to standards of technical drawings and flow diagram<br>• Perspective illustration of pipe systems and apparatus elements<br>• Boiler formula<br>• Stresses and strains of thick-walled cylindrical shells<br>• Wall thickness calculations of thin-walled cylindrical shells applying mechanical strength criterion and equivalent stresses<br>• System flange-bolt-gasket, sealings<br>• Shaft-hub connections<br>• Bearings<br>• Screwed connections<br>• Welded connections<br>• Heat exchangers |
| **Literature** | • Bargel, H.-J.; Schulze, G. (Hrsg.): Werkstoffkunde. Berlin u.a., Springer Vieweg, 2012.<br>• Bergmann, W.: Werkstofftechnik 1. München u.a., Hanser, 2009.<br>• Bergmann, W.: Werkstofftechnik 2. München u.a., Hanser, 2008.<br>• Callister, W. D.; Rethwisch, D. G.: Materialwissenschaften und Werkstofftechnik: eine Einführung, Übersetzungshrsg.: Scheffler, M., 1. Auflage, Weinheim, Wiley-VCH, 2013.<br>• Klapp, E.: Apparate- und Anlagentechnik, Springer, Berlin, 2002.<br>• Tietze, W.: Taschenbuch Dichtungstechnik, Vulkan, Essen, 2005.<br>• Titze, H., Wilke, H.-P.: Elemente des Apparatebaus, Springer, Berlin, 1992.<br>• Schwaigerer, S., Mühlenbeck, G.: Festigkeitsberechnung im Dampfkessel-, Behälter- und Rohrleitungsbau, Springer, Berlin, 1997.<br>• Seidel, W. W.,Hahn, F.: Werkstofftechnik. München u.a., Hanser, 2012.<br>• Wagner, W.: Festigkeitsberechnungen im Apparate- und Rohrleitungsbau, Würzburg, Vogel, 2007.<br>• Wittel, H., Muhs, D., Jannasch, D.; Voßiek, J.: Roloff/Matek Maschinenelemente, Wiesbaden, Springer Vieweg, 22. Auflage, 2015. |

| Course L1741: Fundamentals of Technical Drawing | |
|---|---|
| **Typ** | Lecture |
| **Hrs/wk** | 1 |
| **CP** | 1 |
| **Workload in Hours** | Independent Study Time 16, Study Time in Lecture 14 |
| **Lecturer** | Dr. Marko Hoffmann |
| **Language** | DE |
| **Cycle** | SoSe |
| **Content** | • Technical drawing basics (contents, kinds of drawings and generation of drawings according to relevant standards)<br>• Projective geometry (basics, orthographic projections, isometric projections, cuts, developed views, penetration views) |
| **Literature** | • Hoischen, Hans; Fritz, Andreas (Hrsg.): "Hoischen/Technisches Zeichnen: Grundlagen, Normen, Beispiele, Darstellende Geometrie", 35. überarbeitete und aktualisierte Auflage, Cornelsen Verlag, Berlin, 2016.<br>• Fritz, Andreas; Hoischen, Hans; Rund, Wolfgang (Hrsg.): "Praxis des Technischen Zeichnens Metall / Erklärungen, Übungen, Tests", 17. überarbeitete Auflage; Cornelsen Verlag, Berlin, 2016.<br>• Labisch, Susanna; Weber, Christian: "Technisches Zeichnen : Selbstständig lernen und effektiv üben", 4. überarbeitete und erweiterte Auflage, Springer Vieweg Verlag, Wiesbaden, 2013.<br>• Kurz, Ulrich; Wittel, Herbert: "Böttcher/Forberg Technisches Zeichnen : Grundlagen, Normung, Übungen und Projektaufgaben", 26. überarbeitete und erweiterte Auflage, Springer Vieweg Verlag, Wiesbaden, 2014.<br>• Klein, Martin; Alex, Dieter u.a.; DIN: Deutsches Institut für Normung e.V. (Hrsg.): "Einführung in die DIN-Normen"; 14. neubearbeitete Auflage, Teubner u.a., Stuttgart u.a., 2008. |

| Course L1742: Fundamentals of Technical Drawing | |
|---|---|
| **Typ** | Recitation Section (large) |
| **Hrs/wk** | 1 |
| **CP** | 2 |
| **Workload in Hours** | Independent Study Time 46, Study Time in Lecture 14 |
| **Lecturer** | Dr. Marko Hoffmann |
| **Language** | DE |
| **Cycle** | SoSe |
| **Content** | See interlocking course |
| **Literature** | See interlocking course |

## Module M0851: Mathematics II

**Courses**

| Title | Typ | Hrs/wk | CP |
|---|---|---|---|
| Analysis II (L1025) | Lecture | 2 | 2 |
| Analysis II (L1026) | Recitation Section (large) | 1 | 1 |
| Analysis II (L1027) | Recitation Section (small) | 1 | 1 |
| Linear Algebra II (L0915) | Lecture | 2 | 2 |
| Linear Algebra II (L0916) | Recitation Section (small) | 1 | 1 |
| Linear Algebra II (L0917) | Recitation Section (large) | 1 | 1 |

| | |
|---|---|
| **Module Responsible** | Prof. Anusch Taraz |
| **Admission Requirements** | None |
| **Recommended Previous Knowledge** | Mathematics I |
| **Educational Objectives** | After taking part successfully, students have reached the following learning results |
| **Professional Competence** | |
| *Knowledge* | • Students can name further concepts in analysis and 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 analysis and linear algebra with the help of the concepts studied in this course. Moreover, they are capable of solving them by applying established methods.<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 128, Study Time in Lecture 112 |
| **Credit points** | 8 |
| **Course achievement** | None |
| **Examination** | Written exam |
| **Examination duration and scale** | 60 min (Analysis II) + 60 min (Linear Algebra II) |
| **Assignment for the Following Curricula** | General Engineering Science (German program, 7 semester): Core Qualification: Compulsory<br>Civil- and Environmental Engineering: Core Qualification: Compulsory<br>Bioprocess Engineering: Core Qualification: Compulsory<br>Digital Mechanical Engineering: Core Qualification: Compulsory<br>Electrical Engineering: Core Qualification: Compulsory<br>Green Technologies: Energy, Water, Climate: Core Qualification: Compulsory<br>Computational Science and Engineering: Core Qualification: Compulsory<br>Logistics and Mobility: Core Qualification: Compulsory<br>Mechanical Engineering: Core Qualification: Compulsory<br>Mechatronics: Core Qualification: Compulsory<br>Orientation Studies: Core Qualification: Elective Compulsory<br>Naval Architecture: Core Qualification: Compulsory<br>Process Engineering: Core Qualification: Compulsory<br>Engineering and Management - Major in Logistics and Mobility: Core Qualification: Compulsory |

| Course L1025: Analysis II | |
|---|---|
| **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** | DE |
| **Cycle** | SoSe |
| **Content** | • power series and elementary functions<br>• interpolation<br>• integration (proper integrals, fundamental theorem, integration rules, improper integrals, parameter dependent integrals<br>• applications of integration (volume and surface of bodies of revolution, lines and arc length, line integrals<br>• numerical quadrature<br>• periodic functions |
| **Literature** | • http://www.math.uni-hamburg.de/teaching/export/tuhh/index.html |

| Course L1026: Analysis II | |
|---|---|
| **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, Dr. Sebastian Götschel |
| **Language** | DE |
| **Cycle** | SoSe |
| **Content** | See interlocking course |
| **Literature** | See interlocking course |

| Course L1027: Analysis II | |
|---|---|
| **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** | DE |
| **Cycle** | SoSe |
| **Content** | See interlocking course |
| **Literature** | See interlocking course |

| Course L0915: Linear Algebra II | |
|---|---|
| **Typ** | Lecture |
| **Hrs/wk** | 2 |
| **CP** | 2 |
| **Workload in Hours** | Independent Study Time 32, Study Time in Lecture 28 |
| **Lecturer** | Prof. Anusch Taraz, Dr. Dennis Clemens, Prof. Marko Lindner |
| **Language** | DE |
| **Cycle** | SoSe |
| **Content** | • general vector spaces: subspaces, Euclidean vector spaces<br>• linear mappings: basis transformation, orthogonal projection, orthogonal matrices, householder matrices<br>• linear regression: normal equations, linear discrete approximation<br>• eigenvalues: diagonalising matrices, normal matrices, symmetric and Hermite matrices<br>• system of linear differential equations<br>• matrix factorizations: LR-decomposition, QR-decomposition, Schur decomposition, Jordan normal form, singular value decomposition |
| **Literature** | • T. Arens u.a. : Mathematik, Spektrum Akademischer Verlag, Heidelberg 2009<br>• W. Mackens, H. Voß: Mathematik I für Studierende der Ingenieurwissenschaften, HECO-Verlag, Alsdorf 1994<br>• W. Mackens, H. Voß: Aufgaben und Lösungen zur Mathematik I für Studierende der Ingenieurwissenschaften, HECO-Verlag, Alsdorf 1994<br>• G. Strang: Lineare Algebra, Springer-Verlag, 2003<br>• G. und S. Teschl: Mathematik für Informatiker, Band 1, Springer-Verlag, 2013 |

| Course L0916: Linear Algebra II | |
|---|---|
| **Typ** | Recitation Section (small) |
| **Hrs/wk** | 1 |
| **CP** | 1 |
| **Workload in Hours** | Independent Study Time 16, Study Time in Lecture 14 |
| **Lecturer** | Prof. Anusch Taraz, Dr. Dennis Clemens, Prof. Marko Lindner |
| **Language** | DE |
| **Cycle** | SoSe |
| **Content** | • linear mappings: basis transformation, orthogonal projection, orthogonal matrices, householder matrices<br>• linear regression: QR-decomposition, normal equations, linear discrete approximation<br>• eigenvalues: diagonalising matrices, normal matrices, symmetric and Hermite matrices, Jordan normal form, singular value decomposition<br>• system of linear differential equations |
| **Literature** | • W. Mackens, H. Voß: Mathematik I für Studierende der Ingenieurwissenschaften, HECO-Verlag, Alsdorf 1994<br>• W. Mackens, H. Voß: Aufgaben und Lösungen zur Mathematik I für Studierende der Ingenieurwissenschaften, HECO-Verlag, Alsdorf 1994 |

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

## Module M0696: Mechanics II: Mechanics of Materials

**Courses**

| Title | Typ | Hrs/wk | CP |
|---|---|---|---|
| Mechanics II (L0493) | Lecture | 2 | 2 |
| Mechanics II (L0494) | Recitation Section (small) | 2 | 2 |
| Mechanics II (L1691) | Recitation Section (large) | 2 | 2 |

| | |
|---|---|
| **Module Responsible** | Prof. Christian Cyron |
| **Admission Requirements** | None |
| **Recommended Previous Knowledge** | Mechanics I |
| **Educational Objectives** | After taking part successfully, students have reached the following learning results |
| **Professional Competence** | |
| *Knowledge* | Having accomplished this module, the students know and understand the basic concepts of continuum mechanics and elastostatics, in particular stress, strain, constitutive laws, stretching, bending, torsion, failure analysis, energy methods and stability of structures. |
| *Skills* | Having accomplished this module, the students are able to<br>- apply the fundamental concepts of mathematical and mechanical modeling and analysis to problems of their choice<br>- apply the basic methods of elastostatics to problems of engineering, in particular in the design of mechanical structures<br>- to educate themselves about more advanced aspects of elastostatics |
| **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** | 90 min |
| **Assignment for the Following Curricula** | General Engineering Science (German program, 7 semester): Core Qualification: Compulsory<br>Civil- and Environmental Engineering: Core Qualification: Compulsory<br>Bioprocess Engineering: Core Qualification: Compulsory<br>Data Science: Specialisation Mechanics: Compulsory<br>Digital Mechanical Engineering: Core Qualification: Compulsory<br>Electrical Engineering: Core Qualification: Elective Compulsory<br>Green Technologies: Energy, Water, Climate: Core Qualification: Compulsory<br>Logistics and Mobility: Core Qualification: Compulsory<br>Mechanical Engineering: Core Qualification: Compulsory<br>Mechatronics: Core Qualification: Compulsory<br>Orientation Studies: Core Qualification: Elective Compulsory<br>Naval Architecture: Core Qualification: Compulsory<br>Technomathematics: Specialisation III. Engineering Science: Elective Compulsory<br>Process Engineering: Core Qualification: Compulsory<br>Engineering and Management - Major in Logistics and Mobility: Core Qualification: Compulsory |

### Course L0493: Mechanics II

| | |
|---|---|
| **Typ** | Lecture |
| **Hrs/wk** | 2 |
| **CP** | 2 |
| **Workload in Hours** | Independent Study Time 32, Study Time in Lecture 28 |
| **Lecturer** | Prof. Christian Cyron |
| **Language** | DE |
| **Cycle** | SoSe |
| **Content** | stresses and strains<br>Hooke's law<br>tension and compression<br>torsion<br>bending<br>stability<br>buckling<br>energy methods |
| **Literature** | • Gross, D., Hauger, W., Schröder, J., Wall, W.A.: Technische Mechanik 1, Springer<br>• Gross, D., Hauger, W., Schröder, J., Wall, W.A.: Technische Mechanik 2 Elastostatik, Springer |

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

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

## Module M1286: Technical Logistics

**Courses**

| Title | Typ | Hrs/wk | CP |
|---|---|---|---|
| Technical Logistics (L1746) | Lecture | 3 | 3 |
| Technical Logistics (L1747) | Recitation Section (small) | 2 | 3 |

| | |
|---|---|
| **Module Responsible** | Prof. Jochen Kreutzfeldt |
| **Admission Requirements** | None |
| **Recommended Previous Knowledge** | Successful completion of the modules „Introduction into logistics and mobility“, "Technical mechanics 1", "Mathematics 1" |
| **Educational Objectives** | After taking part successfully, students have reached the following learning results |
| **Professional Competence** | |
| *Knowledge* | The students will acquire the following skills:<br>1. The students know technical solutions for solving logistical problems in the areas of warehousing, conveying, sorting, order picking and identifying.<br>2. The students know approaches to introducing a selected technical solution.<br>3. The students know practical examples of the presented technical solutions. |
| *Skills* | The students will acquire the following skills:<br>1. The students can select different technical solutions for logistic problems of warehousing, conveying, sorting, order picking and identifying.<br>2. The students are able to evaluate critically the presented technical solutions with respect to their applicability for different logistical problems and compare different alternatives.<br>3. The students are able to assess the impact of selected solutions. |
| **Personal Competence** | |
| *Social Competence* | The students will acquire the following social skills:<br>1. The students will be able to sketch technical solutions for solving logistical problems of warehousing, conveying, sorting, order picking and identifying and reflect on their own contribution.<br>2. The technical solutions from the group are jointly documented and presented.<br>3. The students are able to present their technical solutions to an audience and they can derive new ideas and improvements from the feedback. |
| *Autonomy* | The students will acquire the following competencies:<br>1. The students are able to sketch autonomously, but under supervision, technical solutions to logistical problems of warehousing, conveying, sorting, order picking and identifying.<br>2. The students are able to evaluate their technical solutions and discuss the pros and cons. |
| **Workload in Hours** | Independent Study Time 110, Study Time in Lecture 70 |
| **Credit points** | 6 |
| **Course achievement** | Compulsory: No; Bonus: 10 %; Form: Excercises; Description: Bonuspunktaufgaben in Maple |
| **Examination** | Written exam |
| **Examination duration and scale** | 120 min |
| **Assignment for the Following Curricula** | Logistics and Mobility: Core Qualification: Compulsory<br>Engineering and Management - Major in Logistics and Mobility: Core Qualification: Compulsory |

| Course L1746: Technical Logistics | |
|---|---|
| **Typ** | Lecture |
| **Hrs/wk** | 3 |
| **CP** | 3 |
| **Workload in Hours** | Independent Study Time 48, Study Time in Lecture 42 |
| **Lecturer** | Prof. Jochen Kreutzfeldt |
| **Language** | DE |
| **Cycle** | SoSe |
| **Content** | The lecture gives an introduction in solutions and approaches of technical logistics. Five main topics will be addressed:<br>(1) warehousing<br>(2) conveying<br>(3) sorting<br>(4) order picking<br>(5) identifying<br>For each topic, various technical solutions are presented and discussed under consideration of advantages and disadvantages. This content is supplemented by practical examples that can be complemented by inviting guest lecturers.<br>In the exercises selected technical solutions will be presented and discussed for certain problems and practiced by the students. |
| **Literature** | Griemert, Rudolf (2015): Fördertechnik. Auswahl und Berechnung von Elementen und Baugruppen. [S.l.]: Morgan Kaufmann.<br>Hompel, Michael ten; Schmidt, Thorsten; Nagel, Lars (2007): Materialflusssysteme. Förder- und Lagertechnik. 3. Aufl. Berlin: Springer.<br>Hompel, Michael ten; Büchter, Hubert; Franzke, Ulrich (2008): Identifikationssysteme und Automatisierung. [Intralogistik]. Berlin, Heidelberg: Springer.<br>Hompel, Michael ten; Schmidt, Thorsten (2010): Warehouse Management. Organisation und Steuerung von Lager- und Kommissioniersystemen. 4. Aufl. Berlin: Springer.<br>Hompel, Michael ten; Beck, Maria; Sadowsky, Volker (2011): Kommissionierung. Materialflusssysteme 2 - Planung und Berechnung der Kommissionierung in der Logistik. Berlin [u.a.]: Springer.<br>Jodin, Dirk; Hompel, Michael ten (2012): Sortier- und Verteilsysteme. Grundlagen, Aufbau, Berechnung und Realisierung. 2. Aufl. Berlin: Springer.<br>Martin, Heinrich (2014): Transport- und Lagerlogistik. Planung, Struktur, Steuerung und Kosten von Systemen der Intralogistik. 9., vollst. überarb. u. akt. Aufl. 2014. Wiesbaden: Imprint: Springer Vieweg. |

| Course L1747: Technical Logistics | |
|---|---|
| **Typ** | Recitation Section (small) |
| **Hrs/wk** | 2 |
| **CP** | 3 |
| **Workload in Hours** | Independent Study Time 62, Study Time in Lecture 28 |
| **Lecturer** | Prof. Jochen Kreutzfeldt |
| **Language** | DE |
| **Cycle** | SoSe |
| **Content** | See interlocking course |
| **Literature** | See interlocking course |

| **Module M1674: Technical Complementary Course for Logistics and Mobility (according to Subject Specific Regulations)** | |
|---|---|
| **Courses** | |
| **Title** | **Typ** **Hrs/wk** **CP** |
| **Module Responsible** | Prof. Heike Flämig |
| **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** | Depends on choice of courses |
| **Credit points** | 6 |
| **Assignment for the Following Curricula** | Logistics and Mobility: Core Qualification: Compulsory<br>Engineering and Management - Major in Logistics and Mobility: Core Qualification: Compulsory |

## Module M0887: Transportation Planning and Traffic Engineering

**Courses**

| Title | Typ | Hrs/wk | CP |
|---|---|---|---|
| Transport Planning and Traffic Engineering (L0997) | Project-/problem-based Learning | 4 | 6 |

| | |
|---|---|
| **Module Responsible** | Prof. Carsten Gertz |
| **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<br>• understand the facts, contexts and objectives of transport planning.<br>• correctly apply definitions and concepts of transport planning.<br>• reproduce basic concepts of transport modelling.<br>• explain the fundamentals of traffic engineering and transport infrastructure construction. |
| *Skills* | Students are able to<br>• analyse transport supply based on key metrics.<br>• estimate transport demand using key metrics.<br>• design transport networks, links and junctions.<br>• calculate traffic signal plans.<br>• assess transport concepts. |
| **Personal Competence** | |
| *Social Competence* | Students are able to<br>• get together in groups and constructively discuss and analyse set problems.<br>• in a group agree on solutions and document them. |
| *Autonomy* | Students are able to<br>• produce reports on group work.<br>• structure the tasks and timing for working out a set problem. |
| **Workload in Hours** | Independent Study Time 124, Study Time in Lecture 56 |
| **Credit points** | 6 |
| **Course achievement** | **Compulsory** / **Bonus** / **Form** / **Description**<br>Yes / None / Group discussion<br>No / 5 % / Excercises |
| **Examination** | Subject theoretical and practical work |
| **Examination duration and scale** | Project report in four work packages, in small groups, during the semester; mandatory interim presentation |
| **Assignment for the Following Curricula** | Civil- and Environmental Engineering: Specialisation Traffic and Mobility: Compulsory<br>Civil- and Environmental Engineering: Specialisation Water and Environment: Compulsory<br>Civil- and Environmental Engineering: Specialisation Civil Engineering: Elective Compulsory<br>Logistics and Mobility: Core Qualification: Compulsory<br>Engineering and Management - Major in Logistics and Mobility: Core Qualification: Compulsory |

| Course L0997: Transport Planning and Traffic Engineering | |
|---|---|
| **Typ** | Project-/problem-based Learning |
| **Hrs/wk** | 4 |
| **CP** | 6 |
| **Workload in Hours** | Independent Study Time 124, Study Time in Lecture 56 |
| **Lecturer** | Prof. Carsten Gertz |
| **Language** | DE |
| **Cycle** | WiSe |
| **Content** | The course provides an introductory overview over the fundamentals of urban and regional transport planning, including the sub-topic traffic engineering. The following subject areas are covered:<br>• objectives of transport planning,<br>• key mobility metrics,<br>• measuring and predicting demand,<br>• designing and planning transport infrastructure,<br>• fundamentals of traffic engineering and<br>• an introduction to transport concepts and planning processes. |
| **Literature** | Steierwald, Gerd; Kühne, Hans Dieter; Vogt, Walter (Hrsg.) (2005)<br>Stadtverkehrsplanung: Grundlagen, Methoden, Ziele. Springer Verlag. Berlin.<br>Bosserhoff, Dietmar (2000) Integration von Verkehrsplanung und räumlicher Planung. Schriftenreihe der Hessischen Straßen- und Verkehrsverwaltung, Heft 42. Hessisches Landesamt für Straßen- und Verkehrswesen. Wiesbaden.<br>Lohse, Dieter; Schnabel, Werner (2011) Grundlagen der Straßenverkehrstechnik und der Verkehrsplanung: Band 1; Straßenverkehrstechnik. Beuth Verlag. Berlin.<br>Forschungsgesellschaft für Straßen- und Verkehrswesen (2007) Richtlinien für die Anlage von Stadtstraßen – RASt 06. FGSV-Verlag. Köln (FGSV, 200). |

## Module M1671: Introduction to Economics

**Courses**

| Title | Typ | Hrs/wk | CP |
|---|---|---|---|
| Introduction to Economics (L2712) | Lecture | 2 | 3 |
| Introduction to Economics (L2713) | Recitation Section (small) | 2 | 3 |

| | |
|---|---|
| **Module Responsible** | Prof. Timo Heinrich |
| **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<br>• topics and issues in microeconomics and macroeconomics,<br>• the functioning of a market economy and different market forms,<br>• important economic parameters and<br>• possibilities of economic policy interventions. |
| *Skills* | On the basis of the acquired knowledge, students are able to<br>• understand economic models and apply them to economic policy issues,<br>• reduce complex relationships to essential mechanisms and evaluate their practical relevance and<br>• evaluate economic policy decisions and apply basic methods of economic analysis. |
| **Personal Competence** | |
| *Social Competence* | The students are able to<br>• address the taught content argumentatively and discuss current economic topics,<br>• grasp complex issues and formulate systematic solutions and<br>• recognize the functioning of real markets with their opportunities and risks. |
| *Autonomy* | The students are able to<br>• deal with basic economic concepts and independently communicate their own analyses on this basis, as well as<br>• analyze and evaluate micro- and macroeconomic policy measures against the background of the various models. |
| **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** | 60 min |
| **Assignment for the Following Curricula** | Logistics and Mobility: Core Qualification: Compulsory<br>Engineering and Management - Major in Logistics and Mobility: Core Qualification: Compulsory |

### Course L2712: Introduction to Economics

| | |
|---|---|
| **Typ** | Lecture |
| **Hrs/wk** | 2 |
| **CP** | 3 |
| **Workload in Hours** | Independent Study Time 62, Study Time in Lecture 28 |
| **Lecturer** | Prof. Timo Heinrich |
| **Language** | EN |
| **Cycle** | WiSe |
| **Content** | • Capitalism and democracy: Affluence, inequality and the environment<br>• Social interactions and economic outcomes<br>• Public policy for fairness and efficiency<br>• Work, wellbeing and scarcity<br>• Institutions, power and inequality<br>• The firm: Employees, managers and owners<br>• Firms and markets for goods and services<br>• The credit market: Borrowers, lenders and the rate of interest<br>• Banks, money, housing and financial assets<br>• Market failures<br>• Governments and markets in a democratic society |
| **Literature** | • The CORE Team: Economy, Society and Public Policy, Oxford University Press, 2019<br>• Mankiw/Taylor: Economics, Cengage, 5th ed., 2020<br>• Wheelan: Naked Economics, 3rd ed. Norton, 2019 |

| Course L2713: Introduction to Economics | |
|---|---|
| **Typ** | Recitation Section (small) |
| **Hrs/wk** | 2 |
| **CP** | 3 |
| **Workload in Hours** | Independent Study Time 62, Study Time in Lecture 28 |
| **Lecturer** | Prof. Timo Heinrich |
| **Language** | EN |
| **Cycle** | WiSe |
| **Content** | |
| **Literature** | |

## Module M1692: Computer Science for Engineers - Introduction and Overview

**Courses**

| Title | Typ | Hrs/wk | CP |
|---|---|---|---|
| Computer Science for Engineers - Introduction and Overview (L2685) | Lecture | 3 | 3 |
| Computer Science for Engineers - Introduction and Overview (L2686) | Recitation Section (small) | 2 | 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 110, Study Time in Lecture 70 |
| **Credit points** | 6 |
| **Course achievement** | Compulsory: No; Bonus: 10 %; Form: Attestation; Description: Testate finden semesterbegleitend statt. |
| **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>Electrical Engineering: Core Qualification: Compulsory<br>Green Technologies: Energy, Water, Climate: Core Qualification: Compulsory<br>Integrated Building Technology: Core Qualification: Compulsory<br>Logistics and Mobility: Core Qualification: Compulsory<br>Mechanical Engineering: Core Qualification: Compulsory<br>Mechatronics: Core Qualification: Compulsory<br>Orientation Studies: Core Qualification: Elective Compulsory<br>Naval Architecture: Core Qualification: Compulsory<br>Engineering and Management - Major in Logistics and Mobility: Core Qualification: Compulsory |

### Course L2685: Computer Science for Engineers - Introduction and Overview

| | |
|---|---|
| **Typ** | Lecture |
| **Hrs/wk** | 3 |
| **CP** | 3 |
| **Workload in Hours** | Independent Study Time 48, Study Time in Lecture 42 |
| **Lecturer** | Prof. Görschwin Fey |
| **Language** | DE/EN |
| **Cycle** | WiSe |
| **Content** | |
| **Literature** | • Informatik<br>  ◦ Helmut Herold, Bruno Lurz, Jürgen Wohlrab, Matthias Hopf: Grundlagen der Informatik, 3. Auflage, 816 Seiten, Pearson Studium, 2017.<br>• C++<br>  ◦ Bjarne Stroustrup, Einführung in die Programmierung mit C++, 479 Seiten, Pearson Studium, 2010.<br>  --> in der englischen Version bereits eine neuere Auflage!<br>  ◦ Jürgen Wolf : Grundkurs C++: C++-Programmierung verständlich erklärt, Rheinwerk Computing, 3. Auflage, 2016. |

### Course L2686: Computer Science for Engineers - Introduction and Overview

| | |
|---|---|
| **Typ** | Recitation Section (small) |
| **Hrs/wk** | 2 |
| **CP** | 3 |
| **Workload in Hours** | Independent Study Time 62, Study Time in Lecture 28 |
| **Lecturer** | Prof. Görschwin Fey |
| **Language** | DE/EN |
| **Cycle** | WiSe |
| **Content** | See interlocking course |
| **Literature** | See interlocking course |

## Module M1672: IT applications for logistics and mobility

**Courses**

| Title | Typ | Hrs/wk | CP |
|---|---|---|---|
| IT applications for logistics and mobility (L2827) | Lecture | 3 | 4 |
| IT applications for logistics and mobility (L2828) | Recitation Section (small) | 1 | 2 |

| | |
|---|---|
| **Module Responsible** | NN |
| **Admission Requirements** | None |
| **Recommended Previous Knowledge** | Introduction to logistics and mobility |
| **Educational Objectives** | After taking part successfully, students have reached the following learning results |
| **Professional Competence** | |
| *Knowledge* | The students acquire the following knowledge:<br>• The students know the basic types of IT systems in logistics.<br>• The students know different techniques for business process modeling.<br>• The students know technological solutions for communication and identification in logistics. |
| *Skills* | The students acquire the following specialist skills:<br>• The students can describe and evaluate basic IT processes in logistics.<br>• The students can basically operate various IT systems in logistics.<br>• The students can describe and evaluate the differences between different basic technologies. |
| **Personal Competence** | |
| *Social Competence* | The students acquire the following social skills:<br>• The students are able to explain the basic principles of information technology to other students.<br>• The students can help other students to find errors in process modeling.<br>• The students are able to present their results in front of an audience. |
| *Autonomy* | The students acquire the following skills:<br>• The students familiarize themselves independently with unknown IT systems.<br>• The students are able to independently find a suitable modeling technique for a process.<br>• Based on the given task, the students can design a simple application in a basic technology. |
| **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** | 60 min |
| **Assignment for the Following Curricula** | Logistics and Mobility: Core Qualification: Compulsory<br>Engineering and Management - Major in Logistics and Mobility: Core Qualification: Compulsory |

### Course L2827: IT applications for logistics and mobility

| | |
|---|---|
| **Typ** | Lecture |
| **Hrs/wk** | 3 |
| **CP** | 4 |
| **Workload in Hours** | Independent Study Time 78, Study Time in Lecture 42 |
| **Lecturer** | Dr. Jutta Wolff |
| **Language** | DE |
| **Cycle** | WiSe |
| **Content** | The course covers the basics of information technology in relation to logistics systems. The course is divided into five subject areas: (1) Planning of IT systems in logistics, (2) data acquisition systems, (3) communication systems, (4) IT-supported processing, (5) basic technological developments in information technology. The course consists of a basic lecture with connected exercise units. |
| **Literature** | Becker, J.; Mathas, C.; Winkelmann, A. (2009): Geschäftsprozessmanagement. Berlin [u. a.]: Springer<br>Finkenzeller, K.; Gebhart, M. (2015): RFID-Handbuch. Grundlagen und praktische Anwendungen von Transpondern, kontaktlosen Chipkarten und NFC. 7. Auflage, München: Hanser<br>Hausladen, I. (2016): IT-gestützte Logistik.3. akt. und erw. Auflage, Wiesbaden: Springer-Gabler<br>Pfohl, H.-C. (2018): Logistiksysteme. Betriebswirtschaftliche Grundlagen. 9. Auflage, Berlin, Heidelberg: Springer Vieweg<br>ten Hompel, M.; Schmidt, T.; Dregger, J. (2018): Materialflusssysteme. Förder- und Lagertechnik. 4. Auflage, Berlin [u. a.]: Springer Vieweg (VDI-Buch).<br>ten Hompel, M.; Wolf, O.; Nettsträter, A.; Ebel, D.; Geissen, T.; Kraft, V.; Mertens, C.; Pott, C.; Schoneboom, J.; Witthaut, M. (2013): IT in der Logistik 2013/2014. Stuttgart: Fraunhofer-Verlag |

| Course L2828: IT applications for logistics and mobility | |
|---|---|
| **Typ** | Recitation Section (small) |
| **Hrs/wk** | 1 |
| **CP** | 2 |
| **Workload in Hours** | Independent Study Time 46, Study Time in Lecture 14 |
| **Lecturer** | Dr. Jutta Wolff |
| **Language** | DE |
| **Cycle** | WiSe |
| **Content** | See interlocking course |
| **Literature** | See interlocking course |

## Module M0831: Introduction to Operations Research and Statistics

**Courses**

| Title | Typ | Hrs/wk | CP |
|---|---|---|---|
| Introduction to Operations Research (L0884) | Lecture | 2 | 2 |
| Introduction to Statistics (L0883) | Lecture | 2 | 2 |
| Exercises to Introduction in Quantitative Methods in Logistics (L0885) | Recitation Section (small) | 2 | 2 |

| | |
|---|---|
| **Module Responsible** | Prof. Kathrin Fischer |
| **Admission Requirements** | None |
| **Recommended Previous Knowledge** | Knowledge from Mathematics Lectures. |
| **Educational Objectives** | After taking part successfully, students have reached the following learning results |
| **Professional Competence** | |
| *Knowledge* | The students know<br>• different methods from the field of descriptive statistics and can explain them and their importance for Logistics;<br>• selected discrete and continuous distribution functions and can explain their meaning and their areas of application;<br>• the laws of probability theory and can explain them;<br>• different methods of inferential statistics - e.g. confidence intervals, hypothesis testing;<br>• the history and relevance of Operations Research;<br>• linear programming methods for solving planning problems;<br>• selected methods of transportation and network optimization, e.g. methods for finding a shortest path;<br>• models and methods for the travelling salesman and the vehicle routing problem;<br>• appropriate software for solving these problems. |
| *Skills* | Students are able to<br>• collect data by appropriate methods, to aggregate, classify and analyze the data and to illustrate their results;<br>• recognize different distribution functions and to apply them in the solution of Logistics problems;<br>• apply laws of probability to construct solutions for Business problems;<br>• use appropriate methods of inferential statistics, apply them to Business problems and evaluate the results of their analysis;<br>• construct appropriate quantitative - linear or integer - models for Business planning situations;<br>• apply methods from linear programming and interpret the results;<br>• apply methods from transport and network planning and interpretthe results;<br>• solve TSPs and vehicle routing problems by heuristic methods;<br>• carry out a sensitivity analysis and evaluate the results;<br>• critically judge the different methods and their applicability;<br>• apply appropriate software for solving the problems. |
| **Personal Competence** | |
| *Social Competence* | Students are able to<br>• work successfully and respectfully in a team, derive group results and document them;<br>• engage in scientific discussions on topics from the fields of Statistics and OR;<br>• present the results of their work to others in an understandable way. |
| *Autonomy* | Students are able to<br>• carry out data analyses for given tasks independently, individually or in a team;<br>• solve complex Business planning problems independently or in a team, selecting and using appropriate software;<br>• gather knowledge in the area independently and to apply their knowledge in problem solving;<br>• critically reflect on the results of their work. |
| **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 |
| **Assignment for the Following Curricula** | Logistics and Mobility: Core Qualification: Compulsory<br>Engineering and Management - Major in Logistics and Mobility: Core Qualification: Compulsory |

| Course L0884: Introduction to Operations Research | |
|---|---|
| **Typ** | Lecture |
| **Hrs/wk** | 2 |
| **CP** | 2 |
| **Workload in Hours** | Independent Study Time 32, Study Time in Lecture 28 |
| **Lecturer** | Prof. Kathrin Fischer |
| **Language** | DE |
| **Cycle** | SoSe |
| **Content** | 1. Introduction to Operations Research<br>2. Linear Programming and Applications<br>3. Transportation Problems<br>4. Network Problems (e.g. Shortest Paths)<br>5. Travelling Salesman Problems and Vehicle Routing |
| **Literature** | D.R. Anderson / D.J. Sweeney / T.A. Williams / Martin: Quantitative Methods for Business. 11th Edition, Thomson, South Western 2008.<br>W. Domschke / A. Drexl: Einführung in Operations Research, 7. Auflage, Springer, Berlin et al. 2007.<br>F.S. Hillier/ G.J. Lieberman: Introduction to Operations Research. 8th Edition, McGraw-Hill, 2005.<br>L. Suhl / T. Mellouli: Optimierungssysteme. Springer Verlag. Berlin et al. 2006. |

| Course L0883: Introduction to Statistics | |
|---|---|
| **Typ** | Lecture |
| **Hrs/wk** | 2 |
| **CP** | 2 |
| **Workload in Hours** | Independent Study Time 32, Study Time in Lecture 28 |
| **Lecturer** | Prof. Kathrin Fischer |
| **Language** | DE |
| **Cycle** | SoSe |
| **Content** | 1. Introduction to statistics<br>2. Basics of descriptive statistics<br>3. Methods of descriptive statistics<br>4. Probabilities<br>5. Discrete probability distrbutions and their applications<br>6. Continuous probability distrbutions and their application<br>7. Introduction to confidence intervals<br>8. Introduction to hypothesis testing<br>9. Linear regression |
| **Literature** | Bluman, Alan G.: Elementary Statistics - A brief version. Third Edition, McGrawHill 2006.<br>Bowerman, Bruce L. and O'Connell, Richard T.: Business Statistics in Practice, 4 th edition, McGraw-Hill 2007.<br>Fahrmeir, L., Künstler, R., Pigeot, I., Tutz, G.: Statistik - Der Weg zur Datenanalyse. 6. Auflage. Berlin, Heidelberg 2007.<br>Quatember, A.: Statistik ohne Angst vor Formeln. 2. Auflage. Pearson Verlag 2008.<br>Schira, J.: Statistische Methoden der VWL und BWL - Theorie und Praxis. 2. Auflage, Pearson Verlag 2005. |

| Course L0885: Exercises to Introduction in Quantitative Methods in Logistics | |
|---|---|
| **Typ** | Recitation Section (small) |
| **Hrs/wk** | 2 |
| **CP** | 2 |
| **Workload in Hours** | Independent Study Time 32, Study Time in Lecture 28 |
| **Lecturer** | Prof. Kathrin Fischer |
| **Language** | DE |
| **Cycle** | SoSe |
| **Content** | Interactive sessions for discussion and application of the contents of "Introduction to Statistics" and "Introduction to OR". |
| **Literature** | Literaturangaben siehe Vorlesungen<br><br>Übungsblätter und weitere Informationen werden in der Übung verteilt. |

## Module M1261: Management

**Courses**

| Title | Typ | Hrs/wk | CP |
|---|---|---|---|
| Finance and Accounting (L1707) | Lecture | 2 | 3 |
| Foundations of Management (L1706) | Lecture | 2 | 3 |

| | |
|---|---|
| **Module Responsible** | Prof. Thomas Wrona |
| **Admission Requirements** | None |
| **Recommended Previous Knowledge** | Basics of business studies |
| **Educational Objectives** | After taking part successfully, students have reached the following learning results |
| **Professional Competence** | |
| *Knowledge* | Students will accumulate extensive knowledge about different aspects of management after having participated in this module.<br>• Students are able to give an overview of the activities of management and describe processes and content of management.<br>• Students are able to identify the features and procedures by which a modern organization can be managed.<br>• Students are able to explain and analyze relationships between management activities.<br>• Students are able to describe and apply methods of finance and accounting.<br>Students are able to develop procedures and basic approaches in the context of investment and financing decisions for the company. |
| *Skills* | • The students are able to recognize and evaluate important skills for management.<br>• The students are able to develop their own understanding of successful leadership in organizations and evaluate strategies accordingly.<br>• The Students are able to differentiate between different environmental contingencies and asses the underlying risk potentials.<br>Students are able to utilize models and methods of accounting and apply it from a business perspective. |
| **Personal Competence** | |
| *Social Competence* | After attending the module students will be able to<br>• lead and take part in strategy-related discussions<br>• present results, both in written and verbal form<br>work respectful with others in a team. |
| *Autonomy* | The students are able to gather, analyze, and critically reflect on information and data and convert it into manageable summaries. |
| **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** | Logistics and Mobility: Core Qualification: Compulsory<br>Engineering and Management - Major in Logistics and Mobility: Core Qualification: Compulsory |

### Course L1707: Finance and Accounting

| | |
|---|---|
| **Typ** | Lecture |
| **Hrs/wk** | 2 |
| **CP** | 3 |
| **Workload in Hours** | Independent Study Time 62, Study Time in Lecture 28 |
| **Lecturer** | Prof. Ulrich Pape |
| **Language** | DE |
| **Cycle** | SoSe |
| **Content** | Introduction to the theory and practice of finance and accounting:<br>The focus will be on basic principles of capital budgeting, finance and accounting and the underlying various methods of accounting. |
| **Literature** | Wird zu Veranstaltungsbeginn bekannt gegeben. |

### Course L1706: Foundations of Management

| | |
|---|---|
| **Typ** | Lecture |
| **Hrs/wk** | 2 |
| **CP** | 3 |
| **Workload in Hours** | Independent Study Time 62, Study Time in Lecture 28 |
| **Lecturer** | Prof. Thomas Wrona |
| **Language** | DE |
| **Cycle** | SoSe |
| **Content** | Introduction to the theory and practice of management:<br>The fundamentals of corporate governance will be taught, as well as an in-depth perspective on activities, characteristics and methods of management. |
| **Literature** | Wird zum Veranstaltungsbeginn bekannt gegeben. |

## Module M1740: Project Management and Controlling

**Courses**

| Title | Typ | Hrs/wk | CP |
|---|---|---|---|
| Foundations of Controlling (L2832) | Lecture | 2 | 3 |
| Foundations of project management (L2831) | Lecture | 2 | 3 |

| | |
|---|---|
| **Module Responsible** | Ann-Kathrin Lange |
| **Admission Requirements** | None |
| **Recommended Previous Knowledge** | No previous experience required. |
| **Educational Objectives** | After taking part successfully, students have reached the following learning results |
| **Professional Competence** | |
| *Knowledge* | The students know...<br>• common procedure models for project management.<br>• forms of project organization.<br>• success factors in project management.<br>• Types of project controlling.<br>• strategies for risk analysis and avoidance. |
| *Skills* | Students are able to...<br>• independently deal with a new project and divide it into appropriate work packages.<br>• manage and control a project during its execution.<br>• react appropriately in case of project risks.<br>• analyze strategic issues and interpret and present the results. |
| **Personal Competence** | |
| *Social Competence* | The students can...<br>• solve complex tasks in a team and document them accordingly.<br>• perform different roles during teamwork and give themselves appropriate feedback within the team.<br>• present and represent the relevant results of their work in front of experts. |
| *Autonomy* | Students are able to...<br>• independently obtain necessary information for planning a project.<br>• to structure themselves and their project over a longer period of time.<br>• to analyze the progress of the project independently and to intervene in a controlling manner. |
| **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** | Logistics and Mobility: Core Qualification: Compulsory<br>Engineering and Management - Major in Logistics and Mobility: Core Qualification: Compulsory |

### Course L2832: Foundations of Controlling

| | |
|---|---|
| **Typ** | Lecture |
| **Hrs/wk** | 2 |
| **CP** | 3 |
| **Workload in Hours** | Independent Study Time 62, Study Time in Lecture 28 |
| **Lecturer** | NN |
| **Language** | DE |
| **Cycle** | SoSe |
| **Content** | |
| **Literature** | |

| Course L2831: Foundations of project management | |
|---|---|
| **Typ** | Lecture |
| **Hrs/wk** | 2 |
| **CP** | 3 |
| **Workload in Hours** | Independent Study Time 62, Study Time in Lecture 28 |
| **Lecturer** | Ann-Kathrin Lange |
| **Language** | DE |
| **Cycle** | SoSe |
| **Content** | In this lecture the contents of the project management are explained. The technical contents are accompanied by a continuous exercise to deepen the methods and to promote independent work. The students learn the most important contents of the different phases of a project. |
| **Literature** | Deutschen Gesellschaft für Projektmanagement e. V. (GPM 2019), Kompetenzbasiertes Projektmanagement (PM4)<br><br>PMI 2017, A Guide to the Project Management Body of Knowledge(PMBoK Guide®)<br><br>Patzak und Rattay (2018), Projektmanagement - Projekte, Projektportfolios, Programme und projektorientierte Unternehmen<br><br>Timingers (2017), Modernes Projektmanagement |

## Module M1735: Ethics and Technology - Responsible Innovation

**Courses**

| Title | Typ | Hrs/wk | CP |
|---|---|---|---|
| Ethics and Technology - Responsible Innovation (L2830) | Lecture | 4 | 4 |

| | |
|---|---|
| **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 64, Study Time in Lecture 56 |
| **Credit points** | 4 |
| **Course achievement** | None |
| **Examination** | Subject theoretical and practical work |
| **Examination duration and scale** | noch zu definieren |
| **Assignment for the Following Curricula** | Logistics and Mobility: Core Qualification: Compulsory<br>Engineering and Management - Major in Logistics and Mobility: Core Qualification: Compulsory |

### Course L2830: Ethics and Technology - Responsible Innovation

| | |
|---|---|
| **Typ** | Lecture |
| **Hrs/wk** | 4 |
| **CP** | 4 |
| **Workload in Hours** | Independent Study Time 64, Study Time in Lecture 56 |
| **Lecturer** | NN |
| **Language** | DE |
| **Cycle** | WiSe |
| **Content** | |
| **Literature** | |

## Module M1704: Gamification of Strategic Thinking

**Courses**

| Title | Typ | Hrs/wk | CP |
|---|---|---|---|
| Gamification of Strategic Thinking (L2708) | Seminar | 4 | 6 |

| | |
|---|---|
| **Module Responsible** | Prof. Matthias Meyer |
| **Admission Requirements** | None |
| **Recommended Previous Knowledge** | None |
| **Educational Objectives** | After taking part successfully, students have reached the following learning results |
| **Professional Competence** | |
| *Knowledge* | • recognize and analyze relationships and interdependencies between different strategic decision areas<br>• understand problem-related terms, theories and methods of business administration and relate these to practical situations |
| *Skills* | • make well-founded decisions in realistic settings by drawing on the business administration knowledge<br>• consider in parallel and balance several relevant factors when making business-related decisions (e.g. financial situation, behavior of competitors, production capacities)<br>• critically analyze decisions in hindsight and deduce consequences for future decisions from this analysis<br>• analyze and explain economic and strategic phenomena by drawing on business administration theories and methods |
| **Personal Competence** | |
| *Social Competence* | • form stable work groups with fellow students, even those, who were previously unknown, and agree on work habits<br>• arrive at a consensus as a team when making management decisions and, if necessary, to solve conflicts along the way to achieving the consensus<br>• adequately present the situation of a (fictitious) organization and their decision making to teachers and fellow students |
| *Autonomy* | • make and justify decisions in simulated professional situations<br>• reflect their own actions in hindsight and arrive at suggestions for improvements in a structured way<br>• critically depict and reflect situations in a structured way, both, orally as well as in written reports<br>• make transfers from theory into practice |
| **Workload in Hours** | Independent Study Time 124, Study Time in Lecture 56 |
| **Credit points** | 6 |
| **Course achievement** | None |
| **Examination** | Subject theoretical and practical work |
| **Examination duration and scale** | Different achievements (single/team) - learning diary, presentations, reflections, essay |
| **Assignment for the Following Curricula** | Logistics and Mobility: Core Qualification: Elective Compulsory<br>Engineering and Management - Major in Logistics and Mobility: Core Qualification: Elective Compulsory |

### Course L2708: Gamification of Strategic Thinking

| | |
|---|---|
| **Typ** | Seminar |
| **Hrs/wk** | 4 |
| **CP** | 6 |
| **Workload in Hours** | Independent Study Time 124, Study Time in Lecture 56 |
| **Lecturer** | Prof. Matthias Meyer, Thorsten Kodalle |
| **Language** | DE |
| **Cycle** | WiSe |
| **Content** | The seminar "Gamification of Strategic Thinking" is offered as part of the elective course of studies "Logistics and Mobility" and currently offers space for 25 students. In cooperation with the German Armed Forces Command and Staff College, the seminar aims to teach strategic methods within the framework of a wargaming approach. For this purpose, the course consists of two blocks, which take place parallel to each other throughout the semester. In the theoretical block, students are taught the basics of various methods for strategy development and management (including SWOT analysis, SCRUM or Kanban). In the second block, the students apply the methods they have learned on the basis of the board game "Sycthe". For this, the students are divided into five groups with five members each. Each of these groups plays a "party" of the board game and is supposed to develop a strategy with the help of the learned methods that helps the respective team to win. Afterwards, the experiences will be reflected upon by means of a written elaboration and a proposal for an own business wargame will be developed. |
| **Literature** | Green, K. C. (2005), "Game theory, simulated interaction, and unaided judgment for forecasting decisions in conflicts," International Journal of Forecasting, 21, 463-472.<br><br>Romeike. F., Spitzner, J. (2013): Von Szenarioanalyse bis Wargaming, Betriebswirtschaftliche Simulationen im Praxiseinsatz, Wiley-VCH<br><br>Sabin, P. (2012), Simulating War - Studying Conflict through Simulation Games, Part 1, Bloomsbury Press, London. |

## Module M0622: Business Administration and Enterprise Resource Planning: CERMEDES AG

**Courses**

| Title | Typ | Hrs/wk | CP |
|---|---|---|---|
| Business Administration and Enterprise Resource Planning: CERMEDES AG (L0330) | Seminar | 2 | 3 |
| Business Administration and Enterprise Resource Planning: CERMEDES AG (L1785) | Lecture | 2 | 3 |

| | |
|---|---|
| **Module Responsible** | Prof. Christian Ringle |
| **Admission Requirements** | None |
| **Recommended Previous Knowledge** | Basic knowledge in business administration. |
| **Educational Objectives** | After taking part successfully, students have reached the following learning results |
| **Professional Competence** | |
| *Knowledge* | The students are able to...<br>• describe an internationally active company;<br>• describe complex and interrelated business processes along the supply chain;<br>• present important aspects of the project management of enterprise resource planning software implementations;<br>• name rules and processes for the implementation of business processes in SAP;<br>• explain the functioning and use of enterprise resource planning software along the supply chain;<br>• conduct business processes in SAP on their own;<br>• present the integrative role of enterprise resource planning systems. |
| *Skills* | The students are able to...<br>• map the design of business processes along the supply chain of a firm;<br>• implement business processes in an enterprise resource planning software;<br>• use an internationally used enterprise resource planning software in a daily routine;<br>• critically evaluate the enterprise resource planning software along the theoretical requirements for optimally designing a business process. |
| **Personal Competence** | |
| *Social Competence* | The students are able to...<br>• direct fruitful and professional discussions;<br>• work in teams on exercises;<br>• present and defend results of their work;<br>• communicate and collaborate successfully and respectfully with others in teams. |
| *Autonomy* | The students will be able to acquire knowledge in a specific context independently and to map this knowledge onto other new complex problem fields. |
| **Workload in Hours** | Independent Study Time 124, Study Time in Lecture 56 |
| **Credit points** | 6 |
| **Course achievement** | None |
| **Examination** | Subject theoretical and practical work |
| **Examination duration and scale** | Case studies, Mini-Challenges, Presentations |
| **Assignment for the Following Curricula** | Logistics and Mobility: Core Qualification: Elective Compulsory<br>Engineering and Management - Major in Logistics and Mobility: Core Qualification: Elective Compulsory |

| Course L0330: Business Administration and Enterprise Resource Planning: CERMEDES AG | |
|---|---|
| **Typ** | Seminar |
| **Hrs/wk** | 2 |
| **CP** | 3 |
| **Workload in Hours** | Independent Study Time 62, Study Time in Lecture 28 |
| **Lecturer** | Prof. Christian Ringle |
| **Language** | EN |
| **Cycle** | WiSe |
| **Content** | The course involves two main parts:<br><br>During the first part of the course, participants are provided with insights into the market for ERP-Software and are provided with knowledge on how ERP-implementation projects proceed and how these projects should ideally be managed from a theoretical and practical perspective. In addition, participants are provided with an understanding of business functions and processes by means of visiting the TUHH model factory. In the model factory, participants and are solving special business cases on the basis of group-specific tasks. Finally, participants are introduced into the basic functioning of ERP-Software referring to the most common system (SAP). Participants gain a basic understanding of implementing organizational data, master data and processes into the system.<br><br>During the second phase of this course, the students work independently in groups on deepening challenges, which conceptually build up on the executed case studies from phase one. Using the knowledge from phase one, the students are able to transfer the theoretical knowledge on the practical execution of the challes in SAP. The results of the group work will be presented in phase two. |
| **Literature** | Participants will be provided with a course handout in the form of ppt.-slides which can be downloaded in advance. Further literature references regarding the theoretical concepts are not provided (as this is part of the challenge in writing the thesis); literature references with regard to the ERP-System used are as follows:<br><br>• Agrawal, A. (2009): Customizing Materials Management Processes in SAP ERP Operations, Galileo Press: Boston.<br>• Arif, N./Tauseef, S. (2010): Integrating SAP ERP Financials, Galileo Press: Boston.<br>• Chudy, M./Castedo, L. (2015): Sales and Distribution in SAP ERP - Practical Guide, Galileo Press: Boston.<br>• Dickersback, J. T./Keller, G. (2010): Production Planning and Control with SAP ERP, 2e, Galileo Press: Boston.<br>• Franz, M. (2014): Project Management with SAP Project System, 4e, Galileo Press: Boston.<br>• Hoppe, M./Gulyassy, F. (2009): Materials Planning with SAP, Galileo Press: Boston.<br>• Veeriah, N. (2011): Customizing Financial Accounting in SAP, Galileo Press: Boston.<br>• Veeriah, N. (2011): Financial Accounting in SAP, Galileo Press: Boston. |

| Course L1785: Business Administration and Enterprise Resource Planning: CERMEDES AG | |
|---|---|
| **Typ** | Lecture |
| **Hrs/wk** | 2 |
| **CP** | 3 |
| **Workload in Hours** | Independent Study Time 62, Study Time in Lecture 28 |
| **Lecturer** | Prof. Christian Ringle |
| **Language** | EN |
| **Cycle** | WiSe |
| **Content** | See interlocking course |
| **Literature** | See interlocking course |

## Module M0681: Project Course Logistics and Mobility

**Courses**

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

| | |
|---|---|
| **Module Responsible** | Dozenten des Studiengangs |
| **Admission Requirements** | None |
| **Recommended Previous Knowledge** | none |
| **Educational Objectives** | After taking part successfully, students have reached the following learning results |
| **Professional Competence** | |
| *Knowledge* | Students will receive in-depth knowledge and in-depth skills in a special area of business administration, engineering science, logistics or mobility and can reproduce this knowledge. |
| *Skills* | After the project work in a business, engineering related, logistics and or mobility related research field, students are able to...<br>• familiarize themselves with a scientific and/or application-oriented problem<br>• analyze the problem and find a solution (if appropriate as part of a team)<br>• to refer to appropriate literature for the work on a problem as well as to critically evaluate publications<br>• produce a scientifically sound written report on the problem in question (if appropriate as part of a team) |
| **Personal Competence** | |
| *Social Competence* | After the project work students are able to...<br>• work respectfully in teams and to organize themselves in teams<br>• analyse a problem in a team and to find a solution together<br>• present and defend their project work to a sizable (expert) audience |
| *Autonomy* | After the project work students are able to...<br>• familiarize themselves successfully with a demanding scientific or application oriented problem independently<br>• prepare and deliver a presentation of their results independently |
| **Workload in Hours** | Independent Study Time 180, Study Time in Lecture 0 |
| **Credit points** | 6 |
| **Course achievement** | None |
| **Examination** | Study work |
| **Examination duration and scale** | |
| **Assignment for the Following Curricula** | Logistics and Mobility: Core Qualification: Compulsory<br>Engineering and Management - Major in Logistics and Mobility: Core Qualification: Elective Compulsory |

## Module M1911: Project Seminar WILUM

**Courses**

| Title | Typ | Hrs/wk | CP |
|---|---|---|---|
| Project Seminar WILUM (L3153) | Seminar | 3 | 6 |

| | |
|---|---|
| **Module Responsible** | Dozenten des SD W |
| **Admission Requirements** | None |
| **Recommended Previous Knowledge** | Prior knowledge in the relevant area from the relevant Management modules. |
| **Educational Objectives** | After taking part successfully, students have reached the following learning results |
| **Professional Competence** | |
| *Knowledge* | |
| *Skills* | Students are able to<br>• independently acquire the relevant knowledge to handle their project<br>• independently carry out a (pre-defined) complex research task and/or solve a complex problem<br>• select and use the relevant literature and critically evaluate it<br>• aggregate their knowledge and results and present it to others<br>• write a scientific report on the project / problem at hand, individually or in a team. |
| **Personal Competence** | |
| *Social Competence* | Students are able to<br>• work respectfully and successfully in a team, organize the team, and solve complex tasks in a team in a given timeframe<br>• analyse a problem in a team and develop a solution for the problem<br>• present the results of their work to specialists. |
| *Autonomy* | Students are able to<br>• define the scope of their project<br>• independently acquire relevant scientific knowledge<br>• independently carry out a (pre-defined) complex research task<br>• independently prepare a presentation of the relevant aspects of the project. |
| **Workload in Hours** | Independent Study Time 138, Study Time in Lecture 42 |
| **Credit points** | 6 |
| **Course achievement** | None |
| **Examination** | Written elaboration |
| **Examination duration and scale** | To be announced in seminar. |
| **Assignment for the Following Curricula** | Engineering and Management - Major in Logistics and Mobility: Core Qualification: Elective Compulsory |

### Course L3153: Project Seminar WILUM

| | |
|---|---|
| **Typ** | Seminar |
| **Hrs/wk** | 3 |
| **CP** | 6 |
| **Workload in Hours** | Independent Study Time 138, Study Time in Lecture 42 |
| **Lecturer** | Prof. Heike Flämig |
| **Language** | DE/EN |
| **Cycle** | WiSe/SoSe |
| **Content** | Contents differ, depending on the institute which organizes the respective seminar. Topics are always announced at the start of the term. |
| **Literature** | Wird je nach Thema angegeben; in der Regel handelt es sich um wissenschaftliche Fachartikel und Publikationen, vorwiegend in englischer Sprache. |

## Module M1889: Innovation and product development - a business game

**Courses**

| Title | Typ | Hrs/wk | CP |
|---|---|---|---|
| Innovation and product development - a business game (L3126) | Project-/problem-based Learning | 4 | 6 |

| | |
|---|---|
| **Module Responsible** | Prof. Tim Schweisfurth |
| **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 124, Study Time in Lecture 56 |
| **Credit points** | 6 |
| **Course achievement** | None |
| **Examination** | Subject theoretical and practical work |
| **Examination duration and scale** | Different achievements (single/team) - learning diary, presentations, reflections, essay |
| **Assignment for the Following Curricula** | Engineering and Management - Major in Logistics and Mobility: Core Qualification: Elective Compulsory |

### Course L3126: Innovation and product development - a business game

| | |
|---|---|
| **Typ** | Project-/problem-based Learning |
| **Hrs/wk** | 4 |
| **CP** | 6 |
| **Workload in Hours** | Independent Study Time 124, Study Time in Lecture 56 |
| **Lecturer** | Prof. Tim Schweisfurth, Prof. Moritz Göldner |
| **Language** | EN |
| **Cycle** | SoSe |
| **Content** | |
| **Literature** | |

## Module M1675: Legal Foundations of Logistics and Mobility

**Courses**

| Title | Typ | Hrs/wk | CP |
|---|---|---|---|
| Legal Foundations of Transportation and Logistics (L1186) | Lecture | 2 | 2 |
| Legal Foundations of Transportation and Logistics (L1187) | Recitation Section (large) | 1 | 2 |

| | |
|---|---|
| **Module Responsible** | Prof. Heike Flämig |
| **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...<br>• describe the systematics of transport law and logistics law<br>• explain the legal connections in transport and logistics |
| *Skills* | Students can...<br>• analyze and solve questions of law for transport and logistics<br>• discuss and systematically evaluate law cases and verify them with applicable laws |
| **Personal Competence** | |
| *Social Competence* | Students can come to results in groups and document them. |
| *Autonomy* | Students can...<br>• develop systematical thinking<br>• search and analyze laws independently<br>• answer questions of law concerning transport and logistics independently |
| **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** | 60 min |
| **Assignment for the Following Curricula** | Logistics and Mobility: Core Qualification: Compulsory<br>Engineering and Management - Major in Logistics and Mobility: Core Qualification: Compulsory |

### Course L1186: Legal Foundations of Transportation and Logistics

| | |
|---|---|
| **Typ** | Lecture |
| **Hrs/wk** | 2 |
| **CP** | 2 |
| **Workload in Hours** | Independent Study Time 32, Study Time in Lecture 28 |
| **Lecturer** | Dr. Niels Witt |
| **Language** | DE |
| **Cycle** | SoSe |
| **Content** | • Basics of german law<br>• regulations of the HGB<br>• international conventions<br>• maritime trade law<br>• contract logistics<br>• complex logistics chains |
| **Literature** | Aktueller Text des Bürgerlichen Gesetzbuches und Handelsgesetzbuches |

### Course L1187: Legal Foundations of Transportation and Logistics

| | |
|---|---|
| **Typ** | Recitation Section (large) |
| **Hrs/wk** | 1 |
| **CP** | 2 |
| **Workload in Hours** | Independent Study Time 46, Study Time in Lecture 14 |
| **Lecturer** | Dr. Niels Witt |
| **Language** | DE |
| **Cycle** | SoSe |
| **Content** | See interlocking course |
| **Literature** | See interlocking course |

## Module M0974: Business Simulation Marktstrat

**Courses**

| Title | Typ | Hrs/wk | CP |
|---|---|---|---|
| Business Simulation Marktstrat (L0918) | Seminar | 4 | 6 |

| | |
|---|---|
| **Module Responsible** | Prof. Christian Lüthje |
| **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...<br>• recognize and analyze relationships and interdependencies between different decision areas in business management<br>• understand problem-related terms, theories and methods of business administration and relate these to practical situations in businesses |
| *Skills* | Students are able to...<br>• make well-founded decisions in realistic coroporate settings by drawing on the business administration knowledge<br>• consider in parallel and balance several relevant factors when making business-related decisions (e.g. financial situation, behavior of competitors, market demand, production capacities)<br>• critically analyze business decisions in hindsight and deduce consequences for future decisions from this analysis<br>• analyze and explain phenomena from daily business by drawing on business administration theories and methods |
| **Personal Competence** | |
| *Social Competence* | Students are able to...<br>• form stable work groups with fellow students, even those, who were previously unknown, and agree on work habits<br>• arrive at a consensus as a team when making management decisions and, if necessary, to solve conflicts along the way to achieving the consensus<br>• adequately present the situation of a (fictitious) company and their decision making to teachers and fellow students |
| *Autonomy* | Students are able to...<br>• make and justify decisions in simulated professional situations<br>• reflect their own actions in hindsight and arrive at suggestions for improvements in a structured way<br>• critically depict and reflect situations in a structured way, both, orally as well as in written reports<br>• make transfers from theory into practice |
| **Workload in Hours** | Independent Study Time 124, Study Time in Lecture 56 |
| **Credit points** | 6 |
| **Course achievement** | None |
| **Examination** | Subject theoretical and practical work |
| **Examination duration and scale** | different achievements (single/team) - learning diary, presentations, reflections |
| **Assignment for the Following Curricula** | Logistics and Mobility: Core Qualification: Elective Compulsory<br>Engineering and Management - Major in Logistics and Mobility: Core Qualification: Elective Compulsory |

| Course L0918: Business Simulation Marktstrat | |
|---|---|
| **Typ** | Seminar |
| **Hrs/wk** | 4 |
| **CP** | 6 |
| **Workload in Hours** | Independent Study Time 124, Study Time in Lecture 56 |
| **Lecturer** | Prof. Christian Lüthje |
| **Language** | DE |
| **Cycle** | SoSe |
| **Content** | The business simulation game Markstrat B2B - Markstrat is a business simulation which puts you into the role of managing the marketing division of the electro-mechanical business unit of a large corporation. Competing with several other companies, you try to successfully market two products to business customers. To this end, you and other students jointly develop and implement a long-term marketing strategy for your business unit.<br><br>During the 10 rounds of the simulation game, the students and the randomly assigned student team make decisions in the areas of product development, advertising, sales, price, production, and human resources on a weekly basis. To make well-informed decisions, the student teams can draw on a large number of information sources such as customer surveys, experiments, market studies, and benchmarks which you need to analyze during each round of the simulation.<br><br>The simulation is accompanied by a comprehensive introduction, a concomitant coaching, as well as a mid-term and final presentation. In addition, the student teams will prepare a written report. |
| **Literature** | Kotler, Philip und Keller, Kevin Lane (2011): Marketing Management, 14th Edition, Prentice Hall International<br><br>Morris, Michael H.; Pitt, Leyland F.; Honeycutt Jr., Earl D. (2001): Business-To-Business Marketing: A Strategic Approach, 3rd Edition, Sage<br><br>Bruhn, Manfred (2012): Marketing - Grundlagen für Studium und Praxis, 11. Auflage, Gabler |

## Specialization Information Technology

### Module M1693: Computer Science for Engineers - Programming Concepts, Data Handling & Communication

**Courses**

| Title | Typ | Hrs/wk | CP |
|---|---|---|---|
| Computer Science for Engineers - Programming Concepts, Data Handling & Communication (L2689) | Lecture | 3 | 3 |
| Computer Science for Engineers - Programming Concepts, Data Handling & Communication (L2690) | Recitation Section (small) | 2 | 3 |

| | |
|---|---|
| **Module Responsible** | Prof. Sibylle Fröschle |
| **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><br>**Personal Competence**<br>*Social Competence*<br>*Autonomy* | |
| **Workload in Hours** | Independent Study Time 110, Study Time in Lecture 70 |
| **Credit points** | 6 |
| **Course achievement** | Compulsory: No; Bonus: 10 %; Form: Attestation; Description: Testate finden semesterbegleitend statt. |
| **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 Biomechanics: Compulsory<br>General Engineering Science (German program, 7 semester): Specialisation Biomedical Engineering: Compulsory<br>General Engineering Science (German program, 7 semester): Specialisation Green Technologies, Focus Renewable Energy: Elective Compulsory<br>General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Energy Systems: Compulsory<br>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 Mechatronics: Compulsory<br>General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Product Development and Production: Elective Compulsory<br>General Engineering Science (German program, 7 semester): Specialisation Electrical Engineering: Elective Compulsory<br>General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Theoretical Mechanical Engineering: Elective Compulsory<br>Bioprocess Engineering: Core Qualification: Compulsory<br>Chemical and Bioprocess Engineering: Core Qualification: Compulsory<br>Electrical Engineering: Core Qualification: Compulsory<br>Green Technologies: Energy, Water, Climate: Specialisation Energy Systems: Elective Compulsory<br>Logistics and Mobility: Specialisation Information Technology: Compulsory<br>Mechatronics: Core Qualification: Compulsory<br>Process Engineering: Core Qualification: Compulsory<br>Engineering and Management - Major in Logistics and Mobility: Specialisation Information Technology: Compulsory |

#### Course L2689: Computer Science for Engineers - Programming Concepts, Data Handling & Communication

| | |
|---|---|
| **Typ** | Lecture |
| **Hrs/wk** | 3 |
| **CP** | 3 |
| **Workload in Hours** | Independent Study Time 48, Study Time in Lecture 42 |
| **Lecturer** | Prof. Sibylle Fröschle |
| **Language** | DE |
| **Cycle** | SoSe |
| **Content** | |
| **Literature** | John V. Guttag: Introduction to Computation and Programming Using Python.<br>With Application to Understanding Data. 2nd Edition. The MIT Press, 2016. |

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

## Module M1290: Simulation of intra logistics

**Courses**

| Title | Typ | Hrs/wk | CP |
|---|---|---|---|
| Simulation of intra logistics (L1755) | Seminar | 4 | 6 |

| | |
|---|---|
| **Module Responsible** | Dr. Johannes Hinckeldeyn |
| **Admission Requirements** | None |
| **Recommended Previous Knowledge** | Successful completion of the module „Technical Logistics“ |
| **Educational Objectives** | After taking part successfully, students have reached the following learning results |
| **Professional Competence** | |
| *Knowledge* | The students will acquire the following knowledge:<br>1. The students are able to explain the significance, the structure and the components of an event- and object-oriented simulation model in intralogistics.<br>2. The students are able to reflect and explain the process of creating and programming an event- and object-oriented simulation model in intralogistics.<br>3. The students are able to view critically the strengths and weaknesses of event- and object-oriented simulation model. |
| *Skills* | The students will acquire the following skills:<br>1. The students will be able to derive the necessary parameters for the development of an event- and object-oriented simulation model in intralogistics from an existing logistics system.<br>2. The students will be able to program and run Plant Simulation simulation models independently.<br>3. The students can evaluate and interpret the results from a simulation model. |
| **Personal Competence** | |
| *Social Competence* | The students will acquire the following social skills:<br>1. The students are able to develop a complex simulation model in a team.<br>2. The students know the different roles in joint development of a simulation model and can give feedback to their respective roles.<br>3. The students are able to process the simulation results and present them in front of a audience. |
| *Autonomy* | The students will acquire the following independent competencies:<br>1. The students work independently in an initially unknown software (Plant Simulation).<br>2. The students are able to derive independently the necessary simulation parameters from information about a logistics system.<br>3. The students are able to develop and program an event- and object-oriented simulation models from given parameters. |
| **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** | Logistics and Mobility: Specialisation Production Management and Processes: Elective Compulsory<br>Logistics and Mobility: Specialisation Information Technology: Elective Compulsory<br>Engineering and Management - Major in Logistics and Mobility: Specialisation Production Management and Processes: Elective Compulsory<br>Engineering and Management - Major in Logistics and Mobility: Specialisation Information Technology: Elective Compulsory |

| Course L1755: Simulation of intra logistics | |
|---|---|
| **Typ** | Seminar |
| **Hrs/wk** | 4 |
| **CP** | 6 |
| **Workload in Hours** | Independent Study Time 124, Study Time in Lecture 56 |
| **Lecturer** | Dr. Johannes Hinckeldeyn |
| **Language** | DE |
| **Cycle** | SoSe |
| **Content** | The seminar provides an introduction to the development and programming of event and object-oriented simulation models based on the Plant Simulation software. The simulation models are focused on issues and problems in the field of intralogistics.<br>The seminar will be conducted as a combination of theoretical content and autonomously solving simulation tasks on the computer.<br><br>The students learn the ideal development workflow, programming and evaluation of a simulation model.<br><br>Furthermore, the student will become familiar with the standard objects of a simulation model in Plant Simulation and their properties and functions. These standard objects will be used, if necessary with the assistance of the instructor, to build simulation models and analyze and evaluate the results.<br><br>Furthermore, an introduction to the individual programming of simulation models is given on the basis of Sim Talk language. |
| **Literature** | Bangsow, Steffen (2011): Praxishandbuch Plant Simulation und SimTalk, Hanser Verlag, München.<br>Bangsow, Steffen (2015): Tecnomatix plant simulation : modeling and programming by means of examples, Springer, Berlin.<br><br>Eley, Michael (2012): Simulation in der Logistik : Einführung in die Erstellung ereignisdiskreter Modelle unter Verwendung des Werkzeuges "Plant Simulation", Springer, Berlin. |

## Module M0852: Graph Theory and Optimization

**Courses**

| Title | Typ | Hrs/wk | CP |
|---|---|---|---|
| Graph Theory and Optimization (L1046) | Lecture | 2 | 3 |
| Graph Theory and Optimization (L1047) | Recitation Section (small) | 2 | 3 |

| | |
|---|---|
| **Module Responsible** | Prof. Anusch Taraz |
| **Admission Requirements** | None |
| **Recommended Previous Knowledge** | • Discrete Algebraic Structures<br>• Mathematics I |
| **Educational Objectives** | After taking part successfully, students have reached the following learning results |
| **Professional Competence** | |
| *Knowledge* | • Students can name the basic concepts in Graph Theory and Optimization. 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 Graph Theory and Optimization with the help of the concepts studied in this course. Moreover, they are capable of solving them by applying established methods.<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 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: Compulsory<br>Computer Science: Core Qualification: Compulsory<br>Data Science: Core Qualification: Compulsory<br>Logistics and Mobility: Specialisation Engineering Science: Elective Compulsory<br>Logistics and Mobility: Specialisation Traffic Planning and Systems: Elective Compulsory<br>Logistics and Mobility: Specialisation Information Technology: Elective Compulsory<br>Technomathematics: Specialisation I. Mathematics: Elective Compulsory<br>Engineering and Management - Major in Logistics and Mobility: Specialisation Traffic Planning and Systems: Elective Compulsory<br>Engineering and Management - Major in Logistics and Mobility: Specialisation Information Technology: Elective Compulsory |

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

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

## Module M1890: Strategic Management of Technological Innovation

**Courses**

| Title | Typ | Hrs/wk | CP |
|---|---|---|---|
| Strategic Management of Technological Innovation (L3127) | Lecture | 3 | 3 |
| Strategic Management of Technological Innovation (L3128) | Project-/problem-based Learning | 2 | 3 |

| | |
|---|---|
| **Module Responsible** | Prof. Tim Schweisfurth |
| **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 110, Study Time in Lecture 70 |
| **Credit points** | 6 |
| **Course achievement** | **Compulsory** **Bonus** **Form** **Description**<br>Yes 20 % Subject theoretical andsemesterbegleitende Mini-Tests, Gruppenarbeiten<br>practical work |
| **Examination** | Written exam |
| **Examination duration and scale** | 60 minutes |
| **Assignment for the Following Curricula** | Engineering and Management - Major in Logistics and Mobility: Specialisation Information Technology: Elective Compulsory<br>Engineering and Management - Major in Logistics and Mobility: Specialisation Production Management and Processes: Elective Compulsory<br>Engineering and Management - Major in Logistics and Mobility: Specialisation Traffic Planning and Systems: Elective Compulsory |

### Course L3127: Strategic Management of Technological Innovation

| | |
|---|---|
| **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** | WiSe |
| **Content** | |
| **Literature** | |

### Course L3128: Strategic Management of Technological Innovation

| | |
|---|---|
| **Typ** | Project-/problem-based Learning |
| **Hrs/wk** | 2 |
| **CP** | 3 |
| **Workload in Hours** | Independent Study Time 62, Study Time in Lecture 28 |
| **Lecturer** | Prof. Tim Schweisfurth |
| **Language** | EN |
| **Cycle** | WiSe |
| **Content** | |
| **Literature** | |

## Module M1679: Process Management

**Courses**

| Title | Typ | Hrs/wk | CP |
|---|---|---|---|
| Basics of process management (L2810) | Lecture | 2 | 3 |
| Process management practice (L2811) | Seminar | 2 | 3 |

| | |
|---|---|
| **Module Responsible** | Prof. Christian Thies |
| **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** | Compulsory: Yes; Bonus: 20 %; Form: Written elaboration; Description: |
| **Examination** | Written exam |
| **Examination duration and scale** | 60 min |
| **Assignment for the Following Curricula** | Logistics and Mobility: Specialisation Production Management and Processes: Compulsory<br>Logistics and Mobility: Specialisation Information Technology: Elective Compulsory<br>Engineering and Management - Major in Logistics and Mobility: Specialisation Production Management and Processes: Compulsory<br>Engineering and Management - Major in Logistics and Mobility: Specialisation Information Technology: Elective Compulsory |

### Course L2810: Basics of process management

| | |
|---|---|
| **Typ** | Lecture |
| **Hrs/wk** | 2 |
| **CP** | 3 |
| **Workload in Hours** | Independent Study Time 62, Study Time in Lecture 28 |
| **Lecturer** | Prof. Christian Thies |
| **Language** | DE |
| **Cycle** | SoSe |
| **Content** | |
| **Literature** | |

### Course L2811: Process management practice

| | |
|---|---|
| **Typ** | Seminar |
| **Hrs/wk** | 2 |
| **CP** | 3 |
| **Workload in Hours** | Independent Study Time 62, Study Time in Lecture 28 |
| **Lecturer** | Prof. Christian Thies |
| **Language** | DE |
| **Cycle** | SoSe |
| **Content** | |
| **Literature** | |

## Module M1680: Automation in logistics

**Courses**

| Title | Typ | Hrs/wk | CP |
|---|---|---|---|
| Automation in logistics - Lab (L2913) | Project-/problem-based Learning | 2 | 2 |
| Automation in logistics - seminar (L2688) | Seminar | 2 | 4 |

| | |
|---|---|
| **Module Responsible** | NN |
| **Admission Requirements** | None |
| **Recommended Previous Knowledge** | "Technical logistics" successfully completed<br>"Computer Science for Engineers - Introduction and Overview" successfully completed |
| **Educational Objectives** | After taking part successfully, students have reached the following learning results |
| **Professional Competence** | |
| *Knowledge* | 1. The students know the basic principles of measurement and control technology.<br>2. The students know localization and navigation solutions used in mobile robotics.<br>3. The students know automation solutions for storage and order picking.<br>4. The students can developed and implement basic programs with a programmable logic controller. |
| *Skills* | 1. The students can describe and evaluate basic control loops.<br>2. The students can carry out algorithms for localization and navigation.<br>3. The Students can evaluate the performance of automated storage and picking solutions. |
| **Personal Competence** | |
| *Social Competence* | 1. The students are able to explain the basic principles of measurement and control technology to other students.<br>2. The students can help other students to find algorithmic errors in localization and navigation algorithms.<br>3. The students are able to present their results in front of an audience. |
| *Autonomy* | 1. The students familiarize themselves independently with unknown algorithms.<br>2. The students are able to independently find a suitable automation approach for a problem.<br>3. Based on the given task, the students can design an appropriate automation solution. |
| **Workload in Hours** | Independent Study Time 124, Study Time in Lecture 56 |
| **Credit points** | 6 |

| Course achievement | Compulsory | Bonus | Form | Description |
|---|---|---|---|---|
| | Yes | 10 % | Attestation | Programmieraufgaben in SPS |

| | |
|---|---|
| **Examination** | Written exam |
| **Examination duration and scale** | 90 min |
| **Assignment for the Following Curricula** | Logistics and Mobility: Specialisation Information Technology: Compulsory<br>Logistics and Mobility: Specialisation Production Management and Processes: Elective Compulsory<br>Engineering and Management - Major in Logistics and Mobility: Specialisation Information Technology: Compulsory<br>Engineering and Management - Major in Logistics and Mobility: Specialisation Production Management and Processes: Elective Compulsory |

### Course L2913: Automation in logistics - Lab

| | |
|---|---|
| **Typ** | Project-/problem-based Learning |
| **Hrs/wk** | 2 |
| **CP** | 2 |
| **Workload in Hours** | Independent Study Time 32, Study Time in Lecture 28 |
| **Lecturer** | NN |
| **Language** | DE |
| **Cycle** | WiSe |
| **Content** | Introduction to programmable logic controllers (PLC) with CodeSys<br>PLC basics with function blocks and structured text<br>Integration of sensors and actuators<br>Testing of PLC programs in a simulation<br>Transfer of own PLC programs to real control hardware |
| **Literature** | Wellenreuther, Günter; Zastrow, Dieter (2016): Automatisieren mit SPS - Übersichten und Übungsaufgaben. Von Grundverknüpfungen bis Ablaufsteuerungen, Wortverarbeitungen und Regelungen, Programmieren mit STEP 7 und CoDeSys, Beispiele, Lernaufgaben, Kontrollaufgaben, Lösungen. 7. Auflage. Wiesbaden: Springer Vieweg (Lehrbuch). |

| Course L2688: Automation in logistics - seminar | |
|---|---|
| **Typ** | Seminar |
| **Hrs/wk** | 2 |
| **CP** | 4 |
| **Workload in Hours** | Independent Study Time 92, Study Time in Lecture 28 |
| **Lecturer** | NN |
| **Language** | DE |
| **Cycle** | WiSe |
| **Content** | (1) Measurement and sensor technology<br><br>(2) Basics of control theory<br><br>(3) Autonomous Mobile Robots<br><br>(4) Automated storage systems<br><br>(5) Robotics in order picking. |
| **Literature** | Heinrich, Berthold (2019): Grundlagen Regelungstechnik. 5. Auflage. Hg. v. Wolfgang Schneider. Wiesbaden: Springer Vieweg.<br><br>Parthier, Rainer (2016): Messtechnik. Grundlagen und Anwendungen der elektrischen Messtechnik. 8. Auflage. Wiesbaden, Springer Fachmedien Wiesbaden.<br><br>Thrun, Sebastian; Burgard, Wolfram; Fox, Dieter (2006): Probabilistic robotics. Cambridge, Massachusetts, London, England: MIT Press.<br><br>Wehking, Karl-Heinz (2020): Technisches Handbuch Logistik 1. Fördertechnik, Materialfluss, Intralogistik. Berlin, Heidelberg; Springer Vieweg. |

## Module M0833: Introduction to Control Systems

**Courses**

| Title | Typ | Hrs/wk | CP |
|---|---|---|---|
| Introduction to Control Systems (L0654) | Lecture | 2 | 4 |
| Introduction to Control Systems (L0655) | Recitation Section (small) | 2 | 2 |

| | |
|---|---|
| **Module Responsible** | NN |
| **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** | 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>Data Science: Core Qualification: Elective Compulsory<br>Data Science: Specialisation II. Application: Elective Compulsory<br>Electrical Engineering: Core Qualification: Compulsory<br>Green Technologies: Energy, Water, Climate: Core Qualification: Compulsory<br>Computer Science in Engineering: Core Qualification: Compulsory<br>Integrated Building Technology: Core Qualification: Elective Compulsory<br>Logistics and Mobility: Specialisation Information Technology: Elective Compulsory<br>Logistics and Mobility: Specialisation Traffic Planning and Systems: 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>Technomathematics: Specialisation III. Engineering Science: Elective Compulsory<br>Theoretical Mechanical Engineering: Technical Complementary Course Core Studies: Elective Compulsory<br>Process Engineering: Core Qualification: Compulsory<br>Engineering and Management - Major in Logistics and Mobility: Specialisation Information Technology: Elective Compulsory<br>Engineering and Management - Major in Logistics and Mobility: Specialisation Traffic Planning and Systems: Elective Compulsory<br>Engineering and Management - Major in Logistics and Mobility: Specialisation Production Management and Processes: Elective Compulsory |

| Course L0654: Introduction to Control Systems | |
|---|---|
| **Typ** | Lecture |
| **Hrs/wk** | 2 |
| **CP** | 4 |
| **Workload in Hours** | Independent Study Time 92, Study Time in Lecture 28 |
| **Lecturer** | NN |
| **Language** | DE |
| **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 L0655: Introduction to Control Systems | |
|---|---|
| **Typ** | Recitation Section (small) |
| **Hrs/wk** | 2 |
| **CP** | 2 |
| **Workload in Hours** | Independent Study Time 32, Study Time in Lecture 28 |
| **Lecturer** | NN |
| **Language** | DE |
| **Cycle** | WiSe |
| **Content** | See interlocking course |
| **Literature** | See interlocking course |

## Module M1593: Data Mining

**Courses**

| Title | Typ | Hrs/wk | CP |
|---|---|---|---|
| Data Mining (L2434) | Lecture | 2 | 3 |
| Data Mining (L2435) | Project-/problem-based Learning | 2 | 3 |

| | |
|---|---|
| **Module Responsible** | Prof. Stefan Schulte |
| **Admission Requirements** | None |
| **Recommended Previous Knowledge** | • Databases<br>• Machine learning |
| **Educational Objectives** | After taking part successfully, students have reached the following learning results |
| **Professional Competence** | |
| *Knowledge* | After successful completion of the course, students know:<br>• Basic concepts for data preparation<br>• Similarity and distance measures<br>• Methods to mine data patterns<br>• Procedures to analyse clusters<br>• Approaches to identify outliers<br>• Data mining for different types of data, e.g., data streams, text data, time series data |
| *Skills* | Students are able to analyze large, heterogeneous volumes of data. They know methods and their application to recognize patterns in data sets and data clusters. The students are able to apply the studied methods in different domains, e.g., for data streams, text data, or time series data. |
| **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: Yes; Bonus: 20 %; Form: Subject theoretical and practical work; Description: Praktische Arbeiten zu bestimmten Themen aus dem Bereich Data Mining |
| **Examination** | Written exam |
| **Examination duration and scale** | 90 min |
| **Assignment for the Following Curricula** | General Engineering Science (German program, 7 semester): Specialisation Data Science: Compulsory<br>Computer Science: Specialisation I. Computer and Software Engineering: Elective Compulsory<br>Data Science: Core Qualification: Compulsory<br>Engineering Science: Specialisation Data Science: Compulsory<br>Logistics and Mobility: Specialisation Information Technology: Elective Compulsory<br>Mechatronics: Specialisation Dynamic Systems and AI: Elective Compulsory<br>Technomathematics: Specialisation II. Informatics: Elective Compulsory<br>Engineering and Management - Major in Logistics and Mobility: Specialisation Information Technology: Elective Compulsory |

### Course L2434: Data Mining

| | |
|---|---|
| **Typ** | Lecture |
| **Hrs/wk** | 2 |
| **CP** | 3 |
| **Workload in Hours** | Independent Study Time 62, Study Time in Lecture 28 |
| **Lecturer** | Prof. Stefan Schulte, Dr. Dominik Schallmoser |
| **Language** | EN |
| **Cycle** | WiSe |
| **Content** | • Data preparation<br>• Similarity and distance measures<br>• Pattern mining<br>• Cluster analysis<br>• Outliers detection<br>• Data mining for different types of data, e.g., data streams, text data, time series data |
| **Literature** | Charu C. Aggarwal: Text Mining - The Textbook, Springer, 2015. Available at https://link.springer.com/book/10.1007/978-3-319-14142-8 |

| Course L2435: Data Mining | |
|---|---|
| **Typ** | Project-/problem-based Learning |
| **Hrs/wk** | 2 |
| **CP** | 3 |
| **Workload in Hours** | Independent Study Time 62, Study Time in Lecture 28 |
| **Lecturer** | Prof. Stefan Schulte, Dr. Dominik Schallmoser |
| **Language** | EN |
| **Cycle** | WiSe |
| **Content** | See interlocking course |
| **Literature** | See interlocking course |

## Module M1289: Logistical systems - Industry 4.0

**Courses**

| Title | Typ | Hrs/wk | CP |
|---|---|---|---|
| Logistics systems - Industry 4.0 (L1753) | Seminar | 4 | 6 |

| | |
|---|---|
| **Module Responsible** | Prof. Jochen Kreutzfeldt |
| **Admission Requirements** | None |
| **Recommended Previous Knowledge** | Successful completion of the module „Technical Logistics“ |
| **Educational Objectives** | After taking part successfully, students have reached the following learning results |
| **Professional Competence** | |
| *Knowledge* | The students will acquire the following knowledge:<br>1. The students are able to understand and explain the concept "Logistical System".<br>2. The students are able to design a logistic system conceptually.<br>3. The students can develop and implement the control of a logistic system with python. |
| *Skills* | The students will acquire the following skills:<br>1. The students are able to identify logistical systems, analyze and identify potential for change and improvement.<br>2. The students know different technical solutions to address problems in logistical systems.<br>3. The students are capable of deploying technical solutions and ideas from the concept Industry 4.0 to deal with logistical problems. |
| **Personal Competence** | |
| *Social Competence* | The students will acquire the following social skills:<br>1. The students are able to develop technical solutions for logistical systems and reflect their contribution within the team.<br>2. The technical solutions from the group can be jointly documented and presented.<br>3. Students are able to present their technological solutions to an audience and derived from the critique new ideas and improvements. |
| *Autonomy* | The students will acquire the following independent competencies:<br>1. The students can independently develop technical solutions for logistical problems under supervision.<br>2. The students are able to evaluate their technical solutions and discuss the pros and cons.<br>3. The students are able to assess the impact of the concept Industry 4.0 on their own career development. |
| **Workload in Hours** | Independent Study Time 124, Study Time in Lecture 56 |
| **Credit points** | 6 |
| **Course achievement** | None |
| **Examination** | Written elaboration |
| **Examination duration and scale** | Lab prototype with documentation (group work) |
| **Assignment for the Following Curricula** | Logistics and Mobility: Specialisation Information Technology: Elective Compulsory<br>Logistics and Mobility: Specialisation Traffic Planning and Systems: Elective Compulsory<br>Logistics and Mobility: Specialisation Production Management and Processes: Elective Compulsory<br>Engineering and Management - Major in Logistics and Mobility: Specialisation Information Technology: Elective Compulsory<br>Engineering and Management - Major in Logistics and Mobility: Specialisation Traffic Planning and Systems: Elective Compulsory<br>Engineering and Management - Major in Logistics and Mobility: Specialisation Production Management and Processes: Elective Compulsory |

| Course L1753: Logistics systems - Industry 4.0 | |
|---|---|
| **Typ** | Seminar |
| **Hrs/wk** | 4 |
| **CP** | 6 |
| **Workload in Hours** | Independent Study Time 124, Study Time in Lecture 56 |
| **Lecturer** | Prof. Jochen Kreutzfeldt |
| **Language** | DE |
| **Cycle** | WiSe |
| **Content** | The lecture gives an introduction to the concept of logistical systems with a special emphasis on the subject of Industry 4.0. Here, the system concept in logistics from a technical point of view is introduced. A logistical system is understood as a combination of transport, storage and change processes between source and sink of goods. This lecture will look at the technical aspect of these processes.<br>Industry is a topic of this lecture. Industry 4.0 is understood as the far-reaching digitization and networking of logistical systems and the connection of logistical objects, processes and systems. The logistics industry expects Industry 4.0 to be a profound change and the realization of large improvement potentials. The lecture provides an in-depth introduction to application cases and business models of Industry 4.0 in logistics from a technical standpoint. A possible framework for Industry 4.0 is presented and several application examples are shown.<br><br>In the exercises, students learn will learn the exemplary use of different technical solutions and know how, which can be used to improve logistical systems. |
| **Literature** | Bauernhansl, Thomas et al. (2014): Industrie 4.0 in Produktion, Automatisierung und Logistik. Anwendung, Technologien, Migration. Wiesbaden: Springer Vieweg.<br>Hausladen, Iris (2014): IT-gestützte Logistik. Systeme - Prozesse - Anwendungen. 2. Auflage 2014. Wiesbaden: Imprint: Gabler Verlag.<br><br>Hompel, Michael ten; Büchter, Hubert; Franzke, Ulrich (2008): Identifikationssysteme und Automatisierung. [Intralogistik]. Berlin, Heidelberg: Springer.<br><br>Kaufmann, Timothy (2015): Geschäftsmodelle in Industrie 4.0 und dem Internet der Dinge. Der Weg vom Anspruch in die Wirklichkeit. Wiesbaden: Springer Fachmedien Wiesbaden.<br><br>Martin, Heinrich (2014): Transport- und Lagerlogistik. Planung, Struktur, Steuerung und Kosten von Systemen der Intralogistik. 9., Auflage 2014. Wiesbaden: Imprint: Springer Vieweg.<br><br>Runkler, Thomas A. (2010): Data-Mining. Methoden und Algorithmen intelligenter Datenanalyse. 1. Aufl. Wiesbaden: Vieweg + Teubner (Studium). |

## Module M1423: Algorithms and Data Structures

**Courses**

| Title | Typ | Hrs/wk | CP |
|---|---|---|---|
| Algorithms and Data Structures (L2046) | Lecture | 4 | 4 |
| Algorithms and Data Structures (L2047) | Recitation Section (small) | 1 | 2 |

| | |
|---|---|
| **Module Responsible** | Prof. Matthias Mnich |
| **Admission Requirements** | None |
| **Recommended Previous Knowledge** | • Discrete Algebraic Structures<br>• Mathematics I<br>• Mathematics II<br>• Procedual Programming<br>• Objectoriented Programming |
| **Educational Objectives** | After taking part successfully, students have reached the following learning results |
| **Professional Competence** | |
| *Knowledge* | • Students can name the basic concepts in algorithm design, algorithm analysis and problem reductions. 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 discrete decision, search and optimization problems with the help of the concepts studied in this course. Moreover, they are capable of solving them, and reducing them to each other, 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 110, Study Time in Lecture 70 |
| **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 Computer Science: Compulsory<br>General Engineering Science (German program, 7 semester): Specialisation Data Science: Compulsory<br>Computer Science: Core Qualification: Compulsory<br>Data Science: Core Qualification: Compulsory<br>Engineering Science: Specialisation Data Science: Compulsory<br>Computer Science in Engineering: Core Qualification: Compulsory<br>Logistics and Mobility: Specialisation Information Technology: Elective Compulsory<br>Technomathematics: Specialisation II. Informatics: Elective Compulsory<br>Engineering and Management - Major in Logistics and Mobility: Specialisation Information Technology: Elective Compulsory |

| Course L2046: Algorithms and Data Structures | |
|---|---|
| **Typ** | Lecture |
| **Hrs/wk** | 4 |
| **CP** | 4 |
| **Workload in Hours** | Independent Study Time 64, Study Time in Lecture 56 |
| **Lecturer** | Prof. Matthias Mnich |
| **Language** | DE/EN |
| **Cycle** | WiSe |
| **Content** | • Insertion sort<br>• Register machines<br>• Asymptotic analysis, Landau notation<br>• Polynomial-time algorithms and NP-completeness<br>• Divide-and-conquer, merge sort<br>• Strassen algorithm<br>• Greedy algorithm<br>• Dynamic programming<br>• Quick sort<br>• AVL-trees, B-trees<br>• Hashing<br>• Depth first search, breadth first search<br>• Shortest paths<br>• Flow problems, Ford-Fulkerson algorithm |
| **Literature** | • T. Cormen, Ch. Leiserson, R. Rivest, C. Stein: Introduction to Algorithms. MIT Press, 2013<br>• S. Skiena: The Algorithm Design Manual. Springer, 2008<br>• J. M. Kleinberg and É. Tardos. Algorithm Design. Addison-Wesley, 2005. |

| Course L2047: Algorithms and Data Structures | |
|---|---|
| **Typ** | Recitation Section (small) |
| **Hrs/wk** | 1 |
| **CP** | 2 |
| **Workload in Hours** | Independent Study Time 46, Study Time in Lecture 14 |
| **Lecturer** | Prof. Matthias Mnich |
| **Language** | DE/EN |
| **Cycle** | WiSe |
| **Content** | See interlocking course |
| **Literature** | See interlocking course |

## Module M1592: Statistics

**Courses**

| Title | Typ | Hrs/wk | CP |
|---|---|---|---|
| Statistics (L2430) | Lecture | 3 | 4 |
| Statistics (L2431) | Recitation Section (small) | 1 | 2 |

| | |
|---|---|
| **Module Responsible** | Prof. Matthias Schulte |
| **Admission Requirements** | None |
| **Recommended Previous Knowledge** | Stochastics (or a comparable class) |
| **Educational Objectives** | After taking part successfully, students have reached the following learning results |
| **Professional Competence** | |
| *Knowledge* | • Students can name the basic concepts in Statistics. 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. |
| *Skills* | • Students can model statistical problems with the help of the concepts studied in this course. Moreover, they are capable of solving them by applying established methods. They are able to use the statistical software R.<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 and to present their results appropriately (e.g. during exercise class).<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 can put their knowledge in relation to the contents of other lectures.<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 Advanced Materials: Elective Compulsory<br>General Engineering Science (German program, 7 semester): Specialisation Computer Science: Elective Compulsory<br>General Engineering Science (German program, 7 semester): Specialisation Data Science: Compulsory<br>Computer Science: Specialisation II. Mathematics and Engineering Science: Elective Compulsory<br>Data Science: Core Qualification: Compulsory<br>Engineering Science: Specialisation Advanced Materials: Elective Compulsory<br>Engineering Science: Specialisation Data Science: Compulsory<br>Logistics and Mobility: Specialisation Information Technology: Elective Compulsory<br>Technomathematics: Specialisation I. Mathematics: Elective Compulsory<br>Theoretical Mechanical Engineering: Specialisation Robotics and Computer Science: Elective Compulsory<br>Theoretical Mechanical Engineering: Specialisation Robotics and Computer Science: Elective Compulsory<br>Engineering and Management - Major in Logistics and Mobility: Specialisation Information Technology: Elective Compulsory |

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

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

## Module M0853: Mathematics III

**Courses**

| Title | Typ | Hrs/wk | CP |
|---|---|---|---|
| Analysis III (L1028) | Lecture | 2 | 2 |
| Analysis III (L1029) | Recitation Section (small) | 1 | 1 |
| Analysis III (L1030) | Recitation Section (large) | 1 | 1 |
| Differential Equations 1 (Ordinary Differential Equations) (L1031) | Lecture | 2 | 2 |
| Differential Equations 1 (Ordinary Differential Equations) (L1032) | Recitation Section (small) | 1 | 1 |
| Differential Equations 1 (Ordinary Differential Equations) (L1033) | Recitation Section (large) | 1 | 1 |

| | |
|---|---|
| **Module Responsible** | Prof. Marko Lindner |
| **Admission Requirements** | None |
| **Recommended Previous Knowledge** | Mathematics I + II |
| **Educational Objectives** | After taking part successfully, students have reached the following learning results |
| **Professional Competence** | |
| *Knowledge* | • Students can name the basic concepts in the area of analysis and differential equations. 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 the area of analysis and differential equations with the help of the concepts studied in this course. Moreover, they are capable of solving them by applying established methods.<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 128, Study Time in Lecture 112 |
| **Credit points** | 8 |
| **Course achievement** | None |
| **Examination** | Written exam |
| **Examination duration and scale** | 60 min (Analysis III) + 60 min (Differential Equations 1) |
| **Assignment for the Following Curricula** | General Engineering Science (German program, 7 semester): Core Qualification: Compulsory<br>Civil- and Environmental Engineering: Core Qualification: Compulsory<br>Bioprocess Engineering: Core Qualification: Compulsory<br>Chemical and Bioprocess Engineering: Core Qualification: Compulsory<br>Digital Mechanical Engineering: Core Qualification: Compulsory<br>Electrical Engineering: Core Qualification: Compulsory<br>Green Technologies: Energy, Water, Climate: Core Qualification: Compulsory<br>Computer Science in Engineering: Core Qualification: Compulsory<br>Integrated Building Technology: Core Qualification: Compulsory<br>Logistics and Mobility: Specialisation Traffic Planning and Systems: Elective Compulsory<br>Logistics and Mobility: Specialisation Production Management and Processes: Elective Compulsory<br>Logistics and Mobility: Specialisation Information Technology: Compulsory<br>Mechanical Engineering: Core Qualification: Compulsory<br>Mechatronics: Core Qualification: Compulsory<br>Naval Architecture: Core Qualification: Compulsory<br>Process Engineering: Core Qualification: Compulsory<br>Engineering and Management - Major in Logistics and Mobility: Specialisation Traffic Planning and Systems: Elective Compulsory<br>Engineering and Management - Major in Logistics and Mobility: Specialisation Production Management and Processes: Elective Compulsory<br>Engineering and Management - Major in Logistics and Mobility: Specialisation Information Technology: Compulsory |

| Course L1028: Analysis III | |
|---|---|
| **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** | DE |
| **Cycle** | WiSe |
| **Content** | Main features of differential and integrational calculus of several variables<br>• Differential calculus for several variables<br>• Mean value theorems and Taylor's theorem<br>• Maximum and minimum values<br>• Implicit functions<br>• Minimization under equality constraints<br>• Newton's method for multiple variables<br>• Fourier series<br>• Double integrals over general regions<br>• Line and surface integrals<br>• Theorems of Gauß and Stokes |
| **Literature** | • http://www.math.uni-hamburg.de/teaching/export/tuhh/index.html |

| Course L1029: Analysis III | |
|---|---|
| **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** | DE |
| **Cycle** | WiSe |
| **Content** | See interlocking course |
| **Literature** | See interlocking course |

| Course L1030: Analysis III | |
|---|---|
| **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** | DE |
| **Cycle** | WiSe |
| **Content** | See interlocking course |
| **Literature** | See interlocking course |

| Course L1031: 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** | DE |
| **Cycle** | WiSe |
| **Content** | Main features of the theory and numerical treatment of ordinary differential equations<br>• Introduction and elementary methods<br>• Exsitence and uniqueness of initial value problems<br>• Linear differential equations<br>• Stability and qualitative behaviour of the solution<br>• Boundary value problems and basic concepts of calculus of variations<br>• Eigenvalue problems<br>• Numerical methods for the integration of initial and boundary value problems<br>• Classification of partial differential equations |
| **Literature** | • http://www.math.uni-hamburg.de/teaching/export/tuhh/index.html |

| Course L1032: Differential Equations 1 (Ordinary Differential Equations) | |
|---|---|
| **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** | DE |
| **Cycle** | WiSe |
| **Content** | See interlocking course |
| **Literature** | See interlocking course |

| Course L1033: 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** | DE |
| **Cycle** | WiSe |
| **Content** | See interlocking course |
| **Literature** | See interlocking course |

## Module M1070: Simulation of Transport and Handling Systems

**Courses**

| Title | Typ | Hrs/wk | CP |
|---|---|---|---|
| Simulation of Transport and Handling Systems (L1352) | Lecture | 1 | 2 |
| Simulation of Transport and Handling Systems (L1818) | Recitation Section (small) | 3 | 4 |

| | |
|---|---|
| **Module Responsible** | Prof. Carlos Jahn |
| **Admission Requirements** | None |
| **Recommended Previous Knowledge** | Basic knowledge of transport- and handlingtechnology. |
| **Educational Objectives** | After taking part successfully, students have reached the following learning results |
| **Professional Competence** | |
| *Knowledge* | Students can...<br>• Explain the structure and workings of standard external logistics systems.<br>• Outline the benefits of using simulation software subject to the starting situation.<br>• Present different simulation programs and kinds of simulation that are in widespread use and explain their characteristics. |
| *Skills* | Students are able to...<br>• Recognize, analyze, and assemble into a model the elementary building blocks of a logistics system.<br>• Map complex external logistics process using the *Plant Simulation*® simulation software.<br>• Draw inferences from the results of the simulation, transfer them to the reality, and deduce action recommendations from them. |
| **Personal Competence** | |
| *Social Competence* | Students are capable of...<br>• Solving complex tasks in a team and to document assignments accordingly.<br>• Playing different roles in the teamwork and giving each other appropriate feedback in the team.<br>• Presenting the relevant results of their project to specialists and representing them. |
| *Autonomy* | Students are able...<br>• To acquaint themselves independently with software with which they are not familiar and to use it to solve complex tasks.<br>• To define work steps independently and to acquire the knowledge required to do so. |
| **Workload in Hours** | Independent Study Time 124, Study Time in Lecture 56 |
| **Credit points** | 6 |
| **Course achievement** | **Compulsory** / **Bonus** / **Form** / **Description**<br>No / 20 % / Subject theoretical and practical work |
| **Examination** | Subject theoretical and practical work |
| **Examination duration and scale** | Simulation study and report with approximately 15 pages per person |
| **Assignment for the Following Curricula** | Data Science: Core Qualification: Elective Compulsory<br>Logistics and Mobility: Specialisation Information Technology: Elective Compulsory<br>Logistics and Mobility: Specialisation Traffic Planning and Systems: Elective Compulsory<br>Engineering and Management - Major in Logistics and Mobility: Specialisation Information Technology: Elective Compulsory<br>Engineering and Management - Major in Logistics and Mobility: Specialisation Traffic Planning and Systems: Elective Compulsory<br>Engineering and Management - Major in Logistics and Mobility: Specialisation Production Management and Processes: Elective Compulsory<br>Engineering and Management - Major in Logistics and Mobility: Specialisation Production Management and Processes: Elective Compulsory |

| Course L1352: Simulation of Transport and Handling Systems | |
|---|---|
| **Typ** | Lecture |
| **Hrs/wk** | 1 |
| **CP** | 2 |
| **Workload in Hours** | Independent Study Time 46, Study Time in Lecture 14 |
| **Lecturer** | Prof. Carlos Jahn |
| **Language** | DE |
| **Cycle** | WiSe |
| **Content** | The lecture deals with the simulation of external logistics systems. The focus is therefore on the consideration of logistical processes between companies or on transhipment systems, such as ports or individual terminals.<br><br>In the first part of the lecture, students will first acquire basic knowledge of external logistics systems and the advantages of using simulations to present them. Then an overview of existing simulation types and programs is given and examples for existing simulation models of logistic systems in science and practice are shown. Some simulation models will be demonstrated.<br><br>In the second part of the lecture the students learn the basic handling of the simulation software Plant Simulation®. They receive theoretical explanations of the general functionality of the simulation tool, which are further deepened through the use of extensive, interactive examples. At the same time, five exercises, which build on each other, offer students the opportunity to implement the course content they have learnt alone and in small groups. The exercises can be completed during the supervised lecture periods as well as at other times.<br><br>The acquired knowledge is to be applied in the third part in the course of group work. The students will be divided into groups, each of which will then work on a relevant problem from the field of (external) logistic systems by means of simulation. The students are given a defined period of time for their work. During this time at least one person is always available for questions and suggestions. The results of the group work are to be documented in a simulation report and handed in at the end of the processing time. Finally, the individual groups present the problems they have worked on and their results in a presentation. |
| **Literature** | Bangsow, Steffen (2011): Praxishandbuch Plant Simulation und SimTalk. Anwendung und Programmierung in über 150 Beispiel-Modellen. München: Hanser Verlag.<br><br>Eley, Michael (2012): Simulation in der Logistik. Einführung in die Erstellung ereignisdiskreter Modelle unter Verwendung des Werkzeuges "Plant Simulation". Berlin, Heidelberg: Springer.<br><br>Engelhardt-Nowitzki, Corinna; Nowitzki, Olaf; Krenn, Barbara (2008): Management komplexer Materialflüsse mittels Simulation. State-of-the-Art und innovative Konzepte. Wiesbaden: Deutscher Universitäts-Verlag / GWV Fachverlage GmbH, Wiesbaden.<br><br>Rabe, Markus; Spieckermann, Sven; Wenzel, Sigrid (2008): Verifikation und Validierung für die Simulation in Produktion und Logistik. Vorgehensmodelle und Techniken. Berlin, Heidelberg: Springer.<br><br>Sargent, Robert G. (2010): Verification and Validation of Simulation Models. In: B. Johansson, S. Jain, J. Montoya-Torres, J. Hugan, and E. Yücesan, eds.: Proceedings of the 2010 Winter Simulation Conference.<br><br>VDI-Richlinie: VDI 3633. Simulation von Logistik-, Materialfluß-und Produktionssystemen<br><br>Wenzel, Sigrid; Rabe, Markus; Spieckermann, Sven (2006): Verifikation und Validierung für die Simulation in Produktion und Logistik. Vorgehensmodelle und Techniken. 1. Aufl. Berlin: Springer Berlin. |

| Course L1818: Simulation of Transport and Handling Systems | |
|---|---|
| **Typ** | Recitation Section (small) |
| **Hrs/wk** | 3 |
| **CP** | 4 |
| **Workload in Hours** | Independent Study Time 78, Study Time in Lecture 42 |
| **Lecturer** | Prof. Carlos Jahn |
| **Language** | DE |
| **Cycle** | WiSe |
| **Content** | See interlocking course |
| **Literature** | See interlocking course |

## Module M1349: Object-oriented programming in logistics

**Courses**

| Title | Typ | Hrs/wk | CP |
|---|---|---|---|
| Object-oriented programming in logistics (L1901) | Seminar | 4 | 6 |

| | |
|---|---|
| **Module Responsible** | NN |
| **Admission Requirements** | None |
| **Recommended Previous Knowledge** | Basic computer skills<br><br>Computer Science for Engineers - Introduction and Overview |
| **Educational Objectives** | After taking part successfully, students have reached the following learning results |
| **Professional Competence** | |
| *Knowledge* | The students will acquire the following knowledge:<br><br>1. The students are able to explain the basics of object-oriented programming with Java.<br><br>2. The students know basic data types, control structures and basic concepts of object orientation and inheritance in the Java programming language.<br><br>3. The students know the necessary tools for programming with Java. |
| *Skills* | The students will acquire the following skills:<br><br>1. The students will be able to develop and run programs with Java independently.<br><br>2. The students will be able to develop and implement own objects and classes with Java.<br><br>3. The students are able to identify and overcome failures autonomously (debugging). |
| **Personal Competence** | |
| *Social Competence* | The students will acquire the following social skills:<br><br>1. The students can explain self-developed programs to other students.<br><br>2. The students can support others in finding failures and mistakes in their software-code.<br><br>3. The students are able to present their programs in front of a audience. |
| *Autonomy* | The students will acquire the following competencies:<br><br>1. The students work independently with an initially unknown programming language (Java).<br><br>2. The students are able to derive independently the necessary source code for a given problem.<br><br>3. The students are able to write their own source code in Java based on given a problem. |
| **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** | Logistics and Mobility: Specialisation Information Technology: Elective Compulsory<br>Engineering and Management - Major in Logistics and Mobility: Specialisation Information Technology: Elective Compulsory<br>Engineering and Management - Major in Logistics and Mobility: Specialisation Production Management and Processes: Elective Compulsory |

| Course L1901: Object-oriented programming in logistics | |
|---|---|
| **Typ** | Seminar |
| **Hrs/wk** | 4 |
| **CP** | 6 |
| **Workload in Hours** | Independent Study Time 124, Study Time in Lecture 56 |
| **Lecturer** | NN |
| **Language** | DE |
| **Cycle** | WiSe |
| **Content** | The seminar provides an introduction to object-oriented programming with Java. Practical knowledge will be transferred through programming exercises parallel to theoretical content. The exercises will deal mainly with logistical problems.<br><br>The seminar will be conducted as an integrated seminar with a combination of theoretical content and autonomously solved programming problems on the computer.<br><br>Furthermore, the student will become familiar with the standard libraries of Java and their properties and functions. These standard objects will be used, if necessary with the assistance of an instructor, to build own programs.<br><br>Furthermore, an introduction to the actual software development kits (SDK) of Java will be given. |
| **Literature** | Goll, Joachim; Heinisch, Cornelia (2014): Java als erste Programmiersprache. Ein professioneller Einstieg in die Objektorientierung mit Java. 7. Aufl. 2014. Wiesbaden: Imprint: Springer Vieweg.<br><br>Jobst, Fritz (2015): Programmieren in Java. [aktuell zu Java 8]. 7., vollst. überarb. Aufl. München: Hanser.<br><br>Abts, Dietmar (2015): Grundkurs JAVA. Von den Grundlagen bis zu Datenbank- und Netzanwendungen. 8. Aufl. Wiesbaden: Springer Vieweg. |

## Module M0980: Logistics, Transport and Environment

**Courses**

| Title | Typ | Hrs/wk | CP |
|---|---|---|---|
| Logistics, Transport and Environment (L0009) | Project-/problem-based Learning | 2 | 4 |
| Environmental Management and Corporate Responsibilty (L1160) | Seminar | 2 | 2 |

| | |
|---|---|
| **Module Responsible** | Prof. Heike Flämig |
| **Admission Requirements** | None |
| **Recommended Previous Knowledge** | • Introduction to logistics and mobility<br>• Foundations of Management |
| **Educational Objectives** | After taking part successfully, students have reached the following learning results |
| **Professional Competence** | |
| *Knowledge* | Students are able to...<br>• explain basic terms of transport logistics, commercial traffic, transport policy and sustainability<br>• describe actors and system boundaries, challenges and goals of transport logistics<br>• reflect standards of sustainability management |
| *Skills* | Students are able to...<br>• design logistics systems independently<br>• differentiate sustainability, CR, CSR and environmental management<br>• critically evaluate measures for sustainable logistics and develop them |
| **Personal Competence** | |
| *Social Competence* | Students can...<br>• creatively develop solutions in teams and work out presentations<br>• present their knowledge and skills to other students |
| *Autonomy* | Students can...<br>• carry out small research studies independently<br>• apply theoretical knowledge in practical projects<br>• apply presentation techniques such as free speech, designing charts (i.e. in Power-Point), use of media (Flip-Charts, Whiteboard, Metaplan) |
| **Workload in Hours** | Independent Study Time 124, Study Time in Lecture 56 |
| **Credit points** | 6 |
| **Course achievement** | None |
| **Examination** | Written elaboration |
| **Examination duration and scale** | Written assignment with short presentation |
| **Assignment for the Following Curricula** | Logistics and Mobility: Specialisation Traffic Planning and Systems: Elective Compulsory<br>Logistics and Mobility: Specialisation Production Management and Processes: Elective Compulsory<br>Logistics and Mobility: Specialisation Information Technology: Elective Compulsory<br>Engineering and Management - Major in Logistics and Mobility: Specialisation Traffic Planning and Systems: Elective Compulsory<br>Engineering and Management - Major in Logistics and Mobility: Specialisation Production Management and Processes: Elective Compulsory<br>Engineering and Management - Major in Logistics and Mobility: Specialisation Information Technology: Elective Compulsory |

| Course L0009: Logistics, Transport and Environment | |
|---|---|
| **Typ** | Project-/problem-based Learning |
| **Hrs/wk** | 2 |
| **CP** | 4 |
| **Workload in Hours** | Independent Study Time 92, Study Time in Lecture 28 |
| **Lecturer** | Prof. Heike Flämig |
| **Language** | DE |
| **Cycle** | SoSe |
| **Content** | Application and creative development of professional knowledge within the framework of the case study "Environmental impacts of supply chains" using a specific company as example.<br><br>Depending on the chosen focus of the academic year:<br><br>• characteristics of different transport systems<br>• technologies, structures and processes of transport logistics systems (nodes, network, interactions)<br>• location and route planning<br>• connections of information flow and material flows in transport chains<br>• interrelation between private and private (contract logistics) and private and public (business policy, transport policy) and their (diverging)<br>• design approaches for sustainable logistics |
| **Literature** | Ihde, Gösta B.: Transport, Verkehr, Logistik. Gesamtwirtschaftliche Aspekte und einzelwirtschaftliche Handhabung. 3. überarbeitete Auflage. Vahlen, München 2001 |

| Course L1160: Environmental Management and Corporate Responsibilty | |
|---|---|
| **Typ** | Seminar |
| **Hrs/wk** | 2 |
| **CP** | 2 |
| **Workload in Hours** | Independent Study Time 32, Study Time in Lecture 28 |
| **Lecturer** | Prof. Heike Flämig |
| **Language** | DE |
| **Cycle** | SoSe |
| **Content** | • Imparting knowledge about standards (e.g. EMAS and ISO 14.001) as important methodological approaches for the integration of environmental and sustainability management in business companies<br>• Explaination of theoretical concepts of corporate sustainability management<br>• Imparting pracitical knowledge from different stakeholder views: consulting company, trading enterprise, NGO, financial market |
| **Literature** | -- |

## 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) | 3 | 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 110, Study Time in Lecture 70 |
| **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>General Engineering Science (German program, 7 semester): Specialisation Data Science: 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 Mechatronics: Elective Compulsory<br>Engineering Science: Specialisation Data Science: Compulsory<br>Engineering Science: Specialisation Mechanical Engineering: Elective Compulsory<br>Computer Science in Engineering: Specialisation I. Computer Science: Elective Compulsory<br>Logistics and Mobility: Specialisation Information Technology: Elective Compulsory<br>Mechanical Engineering: Specialisation Theoretical Mechanical Engineering: Elective Compulsory<br>Mechatronics: Specialisation Dynamic Systems and AI: 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** | 3 |
| **CP** | 3 |
| **Workload in Hours** | Independent Study Time 48, Study Time in Lecture 42 |
| **Lecturer** | Prof. Nihat Ay |
| **Language** | DE/EN |
| **Cycle** | SoSe |
| **Content** | See interlocking course |
| **Literature** | See interlocking course |

## Module M0727: Stochastics

**Courses**

| Title | Typ | Hrs/wk | CP |
|---|---|---|---|
| Stochastics (L0777) | Lecture | 2 | 4 |
| Stochastics (L0778) | Recitation Section (small) | 2 | 2 |

| | |
|---|---|
| **Module Responsible** | Prof. Matthias Schulte |
| **Admission Requirements** | None |
| **Recommended Previous Knowledge** | • Calculus<br>• Discrete algebraic structures (combinatorics)<br>• Propositional logic |
| **Educational Objectives** | After taking part successfully, students have reached the following learning results |
| **Professional Competence** | |
| *Knowledge* | • Students can name the basic concepts in Stochastics. 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 from stochastics 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).<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 can put their knowledge in relation to the contents of other lectures.<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** | 120 min |
| **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 Advanced Materials: Elective Compulsory<br>General Engineering Science (German program, 7 semester): Specialisation Data Science: Compulsory<br>Computer Science: Core Qualification: Compulsory<br>Data Science: Core Qualification: Compulsory<br>Engineering Science: Specialisation Advanced Materials: Elective Compulsory<br>Engineering Science: Specialisation Data Science: Compulsory<br>Engineering Science: Specialisation Electrical Engineering: Elective Compulsory<br>Engineering Science: Specialisation Electrical Engineering: Elective Compulsory<br>Computer Science in Engineering: Core Qualification: Compulsory<br>Logistics and Mobility: Specialisation Information Technology: Elective Compulsory<br>Orientation Studies: Core Qualification: Elective Compulsory<br>Theoretical Mechanical Engineering: Core Qualification: Elective Compulsory<br>Engineering and Management - Major in Logistics and Mobility: Specialisation Information Technology: Elective Compulsory |

| Course L0777: Stochastics | |
|---|---|
| **Typ** | Lecture |
| **Hrs/wk** | 2 |
| **CP** | 4 |
| **Workload in Hours** | Independent Study Time 92, Study Time in Lecture 28 |
| **Lecturer** | Prof. Matthias Schulte |
| **Language** | DE/EN |
| **Cycle** | SoSe |
| **Content** | • Definitions of probability, conditional probability<br>• Random variables<br>• Independence<br>• Distributions and density functions<br>• Characteristics: expectation, variance, standard deviation, moments<br>• Multivariate distributions<br>• Law of large numbers and central limit theorem<br>• Basic notions of stochastic processes<br>• Basic concepts of statistics (point estimators, confidence intervals, hypothesis testing) |
| **Literature** | • L. Dümbgen (2003): Stochastik für Informatiker, Springer.<br>• H.-O. Georgii (2012): Stochastics: Introduction to Probability and Statistics, 2nd edition, De Gruyter.<br>• N. Henze (2018): Stochastik für Einsteiger, 12th edition, Springer.<br>• A. Klenke (2014): Probability Theory: A Comprehensive Course, 2nd edition, Springer.<br>• U. Krengel (2005): Einführung in die Wahrscheinlichkeitstheorie und Statistik, 8th edition, Vieweg.<br>• A.N. Shiryaev (2012): Problems in probability, Springer. |

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

## Specialization Production Management and Processes

### 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 M1679: Process Management

**Courses**

| Title | Typ | Hrs/wk | CP |
|---|---|---|---|
| Basics of process management (L2810) | Lecture | 2 | 3 |
| Process management practice (L2811) | Seminar | 2 | 3 |

| | |
|---|---|
| **Module Responsible** | Prof. Christian Thies |
| **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** | Compulsory: Yes; Bonus: 20 %; Form: Presentation; Description: |
| **Examination** | Written exam |
| **Examination duration and scale** | 60 min |
| **Assignment for the Following Curricula** | Logistics and Mobility: Specialisation Production Management and Processes: Compulsory<br>Logistics and Mobility: Specialisation Information Technology: Elective Compulsory<br>Engineering and Management - Major in Logistics and Mobility: Specialisation Production Management and Processes: Compulsory<br>Engineering and Management - Major in Logistics and Mobility: Specialisation Information Technology: Elective Compulsory |

### Course L2810: Basics of process management

| | |
|---|---|
| **Typ** | Lecture |
| **Hrs/wk** | 2 |
| **CP** | 3 |
| **Workload in Hours** | Independent Study Time 62, Study Time in Lecture 28 |
| **Lecturer** | Prof. Christian Thies |
| **Language** | DE |
| **Cycle** | SoSe |
| **Content** | |
| **Literature** | |

### Course L2811: Process management practice

| | |
|---|---|
| **Typ** | Seminar |
| **Hrs/wk** | 2 |
| **CP** | 3 |
| **Workload in Hours** | Independent Study Time 62, Study Time in Lecture 28 |
| **Lecturer** | Prof. Christian Thies |
| **Language** | DE |
| **Cycle** | SoSe |
| **Content** | |
| **Literature** | |

## Module M1680: Automation in logistics

**Courses**

| Title | Typ | Hrs/wk | CP |
|---|---|---|---|
| Automation in logistics - Lab (L2913) | Project-/problem-based Learning | 2 | 2 |
| Automation in logistics - seminar (L2688) | Seminar | 2 | 4 |

| | |
|---|---|
| **Module Responsible** | NN |
| **Admission Requirements** | None |
| **Recommended Previous Knowledge** | "Technical logistics" successfully completed<br><br>"Computer Science for Engineers - Introduction and Overview" successfully completed |
| **Educational Objectives** | After taking part successfully, students have reached the following learning results |
| **Professional Competence** | |
| *Knowledge* | 1. The students know the basic principles of measurement and control technology.<br>2. The students know localization and navigation solutions used in mobile robotics.<br>3. The students know automation solutions for storage and order picking.<br>4. The students can developed and implement basic programs with a programmable logic controller. |
| *Skills* | 1. The students can describe and evaluate basic control loops.<br>2. The students can carry out algorithms for localization and navigation.<br>3. The Students can evaluate the performance of automated storage and picking solutions. |
| **Personal Competence** | |
| *Social Competence* | 1. The students are able to explain the basic principles of measurement and control technology to other students.<br>2. The students can help other students to find algorithmic errors in localization and navigation algorithms.<br>3. The students are able to present their results in front of an audience. |
| *Autonomy* | 1. The students familiarize themselves independently with unknown algorithms.<br>2. The students are able to independently find a suitable automation approach for a problem.<br>3. Based on the given task, the students can design an appropriate automation solution. |
| **Workload in Hours** | Independent Study Time 124, Study Time in Lecture 56 |
| **Credit points** | 6 |

| **Course achievement** | Compulsory | Bonus | Form | Description |
|---|---|---|---|---|
| | Yes | 10 % | Attestation | Programmieraufgaben in SPS |

| | |
|---|---|
| **Examination** | Written exam |
| **Examination duration and scale** | 90 min |
| **Assignment for the Following Curricula** | Logistics and Mobility: Specialisation Information Technology: Compulsory<br>Logistics and Mobility: Specialisation Production Management and Processes: Elective Compulsory<br>Engineering and Management - Major in Logistics and Mobility: Specialisation Information Technology: Compulsory<br>Engineering and Management - Major in Logistics and Mobility: Specialisation Production Management and Processes: Elective Compulsory |

### Course L2913: Automation in logistics - Lab

| | |
|---|---|
| **Typ** | Project-/problem-based Learning |
| **Hrs/wk** | 2 |
| **CP** | 2 |
| **Workload in Hours** | Independent Study Time 32, Study Time in Lecture 28 |
| **Lecturer** | NN |
| **Language** | DE |
| **Cycle** | WiSe |
| **Content** | Introduction to programmable logic controllers (PLC) with CodeSys<br><br>PLC basics with function blocks and structured text<br><br>Integration of sensors and actuators<br><br>Testing of PLC programs in a simulation<br><br>Transfer of own PLC programs to real control hardware |
| **Literature** | Wellenreuther, Günter; Zastrow, Dieter (2016): Automatisieren mit SPS - Übersichten und Übungsaufgaben. Von Grundverknüpfungen bis Ablaufsteuerungen, Wortverarbeitungen und Regelungen, Programmieren mit STEP 7 und CoDeSys, Beispiele, Lernaufgaben, Kontrollaufgaben, Lösungen. 7. Auflage. Wiesbaden: Springer Vieweg (Lehrbuch). |

| Course L2688: Automation in logistics - seminar | |
|---|---|
| **Typ** | Seminar |
| **Hrs/wk** | 2 |
| **CP** | 4 |
| **Workload in Hours** | Independent Study Time 92, Study Time in Lecture 28 |
| **Lecturer** | NN |
| **Language** | DE |
| **Cycle** | WiSe |
| **Content** | (1) Measurement and sensor technology<br><br>(2) Basics of control theory<br><br>(3) Autonomous Mobile Robots<br><br>(4) Automated storage systems<br><br>(5) Robotics in order picking. |
| **Literature** | Heinrich, Berthold (2019): Grundlagen Regelungstechnik. 5. Auflage. Hg. v. Wolfgang Schneider. Wiesbaden: Springer Vieweg.<br><br>Parthier, Rainer (2016): Messtechnik. Grundlagen und Anwendungen der elektrischen Messtechnik. 8. Auflage. Wiesbaden, Springer Fachmedien Wiesbaden.<br><br>Thrun, Sebastian; Burgard, Wolfram; Fox, Dieter (2006): Probabilistic robotics. Cambridge, Massachusetts, London, England: MIT Press.<br><br>Wehking, Karl-Heinz (2020): Technisches Handbuch Logistik 1. Fördertechnik, Materialfluss, Intralogistik. Berlin, Heidelberg; Springer Vieweg. |

## Module M0608: Basics of Electrical Engineering

**Courses**

| Title | Typ | Hrs/wk | CP |
|---|---|---|---|
| Basics of Electrical Engineering (L0290) | Lecture | 3 | 4 |
| Basics of Electrical Engineering (L0292) | Recitation Section (small) | 2 | 2 |

| | |
|---|---|
| **Module Responsible** | Prof. Thorsten Kern |
| **Admission Requirements** | None |
| **Recommended Previous Knowledge** | Basics of mathematics |
| **Educational Objectives** | After taking part successfully, students have reached the following learning results |
| **Professional Competence** | |
| *Knowledge* | Students can to draw and explain circuit diagrams for electric and electronic circuits with a small number of components. They can describe the basic function of electric and electronic componentes and can present the corresponding equations. They can demonstrate the use of the standard methods for calculations. |
| *Skills* | Students are able to analyse electric and electronic circuits with few components and to calculate selected quantities in the circuits. They apply the ususal methods of the electrical engineering for this. |
| **Personal Competence** | |
| *Social Competence* | Students are enabled to collaborate in interdisciplinary teams with electrical engineering as a common language<br>With this, they are learning communication in a target-oriented communication style, are able to understand interfaces to neighboring engineering disciplines and learn about commonalities but also limits in the different directions of engineering. |
| *Autonomy* | Students are able independently to analyse electric and electronic circuits and to calculate selected quantities in the circuits. |
| **Workload in Hours** | Independent Study Time 110, Study Time in Lecture 70 |
| **Credit points** | 6 |
| **Course achievement** | **Compulsory** / **Bonus** / **Form** / **Description**<br>No / 20 % / Subject theoretical and practical work / Während des Semesters werden Hausarbeiten in Form von elektrischen Aufgaben vergeben, für die durch Simulation eine Lösung entwickelt und nachgewiesen werden muss. |
| **Examination** | Subject theoretical and practical work |
| **Examination duration and scale** | 135 minutes |
| **Assignment for the Following Curricula** | Bioprocess Engineering: Core Qualification: Compulsory<br>Digital Mechanical Engineering: Core Qualification: Compulsory<br>Green Technologies: Energy, Water, Climate: Core Qualification: Compulsory<br>Logistics and Mobility: Specialisation Production Management and Processes: Elective Compulsory<br>Logistics and Mobility: Specialisation Traffic Planning and Systems: Elective Compulsory<br>Mechanical Engineering: Core Qualification: Compulsory<br>Orientation Studies: Core Qualification: Elective Compulsory<br>Naval Architecture: Core Qualification: Compulsory<br>Process Engineering: Core Qualification: Compulsory<br>Engineering and Management - Major in Logistics and Mobility: Specialisation Production Management and Processes: Elective Compulsory<br>Engineering and Management - Major in Logistics and Mobility: Specialisation Traffic Planning and Systems: Elective Compulsory |

### Course L0290: Basics of Electrical Engineering

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

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

## Module M1890: Strategic Management of Technological Innovation

**Courses**

| Title | Typ | Hrs/wk | CP |
|---|---|---|---|
| Strategic Management of Technological Innovation (L3127) | Lecture | 3 | 3 |
| Strategic Management of Technological Innovation (L3128) | Project-/problem-based Learning | 2 | 3 |

| | |
|---|---|
| **Module Responsible** | Prof. Tim Schweisfurth |
| **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 110, Study Time in Lecture 70 |
| **Credit points** | 6 |
| **Course achievement** | Compulsory: Yes; Bonus: 20 %; Form: Subject theoretical andsemesterbegleitende practical work; Description: Mini-Tests, Gruppenarbeiten |
| **Examination** | Written exam |
| **Examination duration and scale** | 60 minutes |
| **Assignment for the Following Curricula** | Engineering and Management - Major in Logistics and Mobility: Specialisation Information Technology: Elective Compulsory<br>Engineering and Management - Major in Logistics and Mobility: Specialisation Production Management and Processes: Elective Compulsory<br>Engineering and Management - Major in Logistics and Mobility: Specialisation Traffic Planning and Systems: Elective Compulsory |

### Course L3127: Strategic Management of Technological Innovation

| | |
|---|---|
| **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** | WiSe |
| **Content** | |
| **Literature** | |

### Course L3128: Strategic Management of Technological Innovation

| | |
|---|---|
| **Typ** | Project-/problem-based Learning |
| **Hrs/wk** | 2 |
| **CP** | 3 |
| **Workload in Hours** | Independent Study Time 62, Study Time in Lecture 28 |
| **Lecturer** | Prof. Tim Schweisfurth |
| **Language** | EN |
| **Cycle** | WiSe |
| **Content** | |
| **Literature** | |

## Module M0933: Fundamentals of Materials Science

**Courses**

| Title | Typ | Hrs/wk | CP |
|---|---|---|---|
| Fundamentals of Materials Science I (L1085) | Lecture | 2 | 2 |
| Fundamentals of Materials Science II (Advanced Ceramic Materials, Polymers and Composites) (L0506) | Lecture | 2 | 2 |
| Physical and Chemical Basics of Materials Science (L1095) | Lecture | 2 | 2 |

| | |
|---|---|
| **Module Responsible** | Prof. Jörg Weißmüller |
| **Admission Requirements** | None |
| **Recommended Previous Knowledge** | Highschool-level physics, chemistry und mathematics |
| **Educational Objectives** | After taking part successfully, students have reached the following learning results |
| **Professional Competence** | |
| *Knowledge* | The students have acquired a fundamental knowledge on metals, ceramics and polymers and can describe this knowledge comprehensively. Fundamental knowledge here means specifically the issues of atomic structure, microstructure, phase diagrams, phase transformations, corrosion and mechanical properties. The students know about the key aspects of characterization methods for materials and can identify relevant approaches for characterizing specific properties. They are able to trace materials phenomena back to the underlying physical and chemical laws of nature. |
| *Skills* | The students are able to trace materials phenomena back to the underlying physical and chemical laws of nature. Materials phenomena here refers to mechanical properties such as strength, ductility, and stiffness, chemical properties such as corrosion resistance, and to phase transformations such as solidification, precipitation, or melting. The students can explain the relation between processing conditions and the materials microstructure, and they can account for the impact of microstructure on the material's behavior. |
| **Personal Competence** | |
| *Social Competence* | - |
| *Autonomy* | - |
| **Workload in Hours** | Independent Study Time 96, Study Time in Lecture 84 |
| **Credit points** | 6 |
| **Course achievement** | None |
| **Examination** | Written exam |
| **Examination duration and scale** | 180 min |
| **Assignment for the Following Curricula** | General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering: Compulsory<br>General Engineering Science (German program, 7 semester): Specialisation Biomedical Engineering: Compulsory<br>General Engineering Science (German program, 7 semester): Specialisation Naval Architecture: Compulsory<br>General Engineering Science (German program, 7 semester): Specialisation Advanced Materials: Compulsory<br>Data Science: Specialisation II. Application: Elective Compulsory<br>Digital Mechanical Engineering: Core Qualification: Compulsory<br>Green Technologies: Energy, Water, Climate: Specialisation Energy Technology: Elective Compulsory<br>Green Technologies: Energy, Water, Climate: Specialisation Maritime Technologies: 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>Naval Architecture: Core Qualification: Compulsory<br>Technomathematics: Specialisation III. Engineering Science: Elective Compulsory<br>Engineering and Management - Major in Logistics and Mobility: Specialisation Production Management and Processes: Elective Compulsory |

### Course L1085: Fundamentals of Materials Science I

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

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

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

## 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 | 2 |
| Measurement Technology for Mechanical Engineering (L1118) | Practical Course | 2 | 2 |

| | |
|---|---|
| **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 96, Study Time in Lecture 84 |
| **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** | Successfull execution of up to 12 short experiments on measurements technology and sucessfull participation in the practical course of "Practical Course: Measurement and Control Systems" |
| **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>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: Specialisation Naval Engineering: Compulsory<br>Mechatronics: Specialisation Electrical Systems: Compulsory<br>Mechatronics: Specialisation Dynamic Systems and AI: Compulsory<br>Mechatronics: Core Qualification: Compulsory<br>Mechatronics: Specialisation Robot- and Machine-Systems: Compulsory<br>Mechatronics: Specialisation Medical Engineering: 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** | **The content of experiment 1:**<br><br>Accuracy testing of a delta robot: In the course of the experiment, the accuracy of a delta robot is tested through 3 tasks. The first task focuses on the online/offline programming of the robot. The second task deals with sensor calibration. In the third task, the radius of a sphere is determined using three different measurement methods (manual measurement, manual measurement with a sensor, automatic data acquisition and data processing).<br><br>**The content of experiment 3:**<br><br>The aim of the task is to enable the parallel kinematics to find objects, grasp them and place them on a static target position For this purpose, the end effector of the kinematics is equipped with an optical sensor (camera), whose characteristics are to be defined. The measuring range of the sensor is to be identified and, based on this, a movement strategy for finding the objects is to be developed and implemented. Once the objects have been found, they are to be picked up with a magnetic gripper and transported to their destination.<br><br>**The content of experiment 4:**<br><br>The aim of the task is to enable the parallel kinematics to find objects, grab them and deposit them on a moving platform. For this purpose, the end effector of the kinematics is equipped with an optical sensor (camera), the properties of which were worked out in experiment 3. Based on this, the parallel kinematics should now be able to follow the moving platform. For this purpose, a position control must be developed and implemented. Once the controller has been appropriately configured, the objects can be placed on the moving platform. |
| **Literature** | Versuch 1:<br><br>• 1)Weck, Manfred; Brecher, Christian. Maschinenarten und Anwendungsbereiche. Springer (Werkzeugmaschinen, 1, Ed. 6). 2005<br>• 2)Weck, Manfred; Brecher, Christian. Automatisierung von Maschinen und Anlagen. Springer (Werkzeugmaschinen, 4, Ed. 6). 2006<br>• 3)Siciliano, Bruno; Khatib, Oussama. Springer handbook of robotics. Springer. 2008<br>• 4)Schüppstuhl, Thorsten. VL Grundlagen der Handhabungs- und Montagetechnik. 2017<br><br>Versuch 3:<br><br>• 1)Hompel, Michael, Hubert Büchter, and Ulrich Franzke. Identifikationssysteme und Automatisierung. Springer-Verlag, 2007.<br>• ArUco Library Documentation, https://docs.google.com/document/d/1QU9KoBtjSM2kF6ITOjQ76xqL7H0TEtXriJX5kwi9Kgc/edit Stand 10/21<br>• Demant, Christian, Bernd Streicher-Abel, and Axel Springhoff. Industrielle Bildverarbeitung: wie optische Qualitätskontrolle wirklich funktioniert. Springer-Verlag, 2011.<br><br>Versuch 4:<br><br>• 1)Will, Thorsten T. C++ Das umfassende Handbuch, Rheinwerk Computing, 2020<br>• 2)Hildebrand, Walter. Grundkurs Regelungstechnik : Grundlagen für Bachelorstudiengänge aller technischen Fachrichtungen und Wirtschaftsingenieure, Springer Vieweg, 2013.<br>• 3)Erlenkötter, Helmut. C++: Objektorientiertes Programmieren von Anfang an, rororo, 2016<br><br>Bibliography:<br><br>Experiment 1<br><br>• 1)Weck, Manfred; Brecher, Christian. Maschinenarten und Anwendungsbereiche. Springer (Werkzeugmaschinen, 1, Ed. 6). 2005<br>• 2)Weck, Manfred; Brecher, Christian. Automatisierung von Maschinen und Anlagen. Springer (Werkzeugmaschinen, 4, Ed. 6). 2006<br>• 3)Siciliano, Bruno; Khatib, Oussama. Springer handbook of robotics. Springer. 2008<br>• 4)Schüppstuhl, Thorsten. VL Grundlagen der Handhabungs- und Montagetechnik. 2017<br><br>Experiment 3:<br><br>• 1)Hompel, Michael, Hubert Büchter, and Ulrich Franzke. Identifikationssysteme und Automatisierung. Springer-Verlag, 2007.<br>• ArUco Library Documentation, https://docs.google.com/document/d/1QU9KoBtjSM2kF6ITOjQ76xqL7H0TEtXriJX5kwi9Kgc/edit Stand 10/21<br>• Demant, Christian, Bernd Streicher-Abel, and Axel Springhoff. Industrielle Bildverarbeitung: wie optische Qualitätskontrolle wirklich funktioniert. Springer-Verlag, 2011.<br><br>Experiment 4:<br><br>• 1)Will, Thorsten T. C++ Das umfassende Handbuch, Rheinwerk Computing, 2020<br>• 2)Hildebrand, Walter. Grundkurs Regelungstechnik : Grundlagen für Bachelorstudiengänge aller technischen Fachrichtungen und Wirtschaftsingenieure, Springer Vieweg, 2013.<br>• 3)Erlenkötter, Helmut. C++: Objektorientiertes Programmieren von Anfang an, rororo, 2016 |

| Course L1116: Measurement Technology for Mechanical Engineering | |
|---|---|
| **Typ** | Lecture |
| **Hrs/wk** | 2 |
| **CP** | 2 |
| **Workload in Hours** | Independent Study Time 32, 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** | Practical Course |
| **Hrs/wk** | 2 |
| **CP** | 2 |
| **Workload in Hours** | Independent Study Time 32, Study Time in Lecture 28 |
| **Lecturer** | Prof. Thorsten Kern |
| **Language** | EN |
| **Cycle** | WiSe/SoSe |
| **Content** | See interlocking course |
| **Literature** | See interlocking course |

## Module M0853: Mathematics III

**Courses**

| Title | Typ | Hrs/wk | CP |
|---|---|---|---|
| Analysis III (L1028) | Lecture | 2 | 2 |
| Analysis III (L1029) | Recitation Section (small) | 1 | 1 |
| Analysis III (L1030) | Recitation Section (large) | 1 | 1 |
| Differential Equations 1 (Ordinary Differential Equations) (L1031) | Lecture | 2 | 2 |
| Differential Equations 1 (Ordinary Differential Equations) (L1032) | Recitation Section (small) | 1 | 1 |
| Differential Equations 1 (Ordinary Differential Equations) (L1033) | Recitation Section (large) | 1 | 1 |

| | |
|---|---|
| **Module Responsible** | Prof. Marko Lindner |
| **Admission Requirements** | None |
| **Recommended Previous Knowledge** | Mathematics I + II |
| **Educational Objectives** | After taking part successfully, students have reached the following learning results |
| **Professional Competence** | |
| *Knowledge* | • Students can name the basic concepts in the area of analysis and differential equations. 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 the area of analysis and differential equations with the help of the concepts studied in this course. Moreover, they are capable of solving them by applying established methods.<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 128, Study Time in Lecture 112 |
| **Credit points** | 8 |
| **Course achievement** | None |
| **Examination** | Written exam |
| **Examination duration and scale** | 60 min (Analysis III) + 60 min (Differential Equations 1) |
| **Assignment for the Following Curricula** | General Engineering Science (German program, 7 semester): Core Qualification: Compulsory<br>Civil- and Environmental Engineering: Core Qualification: Compulsory<br>Bioprocess Engineering: Core Qualification: Compulsory<br>Chemical and Bioprocess Engineering: Core Qualification: Compulsory<br>Digital Mechanical Engineering: Core Qualification: Compulsory<br>Electrical Engineering: Core Qualification: Compulsory<br>Green Technologies: Energy, Water, Climate: Core Qualification: Compulsory<br>Computer Science in Engineering: Core Qualification: Compulsory<br>Integrated Building Technology: Core Qualification: Compulsory<br>Logistics and Mobility: Specialisation Traffic Planning and Systems: Elective Compulsory<br>Logistics and Mobility: Specialisation Production Management and Processes: Elective Compulsory<br>Logistics and Mobility: Specialisation Information Technology: Compulsory<br>Mechanical Engineering: Core Qualification: Compulsory<br>Mechatronics: Core Qualification: Compulsory<br>Naval Architecture: Core Qualification: Compulsory<br>Process Engineering: Core Qualification: Compulsory<br>Engineering and Management - Major in Logistics and Mobility: Specialisation Traffic Planning and Systems: Elective Compulsory<br>Engineering and Management - Major in Logistics and Mobility: Specialisation Production Management and Processes: Elective Compulsory<br>Engineering and Management - Major in Logistics and Mobility: Specialisation Information Technology: Compulsory |

| Course L1028: Analysis III | |
|---|---|
| **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** | DE |
| **Cycle** | WiSe |
| **Content** | Main features of differential and integrational calculus of several variables<br>• Differential calculus for several variables<br>• Mean value theorems and Taylor's theorem<br>• Maximum and minimum values<br>• Implicit functions<br>• Minimization under equality constraints<br>• Newton's method for multiple variables<br>• Fourier series<br>• Double integrals over general regions<br>• Line and surface integrals<br>• Theorems of Gauß and Stokes |
| **Literature** | • http://www.math.uni-hamburg.de/teaching/export/tuhh/index.html |

| Course L1029: Analysis III | |
|---|---|
| **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** | DE |
| **Cycle** | WiSe |
| **Content** | See interlocking course |
| **Literature** | See interlocking course |

| Course L1030: Analysis III | |
|---|---|
| **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** | DE |
| **Cycle** | WiSe |
| **Content** | See interlocking course |
| **Literature** | See interlocking course |

| Course L1031: 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** | DE |
| **Cycle** | WiSe |
| **Content** | Main features of the theory and numerical treatment of ordinary differential equations<br>• Introduction and elementary methods<br>• Exsitence and uniqueness of initial value problems<br>• Linear differential equations<br>• Stability and qualitative behaviour of the solution<br>• Boundary value problems and basic concepts of calculus of variations<br>• Eigenvalue problems<br>• Numerical methods for the integration of initial and boundary value problems<br>• Classification of partial differential equations |
| **Literature** | • http://www.math.uni-hamburg.de/teaching/export/tuhh/index.html |

| Course L1032: Differential Equations 1 (Ordinary Differential Equations) | |
|---|---|
| **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** | DE |
| **Cycle** | WiSe |
| **Content** | See interlocking course |
| **Literature** | See interlocking course |

| Course L1033: 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** | DE |
| **Cycle** | WiSe |
| **Content** | See interlocking course |
| **Literature** | See interlocking course |

## Module M1013: Traffic systems and handling technology

**Courses**

| Title | Typ | Hrs/wk | CP |
|---|---|---|---|
| Traffic systems and handling technology (L0715) | Lecture | 2 | 3 |
| Traffic systems and handling technology (L0718) | Recitation Section (small) | 2 | 3 |

| | |
|---|---|
| **Module Responsible** | Prof. Carlos Jahn |
| **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:<br>- explain and classify the terms and their meaning in transport and handling technology<br>- reflect current political conditions and technical developments in transport and handling technology;<br>- identify actors and their tasks in the maritime transport chain (pre-carriage, carriage, on-carriage);<br>- determine, compare and assign suitable applications and areas of use of transport and handling techniques based on the questions: What will be transported? On what should it be transported? Where is the cargo to be handled? By which means? |
| *Skills* | Students can, on the basis of the knowledge they have acquired:<br>- identify and evaluate key performance indicators (e.g. transport times, storage costs, etc.) in the maritime transport chain;<br>- select and dimension suitable techniques for defined transport and handling tasks and critically evaluate approaches to solutions;<br>- differentiate and evaluate transport and handling technologies (e.g. by calculating carbon footprints, transport times and costs for different modes of transport as well as point-to-point or hub-and-spoke freight transport in aviation). |
| **Personal Competence** | |
| *Social Competence* | Students are able to:<br>- successfully and respectfully discuss and organise research tasks in small groups in the context of a comprehensive written elaboration during the semester and to present and represent them in a comprehensible way;<br>- describe, differentiate and evaluate problems (e.g. in the joint compilation of factual knowledge on topics such as slow steaming in container shipping or the establishment of different maritime supply chains);<br>- participate in technical discussions on topics from the transport and handling technology. |
| *Autonomy* | After completion of the module students capable to:<br>- acquire knowledge of parts of the subject area independently and apply the acquired knowledge to solve new problems;<br>- conduct a systematic literature search and record this in a scientific text;<br>- critically reflect on the results of their own work. |
| **Workload in Hours** | Independent Study Time 124, Study Time in Lecture 56 |
| **Credit points** | 6 |
| **Course achievement** | Compulsory: No; Bonus: 10 %; Form: Written elaboration; Description: |
| **Examination** | Written exam |
| **Examination duration and scale** | 90 minutes |
| **Assignment for the Following Curricula** | Logistics and Mobility: Specialisation Traffic Planning and Systems: Compulsory<br>Logistics and Mobility: Specialisation Production Management and Processes: Elective Compulsory<br>Engineering and Management - Major in Logistics and Mobility: Specialisation Traffic Planning and Systems: Compulsory<br>Engineering and Management - Major in Logistics and Mobility: Specialisation Production Management and Processes: Elective Compulsory |

| Course L0715: Traffic systems and handling technology | |
|---|---|
| **Typ** | Lecture |
| **Hrs/wk** | 2 |
| **CP** | 3 |
| **Workload in Hours** | Independent Study Time 62, Study Time in Lecture 28 |
| **Lecturer** | Prof. Carlos Jahn |
| **Language** | DE |
| **Cycle** | WiSe |
| **Content** | In the course Transport Systems and Handling Technology the elementary basics, characteristics, possible applications and areas of expediency of transport and handling technology are taught. The students should be enabled to select, conceptualize and evaluate suitable techniques for defined transport and handling tasks. In addition to the goods to be transported and the loading units, the various means of transport, handling concepts and the necessary equipment play a special role. A basic knowledge of the relevant guidelines and standards is also built up. In addition to the transport systems road, rail, water (inland waterways and maritime shipping) and air transport, combined transport is also addressed.<br><br>Contents of the lecture<br><br>• Basics, possible applications, usefulnes of different transport and handling techniques<br>• Overview of transported goods, loading units, means of transport, handling terminals and equipment<br>• Representation of the modes of transport: road, rail, water (inland waterway, ocean-going vessel), air, combined transport |
| **Literature** | Clausen, Uwe; Geiger, Christiane (2013). Verkehrs- und Transportlogistik.<br><br>Conrady, Roland; Fichert, Frank; Sterzenbach, Rüdiger (2019). Luftverkehr: Betriebswirtschaftliches Lehr- und Handbuch.<br><br>Gleißner, Harald; Femerling, Christian (2012). Logistik: Grundlagen - Übungen - Fallbeispiele.<br><br>Kranke, Andre; Schmied, Martin; Schön, Andrea D. (2011). CO2-Berechnung in der Logistik: Datenquellen, Formeln, Standards.<br><br>Pachl, Jörn (2018). Systemtechnik des Schienenverkehrs: Bahnbetrieb planen, steuern und sichern.<br><br>Rodrigue, Jean-Paul (2020). Geography of Transport Systems. |

| Course L0718: Traffic systems and handling technology | |
|---|---|
| **Typ** | Recitation Section (small) |
| **Hrs/wk** | 2 |
| **CP** | 3 |
| **Workload in Hours** | Independent Study Time 62, Study Time in Lecture 28 |
| **Lecturer** | Prof. Carlos Jahn |
| **Language** | DE |
| **Cycle** | WiSe |
| **Content** | The exercise of the course Traffic Systems and Handling Technology is carried out as a guided group exercise. In the exercise sessions, students receive assignment sheets on the sub-topics of the course and work on these independently. The exercise sheets mainly consist of computational tasks as well as comprehension questions. The lecturers are available to the students during the exercise to discuss calculation methods and results. There is the possibility for students to earn 10-15% bonus points on their passed exam in the course of voluntary additional work, depending on the extent. For example, by working on the worksheets in small groups and handing them in. The classroom training can be supplemented by digital exercises. |
| **Literature** | Biebig , Peter; Althof, Wolfgang.; Wagener, Norbert (2008) Seeverkehrswirtschaft : Kompendium. 4. Auflage.<br><br>Geisler, Alexander; Johns, Dirk Max (2018): See Schiff Ladung: Fachbuch für Schifffahrtskaufleute: von Praktikern für Praktiker, 2. Auflage.<br><br>Bänsch, Axel; Alewell, Dorothea; Moll, Tobias (2020): Wissenschaftliches Arbeiten, 12. Auflage.<br><br>Voss, Rüdiger (2019): Wissenschaftliches Arbeiten: … leicht verständlich. 6. Auflage. |

## Module M1112: Production Logistics

**Courses**

| Title | Typ | Hrs/wk | CP |
|---|---|---|---|
| Production Logistics Seminar (L1253) | Seminar | 2 | 6 |

| | |
|---|---|
| **Module Responsible** | Prof. Thorsten Blecker |
| **Admission Requirements** | None |
| **Recommended Previous Knowledge** | none |
| **Educational Objectives** | After taking part successfully, students have reached the following learning results |
| **Professional Competence** | |
| *Knowledge* | Knowledge: Students will have acquired knowledge in the following areas:<br>• interaction of production and logistics and interdependencies<br>• production-related logistics topics |
| *Skills* | Skills: Students will based on the acquired knowledge be in a position to<br>• assess issues on production logistics<br>• to be able to deal critically with developments in production logistics and assess these critically;<br>• to work independently on current topics from the field of "production logistics"; |
| **Personal Competence** | |
| *Social Competence* | Social competence: After completing the module students are capable of<br>• to conduct subject-specific and interdisciplinary discussions;<br>• present orally and in writing their results;<br>• respectful team work |
| *Autonomy* | After completing the module students are capable to work independently on a subject and transfer the acquired knowledge to new problems. |
| **Workload in Hours** | Independent Study Time 152, Study Time in Lecture 28 |
| **Credit points** | 6 |
| **Course achievement** | None |
| **Examination** | Written elaboration |
| **Examination duration and scale** | approx. 20 pages plus presentation (20 minutes per person) |
| **Assignment for the Following Curricula** | Logistics and Mobility: Specialisation Production Management and Processes: Elective Compulsory<br>Engineering and Management - Major in Logistics and Mobility: Specialisation Production Management and Processes: Elective Compulsory |

### Course L1253: Production Logistics Seminar

| | |
|---|---|
| **Typ** | Seminar |
| **Hrs/wk** | 2 |
| **CP** | 6 |
| **Workload in Hours** | Independent Study Time 152, Study Time in Lecture 28 |
| **Lecturer** | Prof. Thorsten Blecker |
| **Language** | DE |
| **Cycle** | WiSe |
| **Content** | Within the Production Logistics Seminar the students shall compose a first term paper. In the beginning production-close logstic topics will be distributed which the students have to elaborate on their own. This workshop aims at the better motivation of the students to structure new and creative ideas and develop them to innovative solutions. This workshop contains regular meetings as well as two presentations in the middle and at the end. |
| **Literature** | Skripte und Textdokumente, die während der Vorlesung herausgegeben werden. |

## Module M0833: Introduction to Control Systems

**Courses**

| Title | Typ | Hrs/wk | CP |
|---|---|---|---|
| Introduction to Control Systems (L0654) | Lecture | 2 | 4 |
| Introduction to Control Systems (L0655) | Recitation Section (small) | 2 | 2 |

| | |
|---|---|
| **Module Responsible** | NN |
| **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** | 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>Data Science: Core Qualification: Elective Compulsory<br>Data Science: Specialisation II. Application: Elective Compulsory<br>Electrical Engineering: Core Qualification: Compulsory<br>Green Technologies: Energy, Water, Climate: Core Qualification: Compulsory<br>Computer Science in Engineering: Core Qualification: Compulsory<br>Integrated Building Technology: Core Qualification: Elective Compulsory<br>Logistics and Mobility: Specialisation Information Technology: Elective Compulsory<br>Logistics and Mobility: Specialisation Traffic Planning and Systems: 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>Technomathematics: Specialisation III. Engineering Science: Elective Compulsory<br>Theoretical Mechanical Engineering: Technical Complementary Course Core Studies: Elective Compulsory<br>Process Engineering: Core Qualification: Compulsory<br>Engineering and Management - Major in Logistics and Mobility: Specialisation Information Technology: Elective Compulsory<br>Engineering and Management - Major in Logistics and Mobility: Specialisation Traffic Planning and Systems: Elective Compulsory<br>Engineering and Management - Major in Logistics and Mobility: Specialisation Production Management and Processes: Elective Compulsory |

| Course L0654: Introduction to Control Systems | |
|---|---|
| **Typ** | Lecture |
| **Hrs/wk** | 2 |
| **CP** | 4 |
| **Workload in Hours** | Independent Study Time 92, Study Time in Lecture 28 |
| **Lecturer** | NN |
| **Language** | DE |
| **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 L0655: Introduction to Control Systems | |
|---|---|
| **Typ** | Recitation Section (small) |
| **Hrs/wk** | 2 |
| **CP** | 2 |
| **Workload in Hours** | Independent Study Time 32, Study Time in Lecture 28 |
| **Lecturer** | NN |
| **Language** | DE |
| **Cycle** | WiSe |
| **Content** | See interlocking course |
| **Literature** | See interlocking course |

## Module M1289: Logistical systems - Industry 4.0

**Courses**

| Title | Typ | Hrs/wk | CP |
|---|---|---|---|
| Logistics systems - Industry 4.0 (L1753) | Seminar | 4 | 6 |

| | |
|---|---|
| **Module Responsible** | Prof. Jochen Kreutzfeldt |
| **Admission Requirements** | None |
| **Recommended Previous Knowledge** | Successful completion of the module „Technical Logistics“ |
| **Educational Objectives** | After taking part successfully, students have reached the following learning results |
| **Professional Competence** | |
| *Knowledge* | The students will acquire the following knowledge:<br>1. The students are able to understand and explain the concept "Logistical System".<br>2. The students are able to design a logistic system conceptually.<br>3. The students can develop and implement the control of a logistic system with python. |
| *Skills* | The students will acquire the following skills:<br>1. The students are able to identify logistical systems, analyze and identify potential for change and improvement.<br>2. The students know different technical solutions to address problems in logistical systems.<br>3. The students are capable of deploying technical solutions and ideas from the concept Industry 4.0 to deal with logistical problems. |
| **Personal Competence** | |
| *Social Competence* | The students will acquire the following social skills:<br>1. The students are able to develop technical solutions for logistical systems and reflect their contribution within the team.<br>2. The technical solutions from the group can be jointly documented and presented.<br>3. Students are able to present their technological solutions to an audience and derived from the critique new ideas and improvements. |
| *Autonomy* | The students will acquire the following independent competencies:<br>1. The students can independently develop technical solutions for logistical problems under supervision.<br>2. The students are able to evaluate their technical solutions and discuss the pros and cons.<br>3. The students are able to assess the impact of the concept Industry 4.0 on their own career development. |
| **Workload in Hours** | Independent Study Time 124, Study Time in Lecture 56 |
| **Credit points** | 6 |
| **Course achievement** | None |
| **Examination** | Written elaboration |
| **Examination duration and scale** | Lab prototype with documentation (group work) |
| **Assignment for the Following Curricula** | Logistics and Mobility: Specialisation Information Technology: Elective Compulsory<br>Logistics and Mobility: Specialisation Traffic Planning and Systems: Elective Compulsory<br>Logistics and Mobility: Specialisation Production Management and Processes: Elective Compulsory<br>Engineering and Management - Major in Logistics and Mobility: Specialisation Information Technology: Elective Compulsory<br>Engineering and Management - Major in Logistics and Mobility: Specialisation Traffic Planning and Systems: Elective Compulsory<br>Engineering and Management - Major in Logistics and Mobility: Specialisation Production Management and Processes: Elective Compulsory |

| Course L1753: Logistics systems - Industry 4.0 | |
|---|---|
| **Typ** | Seminar |
| **Hrs/wk** | 4 |
| **CP** | 6 |
| **Workload in Hours** | Independent Study Time 124, Study Time in Lecture 56 |
| **Lecturer** | Prof. Jochen Kreutzfeldt |
| **Language** | DE |
| **Cycle** | WiSe |
| **Content** | The lecture gives an introduction to the concept of logistical systems with a special emphasis on the subject of Industry 4.0. Here, the system concept in logistics from a technical point of view is introduced. A logistical system is understood as a combination of transport, storage and change processes between source and sink of goods. This lecture will look at the technical aspect of these processes.<br>Industry is a topic of this lecture. Industry 4.0 is understood as the far-reaching digitization and networking of logistical systems and the connection of logistical objects, processes and systems. The logistics industry expects Industry 4.0 to be a profound change and the realization of large improvement potentials. The lecture provides an in-depth introduction to application cases and business models of Industry 4.0 in logistics from a technical standpoint. A possible framework for Industry 4.0 is presented and several application examples are shown.<br><br>In the exercises, students learn will learn the exemplary use of different technical solutions and know how, which can be used to improve logistical systems. |
| **Literature** | Bauernhansl, Thomas et al. (2014): Industrie 4.0 in Produktion, Automatisierung und Logistik. Anwendung, Technologien, Migration. Wiesbaden: Springer Vieweg.<br>Hausladen, Iris (2014): IT-gestützte Logistik. Systeme - Prozesse - Anwendungen. 2. Auflage 2014. Wiesbaden: Imprint: Gabler Verlag.<br><br>Hompel, Michael ten; Büchter, Hubert; Franzke, Ulrich (2008): Identifikationssysteme und Automatisierung. [Intralogistik]. Berlin, Heidelberg: Springer.<br><br>Kaufmann, Timothy (2015): Geschäftsmodelle in Industrie 4.0 und dem Internet der Dinge. Der Weg vom Anspruch in die Wirklichkeit. Wiesbaden: Springer Fachmedien Wiesbaden.<br><br>Martin, Heinrich (2014): Transport- und Lagerlogistik. Planung, Struktur, Steuerung und Kosten von Systemen der Intralogistik. 9., Auflage 2014. Wiesbaden: Imprint: Springer Vieweg.<br><br>Runkler, Thomas A. (2010): Data-Mining. Methoden und Algorithmen intelligenter Datenanalyse. 1. Aufl. Wiesbaden: Vieweg + Teubner (Studium). |

## Module M1349: Object-oriented programming in logistics

**Courses**

| Title | Typ | Hrs/wk | CP |
|---|---|---|---|
| Object-oriented programming in logistics (L1901) | Seminar | 4 | 6 |

| | |
|---|---|
| **Module Responsible** | NN |
| **Admission Requirements** | None |
| **Recommended Previous Knowledge** | Basic computer skills<br><br>Computer Science for Engineers - Introduction and Overview |
| **Educational Objectives** | After taking part successfully, students have reached the following learning results |
| **Professional Competence** | |
| *Knowledge* | The students will acquire the following knowledge:<br><br>1. The students are able to explain the basics of object-oriented programming with Java.<br><br>2. The students know basic data types, control structures and basic concepts of object orientation and inheritance in the Java programming language.<br><br>3. The students know the necessary tools for programming with Java. |
| *Skills* | The students will acquire the following skills:<br><br>1. The students will be able to develop and run programs with Java independently.<br><br>2. The students will be able to develop and implement own objects and classes with Java.<br><br>3. The students are able to identify and overcome failures autonomously (debugging). |
| **Personal Competence** | |
| *Social Competence* | The students will acquire the following social skills:<br><br>1. The students can explain self-developed programs to other students.<br><br>2. The students can support others in finding failures and mistakes in their software-code.<br><br>3. The students are able to present their programs in front of a audience. |
| *Autonomy* | The students will acquire the following competencies:<br><br>1. The students work independently with an initially unknown programming language (Java).<br><br>2. The students are able to derive independently the necessary source code for a given problem.<br><br>3. The students are able to write their own source code in Java based on given a problem. |
| **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** | Logistics and Mobility: Specialisation Information Technology: Elective Compulsory<br>Engineering and Management - Major in Logistics and Mobility: Specialisation Information Technology: Elective Compulsory<br>Engineering and Management - Major in Logistics and Mobility: Specialisation Production Management and Processes: Elective Compulsory |

| Course L1901: Object-oriented programming in logistics | |
|---|---|
| **Typ** | Seminar |
| **Hrs/wk** | 4 |
| **CP** | 6 |
| **Workload in Hours** | Independent Study Time 124, Study Time in Lecture 56 |
| **Lecturer** | NN |
| **Language** | DE |
| **Cycle** | WiSe |
| **Content** | The seminar provides an introduction to object-oriented programming with Java. Practical knowledge will be transferred through programming exercises parallel to theoretical content. The exercises will deal mainly with logistical problems.<br><br>The seminar will be conducted as an integrated seminar with a combination of theoretical content and autonomously solved programming problems on the computer.<br><br>Furthermore, the student will become familiar with the standard libraries of Java and their properties and functions. These standard objects will be used, if necessary with the assistance of an instructor, to build own programs.<br><br>Furthermore, an introduction to the actual software development kits (SDK) of Java will be given. |
| **Literature** | Goll, Joachim; Heinisch, Cornelia (2014): Java als erste Programmiersprache. Ein professioneller Einstieg in die Objektorientierung mit Java. 7. Aufl. 2014. Wiesbaden: Imprint: Springer Vieweg.<br><br>Jobst, Fritz (2015): Programmieren in Java. [aktuell zu Java 8]. 7., vollst. überarb. Aufl. München: Hanser.<br><br>Abts, Dietmar (2015): Grundkurs JAVA. Von den Grundlagen bis zu Datenbank- und Netzanwendungen. 8. Aufl. Wiesbaden: Springer Vieweg. |

## Module M1070: Simulation of Transport and Handling Systems

**Courses**

| Title | Typ | Hrs/wk | CP |
|---|---|---|---|
| Simulation of Transport and Handling Systems (L1352) | Lecture | 1 | 2 |
| Simulation of Transport and Handling Systems (L1818) | Recitation Section (small) | 3 | 4 |

| | |
|---|---|
| **Module Responsible** | Prof. Carlos Jahn |
| **Admission Requirements** | None |
| **Recommended Previous Knowledge** | Basic knowledge of transport- and handlingtechnology. |
| **Educational Objectives** | After taking part successfully, students have reached the following learning results |
| **Professional Competence** | |
| *Knowledge* | Students can...<br>• Explain the structure and workings of standard external logistics systems.<br>• Outline the benefits of using simulation software subject to the starting situation.<br>• Present different simulation programs and kinds of simulation that are in widespread use and explain their characteristics. |
| *Skills* | Students are able to...<br>• Recognize, analyze, and assemble into a model the elementary building blocks of a logistics system.<br>• Map complex external logistics process using the *Plant Simulation*® simulation software.<br>• Draw inferences from the results of the simulation, transfer them to the reality, and deduce action recommendations from them. |
| **Personal Competence** | |
| *Social Competence* | Students are capable of...<br>• Solving complex tasks in a team and to document assignments accordingly.<br>• Playing different roles in the teamwork and giving each other appropriate feedback in the team.<br>• Presenting the relevant results of their project to specialists and representing them. |
| *Autonomy* | Students are able...<br>• To acquaint themselves independently with software with which they are not familiar and to use it to solve complex tasks.<br>• To define work steps independently and to acquire the knowledge required to do so. |
| **Workload in Hours** | Independent Study Time 124, Study Time in Lecture 56 |
| **Credit points** | 6 |
| **Course achievement** | **Compulsory** / **Bonus** / **Form** / **Description**<br>No / 20 % / Subject theoretical and practical work |
| **Examination** | Subject theoretical and practical work |
| **Examination duration and scale** | Simulation study and report with approximately 15 pages per person |
| **Assignment for the Following Curricula** | Data Science: Core Qualification: Elective Compulsory<br>Logistics and Mobility: Specialisation Information Technology: Elective Compulsory<br>Logistics and Mobility: Specialisation Traffic Planning and Systems: Elective Compulsory<br>Engineering and Management - Major in Logistics and Mobility: Specialisation Information Technology: Elective Compulsory<br>Engineering and Management - Major in Logistics and Mobility: Specialisation Traffic Planning and Systems: Elective Compulsory<br>Engineering and Management - Major in Logistics and Mobility: Specialisation Production Management and Processes: Elective Compulsory<br>Engineering and Management - Major in Logistics and Mobility: Specialisation Production Management and Processes: Elective Compulsory |

| Course L1352: Simulation of Transport and Handling Systems | |
|---|---|
| **Typ** | Lecture |
| **Hrs/wk** | 1 |
| **CP** | 2 |
| **Workload in Hours** | Independent Study Time 46, Study Time in Lecture 14 |
| **Lecturer** | Prof. Carlos Jahn |
| **Language** | DE |
| **Cycle** | WiSe |
| **Content** | The lecture deals with the simulation of external logistics systems. The focus is therefore on the consideration of logistical processes between companies or on transhipment systems, such as ports or individual terminals.<br><br>In the first part of the lecture, students will first acquire basic knowledge of external logistics systems and the advantages of using simulations to present them. Then an overview of existing simulation types and programs is given and examples for existing simulation models of logistic systems in science and practice are shown. Some simulation models will be demonstrated.<br><br>In the second part of the lecture the students learn the basic handling of the simulation software Plant Simulation®. They receive theoretical explanations of the general functionality of the simulation tool, which are further deepened through the use of extensive, interactive examples. At the same time, five exercises, which build on each other, offer students the opportunity to implement the course content they have learnt alone and in small groups. The exercises can be completed during the supervised lecture periods as well as at other times.<br><br>The acquired knowledge is to be applied in the third part in the course of group work. The students will be divided into groups, each of which will then work on a relevant problem from the field of (external) logistic systems by means of simulation. The students are given a defined period of time for their work. During this time at least one person is always available for questions and suggestions. The results of the group work are to be documented in a simulation report and handed in at the end of the processing time. Finally, the individual groups present the problems they have worked on and their results in a presentation. |
| **Literature** | Bangsow, Steffen (2011): Praxishandbuch Plant Simulation und SimTalk. Anwendung und Programmierung in über 150 Beispiel-Modellen. München: Hanser Verlag.<br><br>Eley, Michael (2012): Simulation in der Logistik. Einführung in die Erstellung ereignisdiskreter Modelle unter Verwendung des Werkzeuges "Plant Simulation". Berlin, Heidelberg: Springer.<br><br>Engelhardt-Nowitzki, Corinna; Nowitzki, Olaf; Krenn, Barbara (2008): Management komplexer Materialflüsse mittels Simulation. State-of-the-Art und innovative Konzepte. Wiesbaden: Deutscher Universitäts-Verlag / GWV Fachverlage GmbH, Wiesbaden.<br><br>Rabe, Markus; Spieckermann, Sven; Wenzel, Sigrid (2008): Verifikation und Validierung für die Simulation in Produktion und Logistik. Vorgehensmodelle und Techniken. Berlin, Heidelberg: Springer.<br><br>Sargent, Robert G. (2010): Verification and Validation of Simulation Models. In: B. Johansson, S. Jain, J. Montoya-Torres, J. Hugan, and E. Yücesan, eds.: Proceedings of the 2010 Winter Simulation Conference.<br><br>VDI-Richlinie: VDI 3633. Simulation von Logistik-, Materialfluß-und Produktionssystemen<br><br>Wenzel, Sigrid; Rabe, Markus; Spieckermann, Sven (2006): Verifikation und Validierung für die Simulation in Produktion und Logistik. Vorgehensmodelle und Techniken. 1. Aufl. Berlin: Springer Berlin. |

| Course L1818: Simulation of Transport and Handling Systems | |
|---|---|
| **Typ** | Recitation Section (small) |
| **Hrs/wk** | 3 |
| **CP** | 4 |
| **Workload in Hours** | Independent Study Time 78, Study Time in Lecture 42 |
| **Lecturer** | Prof. Carlos Jahn |
| **Language** | DE |
| **Cycle** | WiSe |
| **Content** | See interlocking course |
| **Literature** | See interlocking course |

## Module M0980: Logistics, Transport and Environment

**Courses**

| Title | Typ | Hrs/wk | CP |
|---|---|---|---|
| Logistics, Transport and Environment (L0009) | Project-/problem-based Learning | 2 | 4 |
| Environmental Management and Corporate Responsibilty (L1160) | Seminar | 2 | 2 |

| | |
|---|---|
| **Module Responsible** | Prof. Heike Flämig |
| **Admission Requirements** | None |
| **Recommended Previous Knowledge** | • Introduction to logistics and mobility<br>• Foundations of Management |
| **Educational Objectives** | After taking part successfully, students have reached the following learning results |
| **Professional Competence** | |
| *Knowledge* | Students are able to...<br>• explain basic terms of transport logistics, commercial traffic, transport policy and sustainability<br>• describe actors and system boundaries, challenges and goals of transport logistics<br>• reflect standards of sustainability management |
| *Skills* | Students are able to...<br>• design logistics systems independently<br>• differentiate sustainability, CR, CSR and environmental management<br>• critically evaluate measures for sustainable logistics and develop them |
| **Personal Competence** | |
| *Social Competence* | Students can...<br>• creatively develop solutions in teams and work out presentations<br>• present their knowledge and skills to other students |
| *Autonomy* | Students can...<br>• carry out small research studies independently<br>• apply theoretical knowledge in practical projects<br>• apply presentation techniques such as free speech, designing charts (i.e. in Power-Point), use of media (Flip-Charts, Whiteboard, Metaplan) |
| **Workload in Hours** | Independent Study Time 124, Study Time in Lecture 56 |
| **Credit points** | 6 |
| **Course achievement** | None |
| **Examination** | Written elaboration |
| **Examination duration and scale** | Written assignment with short presentation |
| **Assignment for the Following Curricula** | Logistics and Mobility: Specialisation Traffic Planning and Systems: Elective Compulsory<br>Logistics and Mobility: Specialisation Production Management and Processes: Elective Compulsory<br>Logistics and Mobility: Specialisation Information Technology: Elective Compulsory<br>Engineering and Management - Major in Logistics and Mobility: Specialisation Traffic Planning and Systems: Elective Compulsory<br>Engineering and Management - Major in Logistics and Mobility: Specialisation Production Management and Processes: Elective Compulsory<br>Engineering and Management - Major in Logistics and Mobility: Specialisation Information Technology: Elective Compulsory |

| Course L0009: Logistics, Transport and Environment | |
|---|---|
| **Typ** | Project-/problem-based Learning |
| **Hrs/wk** | 2 |
| **CP** | 4 |
| **Workload in Hours** | Independent Study Time 92, Study Time in Lecture 28 |
| **Lecturer** | Prof. Heike Flämig |
| **Language** | DE |
| **Cycle** | SoSe |
| **Content** | Application and creative development of professional knowledge within the framework of the case study "Environmental impacts of supply chains" using a specific company as example.<br><br>Depending on the chosen focus of the academic year:<br><br>• characteristics of different transport systems<br>• technologies, structures and processes of transport logistics systems (nodes, network, interactions)<br>• location and route planning<br>• connections of information flow and material flows in transport chains<br>• interrelation between private and private (contract logistics) and private and public (business policy, transport policy) and their (diverging)<br>• design approaches for sustainable logistics |
| **Literature** | Ihde, Gösta B.: Transport, Verkehr, Logistik. Gesamtwirtschaftliche Aspekte und einzelwirtschaftliche Handhabung. 3. überarbeitete Auflage. Vahlen, München 2001 |

| Course L1160: Environmental Management and Corporate Responsibilty | |
|---|---|
| **Typ** | Seminar |
| **Hrs/wk** | 2 |
| **CP** | 2 |
| **Workload in Hours** | Independent Study Time 32, Study Time in Lecture 28 |
| **Lecturer** | Prof. Heike Flämig |
| **Language** | DE |
| **Cycle** | SoSe |
| **Content** | • Imparting knowledge about standards (e.g. EMAS and ISO 14.001) as important methodological approaches for the integration of environmental and sustainability management in business companies<br>• Explaination of theoretical concepts of corporate sustainability management<br>• Imparting pracitical knowledge from different stakeholder views: consulting company, trading enterprise, NGO, financial market |
| **Literature** | -- |

## Module M0610: Electrical Machines and Actuators

**Courses**

| Title | Typ | Hrs/wk | CP |
|---|---|---|---|
| Electrical Machines and Actuators (L0293) | Lecture | 3 | 4 |
| Electrical Machines and Actuators (L0294) | Recitation Section (large) | 2 | 2 |

| | |
|---|---|
| **Module Responsible** | Prof. Thorsten Kern |
| **Admission Requirements** | None |
| **Recommended Previous Knowledge** | Basics of mathematics, in particular complexe numbers, integrals, differentials<br><br>Basics of electrical engineering and mechanical engineering |
| **Educational Objectives** | After taking part successfully, students have reached the following learning results |
| **Professional Competence** | |
| *Knowledge* | Students can to draw and explain the basic principles of electric and magnetic fields.<br><br>They can describe the function of the standard types of electric machines and present the corresponding equations and characteristic curves. For typically used drives they can explain the major parameters of the energy efficiency of the whole system from the power grid to the driven engine. |
| *Skills* | Students are able to calculate two-dimensional electric and magnetic fields in particular ferromagnetic circuits with air gap. For this they apply the usual methods of the design auf electric machines.<br><br>They can calulate the operational performance of electric machines from their given characteristic data and selected quantities and characteristic curves. They apply the usual equivalent circuits and graphical methods. |
| **Personal Competence** | |
| *Social Competence* | none |
| *Autonomy* | Students are able independently to calculate electric and magnatic fields for applications. They are able to analyse independently the operational performance of electric machines from the charactersitic data and theycan calculate thereof selected quantities and characteristic curves. |
| **Workload in Hours** | Independent Study Time 110, Study Time in Lecture 70 |
| **Credit points** | 6 |
| **Course achievement** | None |
| **Examination** | Subject theoretical and practical work |
| **Examination duration and scale** | Design of four machines and actuators, review of design files |
| **Assignment for the Following Curricula** | General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Energy Systems: Compulsory<br>General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Mechatronics: Compulsory<br>General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Theoretical Mechanical Engineering: Elective Compulsory<br>General Engineering Science (German program, 7 semester): Specialisation Electrical Engineering: Elective Compulsory<br>Digital Mechanical Engineering: Core Qualification: Compulsory<br>Electrical Engineering: Core Qualification: Elective Compulsory<br>Engineering Science: Specialisation Electrical Engineering: Elective Compulsory<br>Green Technologies: Energy, Water, Climate: Specialisation Energy Technology: Elective Compulsory<br>Green Technologies: Energy, Water, Climate: Specialisation Maritime Technologies: Elective Compulsory<br>Computer Science in Engineering: Specialisation II. Mathematics & Engineering Science: Elective Compulsory<br>Logistics and Mobility: Specialisation Traffic Planning and Systems: Elective Compulsory<br>Logistics and Mobility: Specialisation Production Management and Processes: Elective Compulsory<br>Mechanical Engineering: Core Qualification: Elective Compulsory<br>Mechatronics: Specialisation Naval Engineering: Compulsory<br>Mechatronics: Core Qualification: Compulsory<br>Mechatronics: Specialisation Robot- and Machine-Systems: Compulsory<br>Mechatronics: Specialisation Electrical Systems: Elective Compulsory<br>Technomathematics: Specialisation III. Engineering Science: Elective Compulsory<br>Engineering and Management - Major in Logistics and Mobility: Specialisation Traffic Planning and Systems: Elective Compulsory<br>Engineering and Management - Major in Logistics and Mobility: Specialisation Information Technology: Elective Compulsory<br>Engineering and Management - Major in Logistics and Mobility: Specialisation Production Management and Processes: Elective Compulsory<br>Engineering and Management - Major in Logistics and Mobility: Specialisation Production Management and Processes: Elective Compulsory |

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

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

## Module M1290: Simulation of intra logistics

**Courses**

| Title | Typ | Hrs/wk | CP |
|---|---|---|---|
| Simulation of intra logistics (L1755) | Seminar | 4 | 6 |

| | |
|---|---|
| **Module Responsible** | NN |
| **Admission Requirements** | None |
| **Recommended Previous Knowledge** | Successful completion of the module „Technical Logistics“ |
| **Educational Objectives** | After taking part successfully, students have reached the following learning results |
| **Professional Competence** | |
| *Knowledge* | The students will acquire the following knowledge:<br>1. The students are able to explain the significance, the structure and the components of an event- and object-oriented simulation model in intralogistics.<br>2. The students are able to reflect and explain the process of creating and programming an event- and object-oriented simulation model in intralogistics.<br>3. The students are able to view critically the strengths and weaknesses of event- and object-oriented simulation model. |
| *Skills* | The students will acquire the following skills:<br>1. The students will be able to derive the necessary parameters for the development of an event- and object-oriented simulation model in intralogistics from an existing logistics system.<br>2. The students will be able to program and run Plant Simulation simulation models independently.<br>3. The students can evaluate and interpret the results from a simulation model. |
| **Personal Competence** | |
| *Social Competence* | The students will acquire the following social skills:<br>1. The students are able to develop a complex simulation model in a team.<br>2. The students know the different roles in joint development of a simulation model and can give feedback to their respective roles.<br>3. The students are able to process the simulation results and present them in front of a audience. |
| *Autonomy* | The students will acquire the following independent competencies:<br>1. The students work independently in an initially unknown software (Plant Simulation).<br>2. The students are able to derive independently the necessary simulation parameters from information about a logistics system.<br>3. The students are able to develop and program an event- and object-oriented simulation models from given parameters. |
| **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** | Logistics and Mobility: Specialisation Production Management and Processes: Elective Compulsory<br>Logistics and Mobility: Specialisation Information Technology: Elective Compulsory<br>Engineering and Management - Major in Logistics and Mobility: Specialisation Production Management and Processes: Elective Compulsory<br>Engineering and Management - Major in Logistics and Mobility: Specialisation Information Technology: Elective Compulsory |

| Course L1755: Simulation of intra logistics | |
|---|---|
| **Typ** | Seminar |
| **Hrs/wk** | 4 |
| **CP** | 6 |
| **Workload in Hours** | Independent Study Time 124, Study Time in Lecture 56 |
| **Lecturer** | Dr. Johannes Hinckeldeyn |
| **Language** | DE |
| **Cycle** | SoSe |
| **Content** | The seminar provides an introduction to the development and programming of event and object-oriented simulation models based on the Plant Simulation software. The simulation models are focused on issues and problems in the field of intralogistics.<br>The seminar will be conducted as a combination of theoretical content and autonomously solving simulation tasks on the computer.<br><br>The students learn the ideal development workflow, programming and evaluation of a simulation model.<br><br>Furthermore, the student will become familiar with the standard objects of a simulation model in Plant Simulation and their properties and functions. These standard objects will be used, if necessary with the assistance of the instructor, to build simulation models and analyze and evaluate the results.<br><br>Furthermore, an introduction to the individual programming of simulation models is given on the basis of Sim Talk language. |
| **Literature** | Bangsow, Steffen (2011): Praxishandbuch Plant Simulation und SimTalk, Hanser Verlag, München.<br>Bangsow, Steffen (2015): Tecnomatix plant simulation : modeling and programming by means of examples, Springer, Berlin.<br><br>Eley, Michael (2012): Simulation in der Logistik : Einführung in die Erstellung ereignisdiskreter Modelle unter Verwendung des Werkzeuges "Plant Simulation", Springer, Berlin. |

## 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. Jan Hendrik Dege |
| **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 Theoretical Mechanical Engineering: Elective Compulsory<br>General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Product Development and Production: Compulsory<br>Digital Mechanical Engineering: Core Qualification: Compulsory<br>Engineering Science: Specialisation Mechanical Engineering: Compulsory<br>Engineering Science: Specialisation Mechanical Engineering: Compulsory<br>General Engineering Science (English program, 7 semester): Specialisation Mechanical Engineering: Compulsory<br>Green Technologies: Energy, Water, Climate: Specialisation Energy Technology: Elective Compulsory<br>Logistics and Mobility: Specialisation Production Management and Processes: Compulsory<br>Mechanical Engineering: Core Qualification: Compulsory<br>Mechatronics: Specialisation Naval Engineering: Compulsory<br>Mechatronics: Core Qualification: Compulsory<br>Mechatronics: Specialisation Medical Engineering: Elective Compulsory<br>Mechatronics: Specialisation Robot- and Machine-Systems: Elective Compulsory<br>Engineering and Management - Major in Logistics and Mobility: Specialisation Production Management and Processes: 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. Jan Hendrik Dege |
| **Language** | DE |
| **Cycle** | SoSe |
| **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. Jan Hendrik Dege |
| **Language** | DE |
| **Cycle** | SoSe |
| **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. Jan Hendrik Dege, 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><br>Klocke, F., König, W.: Fertigungsverfahren Bd. 3 Abtragen, Generieren und Lasermaterialbearbeitung. 4. Aufl., Springer (2007)<br><br>Spur, Günter (Stöferle, Theodor.;): Urformen. München [u.a.] : Hanser, 1981<br><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. Jan Hendrik Dege, Prof. Claus Emmelmann |
| **Language** | DE |
| **Cycle** | SoSe |
| **Content** | See interlocking course |
| **Literature** | See interlocking course |

## Module M1014: Logistics Service Provider Management

**Courses**

| Title | Typ | Hrs/wk | CP |
|---|---|---|---|
| Logistics Service Provider Management (L1240) | Seminar | 3 | 6 |

| | |
|---|---|
| **Module Responsible** | Prof. Heike Flämig |
| **Admission Requirements** | None |
| **Recommended Previous Knowledge** | • Introduction to Logistics and Mobility<br>• Transport and cross-docking Technology<br>• Logistics Management |
| **Educational Objectives** | After taking part successfully, students have reached the following learning results |
| **Professional Competence** | |
| *Knowledge* | Students are able to...<br>• integrate LSPs into the concept of business logistics<br>• tell the specifics of business services and logistics Services and their derived characteristics<br>• describe logistics functions as LSP service packages<br>• explain, why companies outsource logistics Services and what are actual trends in Business<br>• describe basic outsorucing processes and tender management success factors<br>• describe and analyze intra- and intermodal transport institutions as well as tasks, challenges and opportunities for the Management of LSPs |
| *Skills* | Students can...<br>• support the sub-segment specific business functions and management Tasks (e.g. for Road Transport, Airlines, SeaPort Providers etc.)<br>• categorize LSPs regarding strategic product-market-positioning<br>• derive action plans regarding management tasks depending on contigencies |
| **Personal Competence** | |
| *Social Competence* | Students can...<br>• discuss case studies in Groups (within and outside of the classroom), reaching a common understanding and result<br>• prepare and deliver Business presentations<br>• give and discuss Feedbacks in the large group |
| *Autonomy* | Students can...<br>• produce written reports independently |
| **Workload in Hours** | Independent Study Time 138, Study Time in Lecture 42 |
| **Credit points** | 6 |
| **Course achievement** | None |
| **Examination** | Written elaboration |
| **Examination duration and scale** | 2 scientific written papers of approx. 20 pages each. Presentation (approx. 15 pages) with 20-minute closing lecture in groups of 3 to max. 5 persons. Grading of 4 partial grades of 25% each (2 seminar papers, 2 presentation documents) individually per group member. |
| **Assignment for the Following Curricula** | Logistics and Mobility: Specialisation Traffic Planning and Systems: Elective Compulsory<br>Logistics and Mobility: Specialisation Production Management and Processes: Elective Compulsory<br>Engineering and Management - Major in Logistics and Mobility: Specialisation Traffic Planning and Systems: Elective Compulsory<br>Engineering and Management - Major in Logistics and Mobility: Specialisation Information Technology: Elective Compulsory<br>Engineering and Management - Major in Logistics and Mobility: Specialisation Production Management and Processes: Elective Compulsory<br>Engineering and Management - Major in Logistics and Mobility: Specialisation Production Management and Processes: Elective Compulsory |

| Course L1240: Logistics Service Provider Management | |
|---|---|
| **Typ** | Seminar |
| **Hrs/wk** | 3 |
| **CP** | 6 |
| **Workload in Hours** | Independent Study Time 138, Study Time in Lecture 42 |
| **Lecturer** | Prof. Stephan Freichel |
| **Language** | DE |
| **Cycle** | SoSe |
| **Content** | **1 Concept and Functions**<br><br>Define the role of logistics services providers in the overall concept and functions of logistics services providers. Workshop on the role of logistics services providers in the economy, based on up-to-date topics in the field and in the news.<br><br>**2 Outsourcing and Cooperation**<br><br>Make or buy, forms and management of inter-organizational relations<br><br>**3 Institutions**<br><br>Special business management features of carriers, haulage contractors, CEP services<br><br>**4 Trends, Strategies and Management Functions**<br><br>Market trends, requirements, basic business management and management functions (operations, business development, HR, IT, finance/planning and control, organization, leadership)<br><br>**5 Strategic Developments and Case Studies**<br><br>Selected aspects (e.g. risk and innovation management, global and regional networking, greenwashing and sustainability)<br><br>Examples:<br><br>Case Study A) Types of company (such as haulage contractors, railway operators, road transport companies, heavy goods, textile and refrigerated goods specialists, CEPs, etc) will be introduced and discussed in the context of a presentation.<br><br>Case Study B) Individual companies will be analyzed on the basis of accessible material such as company reports, websites and possibly telephone interviews and case studies will be explained and discussed with regard to the functions of the logistics services provider and the management task of the corporate managements of the selected cases. |
| **Literature** | Pfohl, H.-Chr.: Logistiksysteme. Betriebswirtschaftliche Grundlagen.<br>8., neu bearbeite und aktualisierte Auflage, Berlin u.a. 2009<br><br>Eßig, M. / Hofmann, E. / Stölzle, W.: Supply Chain Management. München 2013.<br><br>Freichel, S.L.K.: Organisation von Logistikservice-Netzwerken. Reihe: Logistik und Unternehmensführung, hrsg. von Prof. Dr. H.-Chr. Pfohl, Bd. 4. Berlin 1993.<br><br>Aberle, G.: Transportwirtschaft. Einzelwirtschaftliche und gesamtwirtschaftliche Grundlagen, 4. überarbeitete und erweiterte Auflage, München/Wien 2006.<br><br>Buchholz, J./Clausen, U./Vastag, A. (Hrsg): Handbuch der Verkehrslogistik, Heidelberg 1998.<br><br>Corsten, H.: Dienstleistungsmanagement, 3. Auflage, München 1997.<br><br>Müller-Daupert, B. (Hrsg.): Logistik-Outsourcing, 2. Auflage, München, Vogel, 2009<br><br>Ihde, G. B.: Transport, Verkehr, Logistik. Gesamtwirtschaftliche Aspekte und einzelwirtschaftliche Handhabung, 3. völlig überarb. und erw. Auflage, München 2001.<br><br>van Suntum, U.: Verkehrspolitik, München 1986. |

## Specialization Traffic Planning and Systems

### Module M0986: Introduction to Transportation Economics

**Courses**

| Title | Typ | Hrs/wk | CP |
|---|---|---|---|
| Introduction to Transportation Economics (L1188) | Lecture | 3 | 6 |

| | |
|---|---|
| **Module Responsible** | Prof. Heike Flämig |
| **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...<br>• explain basic connections between transport, traffic and logistics<br>• explain the macroeconomic relevance of logistics<br>• state the relevance of different modes of transport for the economy<br>• describe the development and challenges of transport policy<br>• explain trends and developments in transport industry |
| *Skills* | Based on their gained knowledge students can develop ideas for political decisions and design questions in the transport industry. |
| **Personal Competence** | |
| *Social Competence* | Students can discuss small tasks in groups and find solutions together. |
| *Autonomy* | Students are able to solve small tasks on their own with given literature. |
| **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** | 60 minutes |
| **Assignment for the Following Curricula** | Logistics and Mobility: Specialisation Traffic Planning and Systems: Compulsory<br>Engineering and Management - Major in Logistics and Mobility: Specialisation Traffic Planning and Systems: Compulsory |

#### Course L1188: Introduction to Transportation Economics

| | |
|---|---|
| **Typ** | Lecture |
| **Hrs/wk** | 3 |
| **CP** | 6 |
| **Workload in Hours** | Independent Study Time 138, Study Time in Lecture 42 |
| **Lecturer** | Karl Michael Probst |
| **Language** | DE |
| **Cycle** | SoSe |
| **Content** | • Functions of transport<br>• Macroeconomic developments of transport<br>• Special characteristics of transport<br>• Transport infrastructure policy<br>• International transport policy<br>• Transport policy in the EU<br>• External costs of transport<br>• Market entry into transport markets |
| **Literature** | -- |

## Module M0983: Mobility Concepts

**Courses**

| Title | Typ | Hrs/wk | CP |
|---|---|---|---|
| Mobility Research and Transportation Projects (L1181) | Project-/problem-based Learning | 3 | 3 |
| Mobility in Megacities and Developing Countries (L1182) | Seminar | 3 | 3 |

| | |
|---|---|
| **Module Responsible** | Dr. Philine Gaffron |
| **Admission Requirements** | None |
| **Recommended Previous Knowledge** | Module Transportation Planning and Traffic Engineering |
| **Educational Objectives** | After taking part successfully, students have reached the following learning results |
| **Professional Competence** | |
| *Knowledge* | Students are able to:<br>• name the different urban transport systems existing around the world.<br>• explain the transport challenges in Asian and African mega cities.<br>• recognise and relate interactions between transport systems on the one hand and ecological, socio-cultural and economic problem areas on the other.<br>• outline specific issues and problems in urban development and transport (in Germany and developing countries).<br>• explain the effects of external framework factors (like energy costs) on transport. |
| *Skills* | Students are able to:<br>• analyse and evaluate given case studies.<br>• transfer learning results to other regions and cities.<br>• analyse specific issues and problems in urban development and transport (in developing countries).<br>• critically assess actors, planning objectives, planned measures and the implementation of transport projects in the light of the UN Millennium Development Goals<br>• develop and present sustainable (i.e. ecological, poverty oriented, gender balanced and economical) solutions for urban personal and goods transport |
| **Personal Competence** | |
| *Social Competence* | Students are able to:<br>• present and explain independently generated findings.<br>• constructively discuss potentially controversial topics in a group context. |
| *Autonomy* | Students are able to:<br>• carry out independent literature research and analysis.<br>• independently author a written report on a given topic. |
| **Workload in Hours** | Independent Study Time 96, Study Time in Lecture 84 |
| **Credit points** | 6 |
| **Course achievement** | Compulsory: Yes; Bonus: None; Form: Participation in excursions; Description: |
| **Examination** | Written elaboration |
| **Examination duration and scale** | All assignments in groups (2-4 students): written report, 2000 words (incl. 2 short presentations of 10 mins.); final presentation, 20 mins. plus discussion (incl. slides) and 1000 word report incl. peer review (individual). |
| **Assignment for the Following Curricula** | Civil- and Environmental Engineering: Specialisation Traffic and Mobility: Compulsory<br>Civil- and Environmental Engineering: Specialisation Civil Engineering: Elective Compulsory<br>Civil- and Environmental Engineering: Specialisation Water and Environment: Elective Compulsory<br>Logistics and Mobility: Specialisation Traffic Planning and Systems: Compulsory<br>Engineering and Management - Major in Logistics and Mobility: Specialisation Traffic Planning and Systems: Compulsory |

| Course L1181: Mobility Research and Transportation Projects | |
|---|---|
| **Typ** | Project-/problem-based Learning |
| **Hrs/wk** | 3 |
| **CP** | 3 |
| **Workload in Hours** | Independent Study Time 48, Study Time in Lecture 42 |
| **Lecturer** | Dr. Philine Gaffron |
| **Language** | DE |
| **Cycle** | SoSe |
| **Content** | This course places its focus on transport and mobility in Germany. It deals with questions such as:<br>• Which external factors - like e.g. energy costs, availability of renewable and fossil fuels, environmental and climate protection objectives - influence current developments in the transport sector?<br>• Which external effects in turn are caused by mobility choices and traffic?<br>• How should these interactions be evaluated, how and by whom can they be influenced?<br>• Which measures at the municipal level can contribute to a more sustainable transport system?<br>During the course, these questions will be illustrated and discussed with reference to different examples and current developments. Participants will also provide input on specific topics. Potential core subjects of the course could be:<br>• Environmental Justice : which population groups are disproportionately affected by transport emissions and who causes them?<br>• Municipal cycle planning<br>• Transport and Climate Protection: can, want, act - everything could be, nothing must be? |
| **Literature** | Die Literaturempfehlungen sind abhängig von den jeweiligen, wechselnden Themenschwerpunkten und werden rechtzeitig vor Beginn der Veranstaltung bekannt gegeben. |

| Course L1182: Mobility in Megacities and Developing Countries | |
|---|---|
| **Typ** | Seminar |
| **Hrs/wk** | 3 |
| **CP** | 3 |
| **Workload in Hours** | Independent Study Time 48, Study Time in Lecture 42 |
| **Lecturer** | Dr. Jürgen Perschon, Christof Hertel |
| **Language** | DE |
| **Cycle** | SoSe |
| **Content** | The course provides and overview over different transport projects in the metropolitan areas of developing countries. Considering different perspectives on urban growth, social justice, economic development, environmental and climate protection as well as the economic viability of public transport, the specific situation in the urban conglomerates of Asia, Latin America and Africa will be analysed and placed in a regional and global context. Specific public transport systems will be examined to establish, whether they are a suitable example for sustainable urban development.<br>The following examples could be suitable case studies: Singapore (Metro), Lagos (BRT Light), Guanghzou, Bogota, Jakarta (Full BRT), Sao Paulo, Medellin (Cable Car Systems), Johannesburg (Minibus-Taxi).<br>The course will be designed interactively with the students and will partly be in English as is the majority of the literature in this area (also: Skype online interviews with international experts in the transport sector). |
| **Literature** | -- |

## Module M1890: Strategic Management of Technological Innovation

**Courses**

| Title | Typ | Hrs/wk | CP |
|---|---|---|---|
| Strategic Management of Technological Innovation (L3127) | Lecture | 3 | 3 |
| Strategic Management of Technological Innovation (L3128) | Project-/problem-based Learning | 2 | 3 |

| | |
|---|---|
| **Module Responsible** | Prof. Tim Schweisfurth |
| **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 110, Study Time in Lecture 70 |
| **Credit points** | 6 |
| **Course achievement** | **Compulsory** **Bonus** **Form** **Description**<br>Yes 20 % Subject theoretical andsemesterbegleitende Mini-Tests, Gruppenarbeiten<br>practical work |
| **Examination** | Written exam |
| **Examination duration and scale** | 60 minutes |
| **Assignment for the Following Curricula** | Engineering and Management - Major in Logistics and Mobility: Specialisation Information Technology: Elective Compulsory<br>Engineering and Management - Major in Logistics and Mobility: Specialisation Production Management and Processes: Elective Compulsory<br>Engineering and Management - Major in Logistics and Mobility: Specialisation Traffic Planning and Systems: Elective Compulsory |

### Course L3127: Strategic Management of Technological Innovation

| | |
|---|---|
| **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** | WiSe |
| **Content** | |
| **Literature** | |

### Course L3128: Strategic Management of Technological Innovation

| | |
|---|---|
| **Typ** | Project-/problem-based Learning |
| **Hrs/wk** | 2 |
| **CP** | 3 |
| **Workload in Hours** | Independent Study Time 62, Study Time in Lecture 28 |
| **Lecturer** | Prof. Tim Schweisfurth |
| **Language** | EN |
| **Cycle** | WiSe |
| **Content** | |
| **Literature** | |

## Module M1013: Traffic systems and handling technology

**Courses**

| Title | Typ | Hrs/wk | CP |
|---|---|---|---|
| Traffic systems and handling technology (L0715) | Lecture | 2 | 3 |
| Traffic systems and handling technology (L0718) | Recitation Section (small) | 2 | 3 |

| | |
|---|---|
| **Module Responsible** | Prof. Carlos Jahn |
| **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:<br>- explain and classify the terms and their meaning in transport and handling technology<br>- reflect current political conditions and technical developments in transport and handling technology;<br>- identify actors and their tasks in the maritime transport chain (pre-carriage, carriage, on-carriage);<br>- determine, compare and assign suitable applications and areas of use of transport and handling techniques based on the questions: What will be transported? On what should it be transported? Where is the cargo to be handled? By which means? |
| *Skills* | Students can, on the basis of the knowledge they have acquired:<br>- identify and evaluate key performance indicators (e.g. transport times, storage costs, etc.) in the maritime transport chain;<br>- select and dimension suitable techniques for defined transport and handling tasks and critically evaluate approaches to solutions;<br>- differentiate and evaluate transport and handling technologies (e.g. by calculating carbon footprints, transport times and costs for different modes of transport as well as point-to-point or hub-and-spoke freight transport in aviation). |
| **Personal Competence** | |
| *Social Competence* | Students are able to:<br>- successfully and respectfully discuss and organise research tasks in small groups in the context of a comprehensive written elaboration during the semester and to present and represent them in a comprehensible way;<br>- describe, differentiate and evaluate problems (e.g. in the joint compilation of factual knowledge on topics such as slow steaming in container shipping or the establishment of different maritime supply chains);<br>- participate in technical discussions on topics from the transport and handling technology. |
| *Autonomy* | After completion of the module students capable to:<br>- acquire knowledge of parts of the subject area independently and apply the acquired knowledge to solve new problems;<br>- conduct a systematic literature search and record this in a scientific text;<br>- critically reflect on the results of their own work. |
| **Workload in Hours** | Independent Study Time 124, Study Time in Lecture 56 |
| **Credit points** | 6 |
| **Course achievement** | Compulsory: No; Bonus: 10 %; Form: Written elaboration; Description: |
| **Examination** | Written exam |
| **Examination duration and scale** | 90 minutes |
| **Assignment for the Following Curricula** | Logistics and Mobility: Specialisation Traffic Planning and Systems: Compulsory<br>Logistics and Mobility: Specialisation Production Management and Processes: Elective Compulsory<br>Engineering and Management - Major in Logistics and Mobility: Specialisation Traffic Planning and Systems: Compulsory<br>Engineering and Management - Major in Logistics and Mobility: Specialisation Production Management and Processes: Elective Compulsory |

| Course L0715: Traffic systems and handling technology | |
|---|---|
| **Typ** | Lecture |
| **Hrs/wk** | 2 |
| **CP** | 3 |
| **Workload in Hours** | Independent Study Time 62, Study Time in Lecture 28 |
| **Lecturer** | Prof. Carlos Jahn |
| **Language** | DE |
| **Cycle** | WiSe |
| **Content** | In the course Transport Systems and Handling Technology the elementary basics, characteristics, possible applications and areas of expediency of transport and handling technology are taught. The students should be enabled to select, conceptualize and evaluate suitable techniques for defined transport and handling tasks. In addition to the goods to be transported and the loading units, the various means of transport, handling concepts and the necessary equipment play a special role. A basic knowledge of the relevant guidelines and standards is also built up. In addition to the transport systems road, rail, water (inland waterways and maritime shipping) and air transport, combined transport is also addressed.<br><br>Contents of the lecture<br><br>• Basics, possible applications, usefulnes of different transport and handling techniques<br>• Overview of transported goods, loading units, means of transport, handling terminals and equipment<br>• Representation of the modes of transport: road, rail, water (inland waterway, ocean-going vessel), air, combined transport |
| **Literature** | Clausen, Uwe; Geiger, Christiane (2013). Verkehrs- und Transportlogistik.<br><br>Conrady, Roland; Fichert, Frank; Sterzenbach, Rüdiger (2019). Luftverkehr: Betriebswirtschaftliches Lehr- und Handbuch.<br><br>Gleißner, Harald; Femerling, Christian (2012). Logistik: Grundlagen - Übungen - Fallbeispiele.<br><br>Kranke, Andre; Schmied, Martin; Schön, Andrea D. (2011). CO2-Berechnung in der Logistik: Datenquellen, Formeln, Standards.<br><br>Pachl, Jörn (2018). Systemtechnik des Schienenverkehrs: Bahnbetrieb planen, steuern und sichern.<br><br>Rodrigue, Jean-Paul (2020). Geography of Transport Systems. |

| Course L0718: Traffic systems and handling technology | |
|---|---|
| **Typ** | Recitation Section (small) |
| **Hrs/wk** | 2 |
| **CP** | 3 |
| **Workload in Hours** | Independent Study Time 62, Study Time in Lecture 28 |
| **Lecturer** | Prof. Carlos Jahn |
| **Language** | DE |
| **Cycle** | WiSe |
| **Content** | The exercise of the course Traffic Systems and Handling Technology is carried out as a guided group exercise. In the exercise sessions, students receive assignment sheets on the sub-topics of the course and work on these independently. The exercise sheets mainly consist of computational tasks as well as comprehension questions. The lecturers are available to the students during the exercise to discuss calculation methods and results. There is the possibility for students to earn 10-15% bonus points on their passed exam in the course of voluntary additional work, depending on the extent. For example, by working on the worksheets in small groups and handing them in. The classroom training can be supplemented by digital exercises. |
| **Literature** | Biebig , Peter; Althof, Wolfgang.; Wagener, Norbert (2008) Seeverkehrswirtschaft : Kompendium. 4. Auflage.<br><br>Geisler, Alexander; Johns, Dirk Max (2018): See Schiff Ladung: Fachbuch für Schifffahrtskaufleute: von Praktikern für Praktiker, 2. Auflage.<br><br>Bänsch, Axel; Alewell, Dorothea; Moll, Tobias (2020): Wissenschaftliches Arbeiten, 12. Auflage.<br><br>Voss, Rüdiger (2019): Wissenschaftliches Arbeiten: … leicht verständlich. 6. Auflage. |

## Module M0608: Basics of Electrical Engineering

**Courses**

| Title | Typ | Hrs/wk | CP |
|---|---|---|---|
| Basics of Electrical Engineering (L0290) | Lecture | 3 | 4 |
| Basics of Electrical Engineering (L0292) | Recitation Section (small) | 2 | 2 |

| | |
|---|---|
| **Module Responsible** | Prof. Thorsten Kern |
| **Admission Requirements** | None |
| **Recommended Previous Knowledge** | Basics of mathematics |
| **Educational Objectives** | After taking part successfully, students have reached the following learning results |
| **Professional Competence** | |
| *Knowledge* | Students can to draw and explain circuit diagrams for electric and electronic circuits with a small number of components. They can describe the basic function of electric and electronic componentes and can present the corresponding equations. They can demonstrate the use of the standard methods for calculations. |
| *Skills* | Students are able to analyse electric and electronic circuits with few components and to calculate selected quantities in the circuits. They apply the ususal methods of the electrical engineering for this. |
| **Personal Competence** | |
| *Social Competence* | Students are enabled to collaborate in interdisciplinary teams with electrical engineering as a common language<br>With this, they are learning communication in a target-oriented communication style, are able to understand interfaces to neighboring engineering disciplines and learn about commonalities but also limits in the different directions of engineering. |
| *Autonomy* | Students are able independently to analyse electric and electronic circuits and to calculate selected quantities in the circuits. |
| **Workload in Hours** | Independent Study Time 110, Study Time in Lecture 70 |
| **Credit points** | 6 |
| **Course achievement** | **Compulsory** / **Bonus** / **Form** / **Description**<br>No / 20 % / Subject theoretical and practical work / Während des Semesters werden Hausarbeiten in Form von elektrischen Aufgaben vergeben, für die durch Simulation eine Lösung entwickelt und nachgewiesen werden muss. |
| **Examination** | Subject theoretical and practical work |
| **Examination duration and scale** | 135 minutes |
| **Assignment for the Following Curricula** | Bioprocess Engineering: Core Qualification: Compulsory<br>Digital Mechanical Engineering: Core Qualification: Compulsory<br>Green Technologies: Energy, Water, Climate: Core Qualification: Compulsory<br>Logistics and Mobility: Specialisation Production Management and Processes: Elective Compulsory<br>Logistics and Mobility: Specialisation Traffic Planning and Systems: Elective Compulsory<br>Mechanical Engineering: Core Qualification: Compulsory<br>Orientation Studies: Core Qualification: Elective Compulsory<br>Naval Architecture: Core Qualification: Compulsory<br>Process Engineering: Core Qualification: Compulsory<br>Engineering and Management - Major in Logistics and Mobility: Specialisation Production Management and Processes: Elective Compulsory<br>Engineering and Management - Major in Logistics and Mobility: Specialisation Traffic Planning and Systems: Elective Compulsory |

### Course L0290: Basics of Electrical Engineering

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

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

## Module M0740: Structural Analysis I

**Courses**

| Title | Typ | Hrs/wk | CP |
|---|---|---|---|
| Structural Analysis I (L0666) | Lecture | 2 | 3 |
| Structural Analysis I (L0667) | Recitation Section (large) | 2 | 2 |
| Structural Analysis I (L3133) | Recitation Section (small) | 1 | 1 |

| | |
|---|---|
| **Module Responsible** | Prof. Bastian Oesterle |
| **Admission Requirements** | None |
| **Recommended Previous Knowledge** | Mechanics I, Mathematics I |
| **Educational Objectives** | After taking part successfully, students have reached the following learning results |
| **Professional Competence** | |
| *Knowledge* | After successfully completing this module, students can express the basic aspects of linear frame analysis of statically determinate and indeterminate systems. |
| *Skills* | After successful completion of this module, the students are able to distinguish between statically determinate and indeterminate structures. They are able to analyze state variables and to construct influence lines of statically determinate plane and spatial frame and truss structures. |
| **Personal Competence** | |
| *Social Competence* | Students can<br>• participate in subject-specific and interdisciplinary discussions,<br>• defend their own work results in front of others<br>• promote the scientific development of colleagues<br>• Furthermore, they can give and accept professional constructive criticism |
| *Autonomy* | The students are able work in-term homework assignments. Due to the in-term feedback, they are enabled to self-assess their learning progress during the lecture period, already. |
| **Workload in Hours** | Independent Study Time 110, Study Time in Lecture 70 |
| **Credit points** | 6 |
| **Course achievement** | Compulsory: No; Bonus: 10 %; Form: Written elaboration; Description: Hausübungen mit Testat, betreut durch Studentische Tutoren (Tutorium) |
| **Examination** | Written exam |
| **Examination duration and scale** | 90 minutes |
| **Assignment for the Following Curricula** | General Engineering Science (German program, 7 semester): Specialisation Civil Engineering: Compulsory<br>Civil- and Environmental Engineering: Core Qualification: Compulsory<br>Logistics and Mobility: Specialisation Traffic Planning and Systems: Elective Compulsory<br>Technomathematics: Specialisation III. Engineering Science: Elective Compulsory<br>Engineering and Management - Major in Logistics and Mobility: Specialisation Traffic Planning and Systems: Elective Compulsory |

### Course L0666: Structural Analysis I

| | |
|---|---|
| **Typ** | Lecture |
| **Hrs/wk** | 2 |
| **CP** | 3 |
| **Workload in Hours** | Independent Study Time 62, Study Time in Lecture 28 |
| **Lecturer** | Prof. Bastian Oesterle |
| **Language** | DE |
| **Cycle** | WiSe |
| **Content** | • modeling of structures<br>• theory of plane and spacial structures<br>• assessment of structural behaviour, degree of static indeterminacy and kinematics<br>• analysis of forces and moments, as well as diplscements and rotations<br>• principle of virtual work<br>• influence lines<br>• Force Method for statically indeterminate structures |
| **Literature** | • Vorlesungsmanuskript<br>• Bletzinger et al.: Aufgabensammlung zur Baustatik: Übungsaufgaben zur Berechnung ebener Stabtragwerke. Hanser.<br>• Dinkler: Grundlagen der Baustatik. Springer.<br>• Marti: Baustatik. Ernst und Sohn. |

| Course L0667: Structural Analysis I | |
|---|---|
| **Typ** | Recitation Section (large) |
| **Hrs/wk** | 2 |
| **CP** | 2 |
| **Workload in Hours** | Independent Study Time 32, Study Time in Lecture 28 |
| **Lecturer** | Prof. Bastian Oesterle |
| **Language** | DE |
| **Cycle** | WiSe |
| **Content** | See interlocking course |
| **Literature** | See interlocking course |

| Course L3133: Structural Analysis I | |
|---|---|
| **Typ** | Recitation Section (small) |
| **Hrs/wk** | 1 |
| **CP** | 1 |
| **Workload in Hours** | Independent Study Time 16, Study Time in Lecture 14 |
| **Lecturer** | Prof. Bastian Oesterle |
| **Language** | DE |
| **Cycle** | WiSe |
| **Content** | See interlocking course |
| **Literature** | See interlocking course |

## Module M0853: Mathematics III

**Courses**

| Title | Typ | Hrs/wk | CP |
|---|---|---|---|
| Analysis III (L1028) | Lecture | 2 | 2 |
| Analysis III (L1029) | Recitation Section (small) | 1 | 1 |
| Analysis III (L1030) | Recitation Section (large) | 1 | 1 |
| Differential Equations 1 (Ordinary Differential Equations) (L1031) | Lecture | 2 | 2 |
| Differential Equations 1 (Ordinary Differential Equations) (L1032) | Recitation Section (small) | 1 | 1 |
| Differential Equations 1 (Ordinary Differential Equations) (L1033) | Recitation Section (large) | 1 | 1 |

| | |
|---|---|
| **Module Responsible** | Prof. Marko Lindner |
| **Admission Requirements** | None |
| **Recommended Previous Knowledge** | Mathematics I + II |
| **Educational Objectives** | After taking part successfully, students have reached the following learning results |
| **Professional Competence** | |
| *Knowledge* | • Students can name the basic concepts in the area of analysis and differential equations. 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 the area of analysis and differential equations with the help of the concepts studied in this course. Moreover, they are capable of solving them by applying established methods.<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 128, Study Time in Lecture 112 |
| **Credit points** | 8 |
| **Course achievement** | None |
| **Examination** | Written exam |
| **Examination duration and scale** | 60 min (Analysis III) + 60 min (Differential Equations 1) |
| **Assignment for the Following Curricula** | General Engineering Science (German program, 7 semester): Core Qualification: Compulsory<br>Civil- and Environmental Engineering: Core Qualification: Compulsory<br>Bioprocess Engineering: Core Qualification: Compulsory<br>Chemical and Bioprocess Engineering: Core Qualification: Compulsory<br>Digital Mechanical Engineering: Core Qualification: Compulsory<br>Electrical Engineering: Core Qualification: Compulsory<br>Green Technologies: Energy, Water, Climate: Core Qualification: Compulsory<br>Computer Science in Engineering: Core Qualification: Compulsory<br>Integrated Building Technology: Core Qualification: Compulsory<br>Logistics and Mobility: Specialisation Traffic Planning and Systems: Elective Compulsory<br>Logistics and Mobility: Specialisation Production Management and Processes: Elective Compulsory<br>Logistics and Mobility: Specialisation Information Technology: Compulsory<br>Mechanical Engineering: Core Qualification: Compulsory<br>Mechatronics: Core Qualification: Compulsory<br>Naval Architecture: Core Qualification: Compulsory<br>Process Engineering: Core Qualification: Compulsory<br>Engineering and Management - Major in Logistics and Mobility: Specialisation Traffic Planning and Systems: Elective Compulsory<br>Engineering and Management - Major in Logistics and Mobility: Specialisation Production Management and Processes: Elective Compulsory<br>Engineering and Management - Major in Logistics and Mobility: Specialisation Information Technology: Compulsory |

| Course L1028: Analysis III | |
|---|---|
| **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** | DE |
| **Cycle** | WiSe |
| **Content** | Main features of differential and integrational calculus of several variables<br>• Differential calculus for several variables<br>• Mean value theorems and Taylor's theorem<br>• Maximum and minimum values<br>• Implicit functions<br>• Minimization under equality constraints<br>• Newton's method for multiple variables<br>• Fourier series<br>• Double integrals over general regions<br>• Line and surface integrals<br>• Theorems of Gauß and Stokes |
| **Literature** | • http://www.math.uni-hamburg.de/teaching/export/tuhh/index.html |

| Course L1029: Analysis III | |
|---|---|
| **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** | DE |
| **Cycle** | WiSe |
| **Content** | See interlocking course |
| **Literature** | See interlocking course |

| Course L1030: Analysis III | |
|---|---|
| **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** | DE |
| **Cycle** | WiSe |
| **Content** | See interlocking course |
| **Literature** | See interlocking course |

| Course L1031: 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** | DE |
| **Cycle** | WiSe |
| **Content** | Main features of the theory and numerical treatment of ordinary differential equations<br>• Introduction and elementary methods<br>• Exsitence and uniqueness of initial value problems<br>• Linear differential equations<br>• Stability and qualitative behaviour of the solution<br>• Boundary value problems and basic concepts of calculus of variations<br>• Eigenvalue problems<br>• Numerical methods for the integration of initial and boundary value problems<br>• Classification of partial differential equations |
| **Literature** | • http://www.math.uni-hamburg.de/teaching/export/tuhh/index.html |

| Course L1032: Differential Equations 1 (Ordinary Differential Equations) | |
|---|---|
| **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** | DE |
| **Cycle** | WiSe |
| **Content** | See interlocking course |
| **Literature** | See interlocking course |

| Course L1033: 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** | DE |
| **Cycle** | WiSe |
| **Content** | See interlocking course |
| **Literature** | See interlocking course |

## Module M0728: Hydromechanics and Hydrology

**Courses**

| Title | Typ | Hrs/wk | CP |
|---|---|---|---|
| Hydrology (L0909) | Lecture | 1 | 1 |
| Hydrology (L0956) | Project-/problem-based Learning | 1 | 2 |
| Hydromechanics (L0615) | Lecture | 2 | 2 |
| Hydromechanics (L0616) | Project-/problem-based Learning | 1 | 1 |

| | |
|---|---|
| **Module Responsible** | Prof. Peter Fröhle |
| **Admission Requirements** | None |
| **Recommended Previous Knowledge** | Mathematics I, II and III<br><br>Mechanics I und II |
| **Educational Objectives** | After taking part successfully, students have reached the following learning results |
| **Professional Competence** | |
| *Knowledge* | The students are able to define the basic terms of hydromechanics, hydrology groundwater hydrology and water management. They are able to derive the basic formulations of i) hydrostatics, ii) kinematics of flows and iii) conservation laws and to describe and quantify the relevant processes of the hydrological water cycle. Besides, the students can describe the main aspects of rainfall-run-off-modelling and of established reservoir / storage models as well as the concepts of the determination of a unit-hydrograph. |
| *Skills* | The students are able to apply the fundamental formulations of hydromechanics to basic practical problems. Furthermore, they are able to run, explain and document basic hydraulic experiments.<br><br>Besides, they are able to apply basic hydrological approaches and methods to simple hydrological problems. The students have the capability to exemplarily apply simple reservoir/storage models and a unit-hydrograph to given problems.<br><br>In addition, the basic concepts of field-measurements of hydrological and hydrodynamic values can be described and the students are able to perform, analyze and assess respective measurements. |
| **Personal Competence** | |
| *Social Competence* | The students are able to work in groups in a goal-orientated, structured manner. They can explain their results sustainably in plenary sessions by use of peer learning approaches. Furthermore, they are able to prepare and present technical presentations for given topics in groups. |
| *Autonomy* | Students are capable of organising their individual work flow to contribute to the conduct of experiments and to present discipline-specific knowledge. They can provide each other with feedback and suggestions on their results. They are capable of reflecting their study techniques and learning strategy on an individual basis. |
| **Workload in Hours** | Independent Study Time 110, Study Time in Lecture 70 |
| **Credit points** | 6 |
| **Course achievement** | **Compulsory** / **Bonus** / **Form** / **Description**<br>Yes / None / Excercises / Übungsaufgaben Hydrologie<br>Yes / None / Subject theoretical and practical work / Durchführung, Dokumentation und Präsentation zu einem Versuchs Hydromechanik oder Hydraulik in Gruppen<br>Yes / None / Group discussion / Erstellung eine Posters zu einer Thematik aus dem Themengebiet der Hydrologie in Gruppen und Präsentation |
| **Examination** | Written exam |
| **Examination duration and scale** | 150 minutes |
| **Assignment for the Following Curricula** | General Engineering Science (German program, 7 semester): Specialisation Civil Engineering: Compulsory<br>Civil- and Environmental Engineering: Core Qualification: Compulsory<br>Logistics and Mobility: Specialisation Traffic Planning and Systems: Elective Compulsory<br>Engineering and Management - Major in Logistics and Mobility: Specialisation Traffic Planning and Systems: Elective Compulsory |

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

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

| Course L0615: Hydromechanics | |
|---|---|
| **Typ** | Lecture |
| **Hrs/wk** | 2 |
| **CP** | 2 |
| **Workload in Hours** | Independent Study Time 32, Study Time in Lecture 28 |
| **Lecturer** | Prof. Peter Fröhle |
| **Language** | DE |
| **Cycle** | WiSe |
| **Content** | Fundamentals of Hydromechanics<br>• Characteristics of fluids<br>• Hydrostatics<br>• Kinematics of flows, laminar and turbulent flows<br>• Conservation laws<br>  ◦ Conservation of mass<br>  ◦ Conservation of Energy<br>  ◦ Momentum Equation<br>• Application of conservation laws to flow conditions |
| **Literature** | Skript zur Vorlesung Hydromechanik/Hydraulik, Kapitel 1-2<br>Truckenbrodt, E.: Lehrbuch der angewandten Fluidmechanik, Springer Verlag, Berlin, 1998.<br>Truckenbrodt, E.: Grundlagen und elementare Strömungsvorgänge dichtebeständiger Fluide / Fluidmechanik, Springer Verlag, Berlin, 1996. |

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

## Module M1289: Logistical systems - Industry 4.0

**Courses**

| Title | Typ | Hrs/wk | CP |
|---|---|---|---|
| Logistics systems - Industry 4.0 (L1753) | Seminar | 4 | 6 |

| | |
|---|---|
| **Module Responsible** | Prof. Jochen Kreutzfeldt |
| **Admission Requirements** | None |
| **Recommended Previous Knowledge** | Successful completion of the module „Technical Logistics“ |
| **Educational Objectives** | After taking part successfully, students have reached the following learning results |
| **Professional Competence** | |
| *Knowledge* | The students will acquire the following knowledge:<br>1. The students are able to understand and explain the concept "Logistical System".<br>2. The students are able to design a logistic system conceptually.<br>3. The students can develop and implement the control of a logistic system with python. |
| *Skills* | The students will acquire the following skills:<br>1. The students are able to identify logistical systems, analyze and identify potential for change and improvement.<br>2. The students know different technical solutions to address problems in logistical systems.<br>3. The students are capable of deploying technical solutions and ideas from the concept Industry 4.0 to deal with logistical problems. |
| **Personal Competence** | |
| *Social Competence* | The students will acquire the following social skills:<br>1. The students are able to develop technical solutions for logistical systems and reflect their contribution within the team.<br>2. The technical solutions from the group can be jointly documented and presented.<br>3. Students are able to present their technological solutions to an audience and derived from the critique new ideas and improvements. |
| *Autonomy* | The students will acquire the following independent competencies:<br>1. The students can independently develop technical solutions for logistical problems under supervision.<br>2. The students are able to evaluate their technical solutions and discuss the pros and cons.<br>3. The students are able to assess the impact of the concept Industry 4.0 on their own career development. |
| **Workload in Hours** | Independent Study Time 124, Study Time in Lecture 56 |
| **Credit points** | 6 |
| **Course achievement** | None |
| **Examination** | Written elaboration |
| **Examination duration and scale** | Lab prototype with documentation (group work) |
| **Assignment for the Following Curricula** | Logistics and Mobility: Specialisation Information Technology: Elective Compulsory<br>Logistics and Mobility: Specialisation Traffic Planning and Systems: Elective Compulsory<br>Logistics and Mobility: Specialisation Production Management and Processes: Elective Compulsory<br>Engineering and Management - Major in Logistics and Mobility: Specialisation Information Technology: Elective Compulsory<br>Engineering and Management - Major in Logistics and Mobility: Specialisation Traffic Planning and Systems: Elective Compulsory<br>Engineering and Management - Major in Logistics and Mobility: Specialisation Production Management and Processes: Elective Compulsory |

| Course L1753: Logistics systems - Industry 4.0 | |
|---|---|
| **Typ** | Seminar |
| **Hrs/wk** | 4 |
| **CP** | 6 |
| **Workload in Hours** | Independent Study Time 124, Study Time in Lecture 56 |
| **Lecturer** | Prof. Jochen Kreutzfeldt |
| **Language** | DE |
| **Cycle** | WiSe |
| **Content** | The lecture gives an introduction to the concept of logistical systems with a special emphasis on the subject of Industry 4.0. Here, the system concept in logistics from a technical point of view is introduced. A logistical system is understood as a combination of transport, storage and change processes between source and sink of goods. This lecture will look at the technical aspect of these processes.<br>Industry is a topic of this lecture. Industry 4.0 is understood as the far-reaching digitization and networking of logistical systems and the connection of logistical objects, processes and systems. The logistics industry expects Industry 4.0 to be a profound change and the realization of large improvement potentials. The lecture provides an in-depth introduction to application cases and business models of Industry 4.0 in logistics from a technical standpoint. A possible framework for Industry 4.0 is presented and several application examples are shown.<br><br>In the exercises, students learn will learn the exemplary use of different technical solutions and know how, which can be used to improve logistical systems. |
| **Literature** | Bauernhansl, Thomas et al. (2014): Industrie 4.0 in Produktion, Automatisierung und Logistik. Anwendung, Technologien, Migration. Wiesbaden: Springer Vieweg.<br>Hausladen, Iris (2014): IT-gestützte Logistik. Systeme - Prozesse - Anwendungen. 2. Auflage 2014. Wiesbaden: Imprint: Gabler Verlag.<br><br>Hompel, Michael ten; Büchter, Hubert; Franzke, Ulrich (2008): Identifikationssysteme und Automatisierung. [Intralogistik]. Berlin, Heidelberg: Springer.<br><br>Kaufmann, Timothy (2015): Geschäftsmodelle in Industrie 4.0 und dem Internet der Dinge. Der Weg vom Anspruch in die Wirklichkeit. Wiesbaden: Springer Fachmedien Wiesbaden.<br><br>Martin, Heinrich (2014): Transport- und Lagerlogistik. Planung, Struktur, Steuerung und Kosten von Systemen der Intralogistik. 9., Auflage 2014. Wiesbaden: Imprint: Springer Vieweg.<br><br>Runkler, Thomas A. (2010): Data-Mining. Methoden und Algorithmen intelligenter Datenanalyse. 1. Aufl. Wiesbaden: Vieweg + Teubner (Studium). |

## Module M0706: Geotechnics I

**Courses**

| Title | Typ | Hrs/wk | CP |
|---|---|---|---|
| Soil Mechanics (L0550) | Lecture | 2 | 2 |
| Soil Mechanics (L0551) | Recitation Section (large) | 2 | 2 |
| Soil Mechanics (L1493) | Recitation Section (small) | 2 | 2 |

| | |
|---|---|
| **Module Responsible** | Prof. Jürgen Grabe |
| **Admission Requirements** | None |
| **Recommended Previous Knowledge** | Modules :<br>• Mechanics I-II |
| **Educational Objectives** | After taking part successfully, students have reached the following learning results |
| **Professional Competence** | |
| *Knowledge* | The students know the basics of soil mechanics as the structure and characteristics of soil, stress distribution due to weight, water or structures, consolidation and settlement calculations, as well as failure of the soil due to ground- or slope failure. |
| *Skills* | After the successful completion of the module the students should be able to describe the mechanical properties and to evaluate them with the help of geotechnical standard tests. They can calculate stresses and deformation in the soils due to weight or influence of structures. They are are able to prove the usability (settlements) for shallow foundations. |
| **Personal Competence** | |
| *Social Competence* | |
| *Autonomy* | |
| **Workload in Hours** | Independent Study Time 96, Study Time in Lecture 84 |
| **Credit points** | 6 |
| **Course achievement** | Compulsory: No; Bonus: 20 %; Form: Attestation; Description: |
| **Examination** | Written exam |
| **Examination duration and scale** | 90 minutes |
| **Assignment for the Following Curricula** | General Engineering Science (German program, 7 semester): Specialisation Civil Engineering: Compulsory<br>Civil- and Environmental Engineering: Core Qualification: Compulsory<br>Logistics and Mobility: Specialisation Traffic Planning and Systems: Elective Compulsory<br>Technomathematics: Specialisation III. Engineering Science: Elective Compulsory<br>Engineering and Management - Major in Logistics and Mobility: Specialisation Traffic Planning and Systems: Elective Compulsory |

### Course L0550: Soil Mechanics

| | |
|---|---|
| **Typ** | Lecture |
| **Hrs/wk** | 2 |
| **CP** | 2 |
| **Workload in Hours** | Independent Study Time 32, Study Time in Lecture 28 |
| **Lecturer** | Prof. Jürgen Grabe |
| **Language** | DE |
| **Cycle** | WiSe |
| **Content** | • Structure of the soil<br>• Ground surveying<br>• Compsitition and properties of the soil<br>• Groundwater<br>• One-dimensional compression<br>• Spreading of stresses<br>• Settlement calculation<br>• Consolidation<br>• Shear strength<br>• Earth pressure<br>• Slope failure<br>• Ground failure<br>• Suspension based earth tenches |
| **Literature** | • Vorlesungsumdruck, s. ww.tu-harburg.de/gbt<br>• Grabe, J. (2004): Bodenmechanik und Grundbau<br>• Gudehus, G. (1981): Bodenmechanik<br>• Kolymbas, D. (1998): Geotechnik - Bodenmechanik und Grundbau<br>• Grundbau-Taschenbuch, Teil 1, aktuelle Auflage |

| Course L0551: Soil Mechanics | |
|---|---|
| **Typ** | Recitation Section (large) |
| **Hrs/wk** | 2 |
| **CP** | 2 |
| **Workload in Hours** | Independent Study Time 32, Study Time in Lecture 28 |
| **Lecturer** | Prof. Jürgen Grabe |
| **Language** | DE |
| **Cycle** | WiSe |
| **Content** | See interlocking course |
| **Literature** | See interlocking course |

| Course L1493: Soil Mechanics | |
|---|---|
| **Typ** | Recitation Section (small) |
| **Hrs/wk** | 2 |
| **CP** | 2 |
| **Workload in Hours** | Independent Study Time 32, Study Time in Lecture 28 |
| **Lecturer** | Prof. Jürgen Grabe |
| **Language** | DE |
| **Cycle** | WiSe |
| **Content** | See interlocking course |
| **Literature** | See interlocking course |

## Module M0833: Introduction to Control Systems

**Courses**

| Title | Typ | Hrs/wk | CP |
|---|---|---|---|
| Introduction to Control Systems (L0654) | Lecture | 2 | 4 |
| Introduction to Control Systems (L0655) | Recitation Section (small) | 2 | 2 |

| | |
|---|---|
| **Module Responsible** | NN |
| **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** | 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>Data Science: Core Qualification: Elective Compulsory<br>Data Science: Specialisation II. Application: Elective Compulsory<br>Electrical Engineering: Core Qualification: Compulsory<br>Green Technologies: Energy, Water, Climate: Core Qualification: Compulsory<br>Computer Science in Engineering: Core Qualification: Compulsory<br>Integrated Building Technology: Core Qualification: Elective Compulsory<br>Logistics and Mobility: Specialisation Information Technology: Elective Compulsory<br>Logistics and Mobility: Specialisation Traffic Planning and Systems: 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>Technomathematics: Specialisation III. Engineering Science: Elective Compulsory<br>Theoretical Mechanical Engineering: Technical Complementary Course Core Studies: Elective Compulsory<br>Process Engineering: Core Qualification: Compulsory<br>Engineering and Management - Major in Logistics and Mobility: Specialisation Information Technology: Elective Compulsory<br>Engineering and Management - Major in Logistics and Mobility: Specialisation Traffic Planning and Systems: Elective Compulsory<br>Engineering and Management - Major in Logistics and Mobility: Specialisation Production Management and Processes: Elective Compulsory |

| Course L0654: Introduction to Control Systems | |
|---|---|
| **Typ** | Lecture |
| **Hrs/wk** | 2 |
| **CP** | 4 |
| **Workload in Hours** | Independent Study Time 92, Study Time in Lecture 28 |
| **Lecturer** | NN |
| **Language** | DE |
| **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 L0655: Introduction to Control Systems | |
|---|---|
| **Typ** | Recitation Section (small) |
| **Hrs/wk** | 2 |
| **CP** | 2 |
| **Workload in Hours** | Independent Study Time 32, Study Time in Lecture 28 |
| **Lecturer** | NN |
| **Language** | DE |
| **Cycle** | WiSe |
| **Content** | See interlocking course |
| **Literature** | See interlocking course |

## Module M1070: Simulation of Transport and Handling Systems

**Courses**

| Title | Typ | Hrs/wk | CP |
|---|---|---|---|
| Simulation of Transport and Handling Systems (L1352) | Lecture | 1 | 2 |
| Simulation of Transport and Handling Systems (L1818) | Recitation Section (small) | 3 | 4 |

| | |
|---|---|
| **Module Responsible** | Prof. Carlos Jahn |
| **Admission Requirements** | None |
| **Recommended Previous Knowledge** | Basic knowledge of transport- and handlingtechnology. |
| **Educational Objectives** | After taking part successfully, students have reached the following learning results |
| **Professional Competence** | |
| *Knowledge* | Students can...<br>• Explain the structure and workings of standard external logistics systems.<br>• Outline the benefits of using simulation software subject to the starting situation.<br>• Present different simulation programs and kinds of simulation that are in widespread use and explain their characteristics. |
| *Skills* | Students are able to...<br>• Recognize, analyze, and assemble into a model the elementary building blocks of a logistics system.<br>• Map complex external logistics process using the *Plant Simulation*® simulation software.<br>• Draw inferences from the results of the simulation, transfer them to the reality, and deduce action recommendations from them. |
| **Personal Competence** | |
| *Social Competence* | Students are capable of...<br>• Solving complex tasks in a team and to document assignments accordingly.<br>• Playing different roles in the teamwork and giving each other appropriate feedback in the team.<br>• Presenting the relevant results of their project to specialists and representing them. |
| *Autonomy* | Students are able...<br>• To acquaint themselves independently with software with which they are not familiar and to use it to solve complex tasks.<br>• To define work steps independently and to acquire the knowledge required to do so. |
| **Workload in Hours** | Independent Study Time 124, Study Time in Lecture 56 |
| **Credit points** | 6 |
| **Course achievement** | **Compulsory** / **Bonus** / **Form** / **Description**<br>No / 20 % / Subject theoretical and practical work |
| **Examination** | Subject theoretical and practical work |
| **Examination duration and scale** | Simulation study and report with approximately 15 pages per person |
| **Assignment for the Following Curricula** | Data Science: Core Qualification: Elective Compulsory<br>Logistics and Mobility: Specialisation Information Technology: Elective Compulsory<br>Logistics and Mobility: Specialisation Traffic Planning and Systems: Elective Compulsory<br>Engineering and Management - Major in Logistics and Mobility: Specialisation Information Technology: Elective Compulsory<br>Engineering and Management - Major in Logistics and Mobility: Specialisation Traffic Planning and Systems: Elective Compulsory<br>Engineering and Management - Major in Logistics and Mobility: Specialisation Production Management and Processes: Elective Compulsory<br>Engineering and Management - Major in Logistics and Mobility: Specialisation Production Management and Processes: Elective Compulsory |

| Course L1352: Simulation of Transport and Handling Systems | |
|---|---|
| **Typ** | Lecture |
| **Hrs/wk** | 1 |
| **CP** | 2 |
| **Workload in Hours** | Independent Study Time 46, Study Time in Lecture 14 |
| **Lecturer** | Prof. Carlos Jahn |
| **Language** | DE |
| **Cycle** | WiSe |
| **Content** | The lecture deals with the simulation of external logistics systems. The focus is therefore on the consideration of logistical processes between companies or on transhipment systems, such as ports or individual terminals.<br><br>In the first part of the lecture, students will first acquire basic knowledge of external logistics systems and the advantages of using simulations to present them. Then an overview of existing simulation types and programs is given and examples for existing simulation models of logistic systems in science and practice are shown. Some simulation models will be demonstrated.<br><br>In the second part of the lecture the students learn the basic handling of the simulation software Plant Simulation®. They receive theoretical explanations of the general functionality of the simulation tool, which are further deepened through the use of extensive, interactive examples. At the same time, five exercises, which build on each other, offer students the opportunity to implement the course content they have learnt alone and in small groups. The exercises can be completed during the supervised lecture periods as well as at other times.<br><br>The acquired knowledge is to be applied in the third part in the course of group work. The students will be divided into groups, each of which will then work on a relevant problem from the field of (external) logistic systems by means of simulation. The students are given a defined period of time for their work. During this time at least one person is always available for questions and suggestions. The results of the group work are to be documented in a simulation report and handed in at the end of the processing time. Finally, the individual groups present the problems they have worked on and their results in a presentation. |
| **Literature** | Bangsow, Steffen (2011): Praxishandbuch Plant Simulation und SimTalk. Anwendung und Programmierung in über 150 Beispiel-Modellen. München: Hanser Verlag.<br><br>Eley, Michael (2012): Simulation in der Logistik. Einführung in die Erstellung ereignisdiskreter Modelle unter Verwendung des Werkzeuges "Plant Simulation". Berlin, Heidelberg: Springer.<br><br>Engelhardt-Nowitzki, Corinna; Nowitzki, Olaf; Krenn, Barbara (2008): Management komplexer Materialflüsse mittels Simulation. State-of-the-Art und innovative Konzepte. Wiesbaden: Deutscher Universitäts-Verlag / GWV Fachverlage GmbH, Wiesbaden.<br><br>Rabe, Markus; Spieckermann, Sven; Wenzel, Sigrid (2008): Verifikation und Validierung für die Simulation in Produktion und Logistik. Vorgehensmodelle und Techniken. Berlin, Heidelberg: Springer.<br><br>Sargent, Robert G. (2010): Verification and Validation of Simulation Models. In: B. Johansson, S. Jain, J. Montoya-Torres, J. Hugan, and E. Yücesan, eds.: Proceedings of the 2010 Winter Simulation Conference.<br><br>VDI-Richlinie: VDI 3633. Simulation von Logistik-, Materialfluß-und Produktionssystemen<br><br>Wenzel, Sigrid; Rabe, Markus; Spieckermann, Sven (2006): Verifikation und Validierung für die Simulation in Produktion und Logistik. Vorgehensmodelle und Techniken. 1. Aufl. Berlin: Springer Berlin. |

| Course L1818: Simulation of Transport and Handling Systems | |
|---|---|
| **Typ** | Recitation Section (small) |
| **Hrs/wk** | 3 |
| **CP** | 4 |
| **Workload in Hours** | Independent Study Time 78, Study Time in Lecture 42 |
| **Lecturer** | Prof. Carlos Jahn |
| **Language** | DE |
| **Cycle** | WiSe |
| **Content** | See interlocking course |
| **Literature** | See interlocking course |

## Module M0852: Graph Theory and Optimization

**Courses**

| Title | Typ | Hrs/wk | CP |
|---|---|---|---|
| Graph Theory and Optimization (L1046) | Lecture | 2 | 3 |
| Graph Theory and Optimization (L1047) | Recitation Section (small) | 2 | 3 |

| | |
|---|---|
| **Module Responsible** | Prof. Anusch Taraz |
| **Admission Requirements** | None |
| **Recommended Previous Knowledge** | • Discrete Algebraic Structures<br>• Mathematics I |
| **Educational Objectives** | After taking part successfully, students have reached the following learning results |
| **Professional Competence** | |
| *Knowledge* | • Students can name the basic concepts in Graph Theory and Optimization. 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 Graph Theory and Optimization with the help of the concepts studied in this course. Moreover, they are capable of solving them by applying established methods.<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 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: Compulsory<br>General Engineering Science (German program, 7 semester): Specialisation Data Science: Elective Compulsory<br>Computer Science: Core Qualification: Compulsory<br>Data Science: Core Qualification: Compulsory<br>Engineering Science: Specialisation Data Science: Elective Compulsory<br>Computer Science in Engineering: Specialisation II. Mathematics & Engineering Science: Elective Compulsory<br>Logistics and Mobility: Specialisation Traffic Planning and Systems: Elective Compulsory<br>Logistics and Mobility: Specialisation Information Technology: Elective Compulsory<br>Technomathematics: Specialisation I. Mathematics: Elective Compulsory<br>Engineering and Management - Major in Logistics and Mobility: Specialisation Traffic Planning and Systems: Elective Compulsory<br>Engineering and Management - Major in Logistics and Mobility: Specialisation Information Technology: Elective Compulsory |

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

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

## Module M0767: Aeronautical Systems

**Courses**

| Title | Typ | Hrs/wk | CP |
|---|---|---|---|
| Fundamentals of Aircraft Systems (L0741) | Lecture | 2 | 2 |
| Fundamentals of Aircraft Systems (L0742) | Recitation Section (small) | 1 | 1 |
| Air Transportation Systems (L0591) | Lecture | 2 | 2 |
| Air Transportation Systems (L0816) | Recitation Section (large) | 1 | 1 |

| | |
|---|---|
| **Module Responsible** | Prof. Frank Thielecke |
| **Admission Requirements** | None |
| **Recommended Previous Knowledge** | Basics of mathematics, mechanics and thermodynamics |
| **Educational Objectives** | After taking part successfully, students have reached the following learning results |
| **Professional Competence** | |
| *Knowledge* | Students get a basic understanding of the structure and design of an aircraft, as well as an overview of the systems inside an aircraft. In addition, a basic knowledge of the relationchips, the key parameters, roles and ways of working in different subsystems in the air transport is acquired. |
| *Skills* | Due to the learned cross-system thinking students can gain a deeper understanding of different system concepts and their technical system implementation. In addition, they can apply the learned methods for the design and assessment of subsystems of the air transportation system in the context of the overall system. |
| **Personal Competence** | |
| *Social Competence* | Students are made aware of interdisciplinary communication in groups. |
| *Autonomy* | Students are able to independently analyze different system concepts and their technical implementation as well as to think system oriented. |
| **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** | 150 min |
| **Assignment for the Following Curricula** | General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Aircraft Systems Engineering: Compulsory<br>Data Science: Specialisation II. Application: Elective Compulsory<br>Logistics and Mobility: Specialisation Traffic Planning and Systems: Elective Compulsory<br>Mechanical Engineering: Specialisation Aircraft Systems Engineering: Compulsory<br>Engineering and Management - Major in Logistics and Mobility: Specialisation Traffic Planning and Systems: Elective Compulsory |

### Course L0741: Fundamentals of Aircraft Systems

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

### Course L0742: Fundamentals of Aircraft Systems

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

| **Course L0591: Air Transportation Systems** | |
|---|---|
| **Typ** | Lecture |
| **Hrs/wk** | 2 |
| **CP** | 2 |
| **Workload in Hours** | Independent Study Time 32, Study Time in Lecture 28 |
| **Lecturer** | Prof. Volker Gollnick |
| **Language** | DE |
| **Cycle** | SoSe |
| **Content** | 1. Air transport as part of the global transportation system<br>2. Legal basis of air transportation<br>3. Safety and security aspects<br>4. Aircraft basics<br>5. The role of the aircraft amnufacturer<br>6. The role of the aircraft operator<br>7. Airport operation<br>8. The principles of air traffic management<br>9. Environmental aspects of air transportation |
| **Literature** | 1. V. Gollnick, D. Schmitt: "Air Transport System", Springer-Verlag, ISBN 978-3-7091-1879-5<br>2. H. Mensen: "Handbuch der Luftfahrt", Springer-Verlag, 2003<br>3. J.P. Clark: “Buying the Big Jets”, ISBN 9781317170341 , Taylor & Francis, 2017<br>4. Mike Hirst: The Air Transport System, AIAA, 2008<br>5. D.P. Raymer: "Aircraft Design - A Conceptual Approach", AIAA Education Series, 2006, ISBN 1-56347-281-3<br>6. N. Ashford: "Airport Operations", McGraw-Hill, 1997, ISBN 0-07-003077-4<br>7. P. Maurer: "Luftverkehrsmanagement", Oldenbourg-Verlag, ISBN 3-486-27422-8<br>8. H. Mensen: "Moderne Flugsicherung", Springer-Verlag, 2004, ISBN 3-540-20581-0 |

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

## Module M0536: Fundamentals of Fluid Mechanics

**Courses**

| Title | Typ | Hrs/wk | CP |
|---|---|---|---|
| Fundamentals of Fluid Mechanics (L0091) | Lecture | 2 | 2 |
| Fundamentals on Fluid Mechanics (L2933) | Recitation Section (small) | 2 | 2 |
| Fluid Mechanics for Process Engineering (L0092) | Recitation Section (large) | 2 | 2 |

**Module Responsible**
Prof. Michael Schlüter

**Admission Requirements**
None

**Recommended Previous Knowledge**

- Mathematics I+II+III
- Technical Mechanics I+II
- Technical Thermodynamics I+II
- Working with force balances
- Simplification and solving of partial differential equations
- Integration

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

**Professional Competence**

*Knowledge*
Students are able to:

- explain the difference between different types of flow
- give an overview for different applications of the Reynolds Transport-Theorem in process engineering
- explain simplifications of the Continuity- and Navier-Stokes-Equation by using physical boundary conditions

*Skills*
The students are able to

- describe and model incompressible flows mathematically
- reduce the governing equations of fluid mechanics by simplifications to archive quantitative solutions e.g. by integration
- notice the dependency between theory and technical applications
- use the learned basics for fluid dynamical applications in fields of process engineering

**Personal Competence**

*Social Competence*
The students

- are capable to gather information from subject related, professional publications and relate that information to the context of the lecture and
- able to work together on subject related tasks in small groups. They are able to present their results effectively in English (e.g. during small group exercises)
- are able to work out solutions for exercises by themselves, to discuss the solutions orally and to present the results.

*Autonomy*
The students are able to

- search further literature for each topic and to expand their knowledge with this literature,
- work on their exercises by their own and to evaluate their actual knowledge with the feedback.

**Workload in Hours**
Independent Study Time 96, Study Time in Lecture 84

**Credit points**
6

**Course achievement**

| Compulsory | Bonus | Form | Description |
|---|---|---|---|
| No | 5 % | Midterm | |

**Examination**
Written exam

**Examination duration and scale**
3 hours

**Assignment for the Following Curricula**
General Engineering Science (German program, 7 semester): Specialisation Green Technologies: Compulsory
General Engineering Science (German program, 7 semester): Specialisation Chemical and Bioengineering: Compulsory
Bioprocess Engineering: Core Qualification: Compulsory
Chemical and Bioprocess Engineering: Core Qualification: Compulsory
Green Technologies: Energy, Water, Climate: Core Qualification: Compulsory
Integrated Building Technology: Core Qualification: Compulsory
Logistics and Mobility: Specialisation Traffic Planning and Systems: Elective Compulsory
Technomathematics: Specialisation III. Engineering Science: Elective Compulsory
Process Engineering: Core Qualification: Compulsory
Engineering and Management - Major in Logistics and Mobility: Specialisation Traffic Planning and Systems: Elective Compulsory

| Course L0091: Fundamentals of Fluid Mechanics | |
|---|---|
| **Typ** | Lecture |
| **Hrs/wk** | 2 |
| **CP** | 2 |
| **Workload in Hours** | Independent Study Time 32, Study Time in Lecture 28 |
| **Lecturer** | Prof. Michael Schlüter |
| **Language** | DE |
| **Cycle** | SoSe |
| **Content** | • fluid properties<br>• hydrostatic<br>• overall balances - theory of streamline<br>• overall balances- conservation equations<br>• differential balances - Navier Stokes equations<br>• irrotational flows - Potenzialströmungen<br>• flow around bodies - theory of physical similarity<br>• turbulent flows<br>• compressible flows |
| **Literature** | 1. Crowe, C. T.: Engineering fluid mechanics. Wiley, New York, 2009.<br>2. Durst, F.: Strömungsmechanik: Einführung in die Theorie der Strömungen von Fluiden. Springer-Verlag, Berlin, Heidelberg, 2006.<br>3. Fox, R.W.; et al.: Introduction to Fluid Mechanics. J. Wiley & Sons, 1994<br>4. Herwig, H.: Strömungsmechanik: Eine Einführung in die Physik und die mathematische Modellierung von Strömungen. Springer Verlag, Berlin, Heidelberg, New York, 2006<br>5. Herwig, H.: Strömungsmechanik: Einführung in die Physik von technischen Strömungen: Vieweg+Teubner Verlag / GWV Fachverlage GmbH, Wiesbaden, 2008<br>6. Kuhlmann, H.C.: Strömungsmechanik. München, Pearson Studium, 2007<br>7. Oertl, H.: Strömungsmechanik: Grundlagen, Grundgleichungen, Lösungsmethoden, Softwarebeispiele. Vieweg+ Teubner Verlag / GWV Fachverlage GmbH, Wiesbaden, 2009<br>8. Schade, H.; Kunz, E.: Strömungslehre. Verlag de Gruyter, Berlin, New York, 2007<br>9. Truckenbrodt, E.: Fluidmechanik 1: Grundlagen und elementare Strömungsvorgänge dichtebeständiger Fluide. Springer-Verlag, Berlin, Heidelberg, 2008<br>10. Schlichting, H. : Grenzschicht-Theorie. Springer-Verlag, Berlin, 2006<br>11. van Dyke, M.: An Album of Fluid Motion. The Parabolic Press, Stanford California, 1882.<br>12. White, F.: Fluid Mechanics, Mcgraw-Hill, ISBN-10: 0071311211, ISBN-13: 978-0071311212, 2011 |

| Course L2933: Fundamentals on Fluid Mechanics | |
|---|---|
| **Typ** | Recitation Section (small) |
| **Hrs/wk** | 2 |
| **CP** | 2 |
| **Workload in Hours** | Independent Study Time 32, Study Time in Lecture 28 |
| **Lecturer** | Prof. Michael Schlüter |
| **Language** | DE |
| **Cycle** | SoSe |
| **Content** | In the group exercise, the contents of the lecture are taken up and deepened by means of exercises. The exercise tasks correspond in quality and scope to the tasks of the written exam. Topics: Reynolds transport-theorem, pipe flow, free jet, angular momentum, Navier-Stokes equations, potential theory, mock exam, pipe hydraulics, pump design. |
| **Literature** | Heinz Herwig: Strömungsmechanik, Eine Einführung in die Physik und die mathematische Modellierung von Strömungen, Springer Verlag, Berlin, 978-3-540-32441-6 (ISBN)<br><br>Herbert Oertel, Martin Böhle, Thomas Reviol: Strömungsmechanik für Ingenieure und Naturwissenschaftler, Springer Verlag, Berlin, ISBN: 978-3-658-07786-0<br><br>Joseph Spurk, Nuri Aksel: Strömungslehre, Einführung in die Theorie der Strömungen, Springer Verlag, Berlin, ISBN: 978-3-642-13143-1. |

| Course L0092: Fluid Mechanics for Process Engineering | |
|---|---|
| **Typ** | Recitation Section (large) |
| **Hrs/wk** | 2 |
| **CP** | 2 |
| **Workload in Hours** | Independent Study Time 32, Study Time in Lecture 28 |
| **Lecturer** | Prof. Michael Schlüter |
| **Language** | DE |
| **Cycle** | SoSe |
| **Content** | In the exercise-lecture the topics from the main lecture are discussed intensively and transferred into application. For that, the students receive example tasks for download. The students solve these problems based on the lecture material either independently or in small groups. The solution is discussed with the students under scientific supervision and parts of the solutions are presented on the chalk board. At the end of each exercise-lecture, the correct solution is presented on the chalk board. Parallel to the exercise-lecture tutorials are held where the student solve exam questions under a set time-frame in small groups and discuss the solutions afterwards. |
| **Literature** | 1. Crowe, C. T.: Engineering fluid mechanics. Wiley, New York, 2009.<br>2. Durst, F.: Strömungsmechanik: Einführung in die Theorie der Strömungen von Fluiden. Springer-Verlag, Berlin, Heidelberg, 2006.<br>3. Fox, R.W.; et al.: Introduction to Fluid Mechanics. J. Wiley & Sons, 1994<br>4. Herwig, H.: Strömungsmechanik: Eine Einführung in die Physik und die mathematische Modellierung von Strömungen. Springer Verlag, Berlin, Heidelberg, New York, 2006<br>5. Herwig, H.: Strömungsmechanik: Einführung in die Physik von technischen Strömungen: Vieweg+Teubner Verlag / GWV Fachverlage GmbH, Wiesbaden, 2008<br>6. Kuhlmann, H.C.: Strömungsmechanik. München, Pearson Studium, 2007<br>7. Oertl, H.: Strömungsmechanik: Grundlagen, Grundgleichungen, Lösungsmethoden, Softwarebeispiele. Vieweg+ Teubner Verlag / GWV Fachverlage GmbH, Wiesbaden, 2009<br>8. Schade, H.; Kunz, E.: Strömungslehre. Verlag de Gruyter, Berlin, New York, 2007<br>9. Truckenbrodt, E.: Fluidmechanik 1: Grundlagen und elementare Strömungsvorgänge dichtebeständiger Fluide. Springer-Verlag, Berlin, Heidelberg, 2008<br>10. Schlichting, H. : Grenzschicht-Theorie. Springer-Verlag, Berlin, 2006<br>11. van Dyke, M.: An Album of Fluid Motion. The Parabolic Press, Stanford California, 1882.<br>12. White, F.: Fluid Mechanics, Mcgraw-Hill, ISBN-10: 0071311211, ISBN-13: 978-0071311212, 2011 |

## Module M1633: Planning Law and Environmental Law/ Sustainable Urban Development

**Courses**

| Title | Typ | Hrs/wk | CP |
|---|---|---|---|
| Sustainable Urban Development (L2474) | Lecture | 2 | 3 |
| Planning law and Environmental law (L2473) | Lecture | 2 | 3 |

| | |
|---|---|
| **Module Responsible** | Prof. Ralf Otterpohl |
| **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 124, Study Time in Lecture 56 |
| **Credit points** | 6 |
| **Course achievement** | None |
| **Examination** | Subject theoretical and practical work |
| **Examination duration and scale** | Written-theoretical part and report |
| **Assignment for the Following Curricula** | Civil- and Environmental Engineering: Specialisation Civil Engineering: Elective Compulsory<br>Civil- and Environmental Engineering: Specialisation Water and Environment: Elective Compulsory<br>Civil- and Environmental Engineering: Specialisation Traffic and Mobility: Elective Compulsory<br>Logistics and Mobility: Specialisation Traffic Planning and Systems: Elective Compulsory<br>Engineering and Management - Major in Logistics and Mobility: Specialisation Traffic Planning and Systems: Elective Compulsory |

### Course L2474: Sustainable Urban Development

| | |
|---|---|
| **Typ** | Lecture |
| **Hrs/wk** | 2 |
| **CP** | 3 |
| **Workload in Hours** | Independent Study Time 62, Study Time in Lecture 28 |
| **Lecturer** | Prof. Irene Peters |
| **Language** | DE |
| **Cycle** | SoSe |
| **Content** | |
| **Literature** | |

### Course L2473: Planning law and Environmental law

| | |
|---|---|
| **Typ** | Lecture |
| **Hrs/wk** | 2 |
| **CP** | 3 |
| **Workload in Hours** | Independent Study Time 62, Study Time in Lecture 28 |
| **Lecturer** | Prof. Martin Wickel |
| **Language** | DE |
| **Cycle** | SoSe |
| **Content** | |
| **Literature** | |

## Module M0610: Electrical Machines and Actuators

**Courses**

| Title | Typ | Hrs/wk | CP |
|---|---|---|---|
| Electrical Machines and Actuators (L0293) | Lecture | 3 | 4 |
| Electrical Machines and Actuators (L0294) | Recitation Section (large) | 2 | 2 |

| | |
|---|---|
| **Module Responsible** | Prof. Thorsten Kern |
| **Admission Requirements** | None |
| **Recommended Previous Knowledge** | Basics of mathematics, in particular complexe numbers, integrals, differentials<br><br>Basics of electrical engineering and mechanical engineering |
| **Educational Objectives** | After taking part successfully, students have reached the following learning results |
| **Professional Competence** | |
| *Knowledge* | Students can to draw and explain the basic principles of electric and magnetic fields.<br><br>They can describe the function of the standard types of electric machines and present the corresponding equations and characteristic curves. For typically used drives they can explain the major parameters of the energy efficiency of the whole system from the power grid to the driven engine. |
| *Skills* | Students are able to calculate two-dimensional electric and magnetic fields in particular ferromagnetic circuits with air gap. For this they apply the usual methods of the design auf electric machines.<br><br>They can calulate the operational performance of electric machines from their given characteristic data and selected quantities and characteristic curves. They apply the usual equivalent circuits and graphical methods. |
| **Personal Competence** | |
| *Social Competence* | none |
| *Autonomy* | Students are able independently to calculate electric and magnatic fields for applications. They are able to analyse independently the operational performance of electric machines from the charactersitic data and theycan calculate thereof selected quantities and characteristic curves. |
| **Workload in Hours** | Independent Study Time 110, Study Time in Lecture 70 |
| **Credit points** | 6 |
| **Course achievement** | None |
| **Examination** | Subject theoretical and practical work |
| **Examination duration and scale** | Design of four machines and actuators, review of design files |
| **Assignment for the Following Curricula** | General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Energy Systems: Compulsory<br>General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Mechatronics: Compulsory<br>General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Theoretical Mechanical Engineering: Elective Compulsory<br>General Engineering Science (German program, 7 semester): Specialisation Electrical Engineering: Elective Compulsory<br>Digital Mechanical Engineering: Core Qualification: Compulsory<br>Electrical Engineering: Core Qualification: Elective Compulsory<br>Engineering Science: Specialisation Electrical Engineering: Elective Compulsory<br>Green Technologies: Energy, Water, Climate: Specialisation Energy Technology: Elective Compulsory<br>Green Technologies: Energy, Water, Climate: Specialisation Maritime Technologies: Elective Compulsory<br>Computer Science in Engineering: Specialisation II. Mathematics & Engineering Science: Elective Compulsory<br>Logistics and Mobility: Specialisation Traffic Planning and Systems: Elective Compulsory<br>Logistics and Mobility: Specialisation Production Management and Processes: Elective Compulsory<br>Mechanical Engineering: Core Qualification: Elective Compulsory<br>Mechatronics: Specialisation Naval Engineering: Compulsory<br>Mechatronics: Core Qualification: Compulsory<br>Mechatronics: Specialisation Robot- and Machine-Systems: Compulsory<br>Mechatronics: Specialisation Electrical Systems: Elective Compulsory<br>Technomathematics: Specialisation III. Engineering Science: Elective Compulsory<br>Engineering and Management - Major in Logistics and Mobility: Specialisation Traffic Planning and Systems: Elective Compulsory<br>Engineering and Management - Major in Logistics and Mobility: Specialisation Information Technology: Elective Compulsory<br>Engineering and Management - Major in Logistics and Mobility: Specialisation Production Management and Processes: Elective Compulsory<br>Engineering and Management - Major in Logistics and Mobility: Specialisation Production Management and Processes: Elective Compulsory |

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

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

## Module M1014: Logistics Service Provider Management

**Courses**

| Title | Typ | Hrs/wk | CP |
|---|---|---|---|
| Logistics Service Provider Management (L1240) | Seminar | 3 | 6 |

| | |
|---|---|
| **Module Responsible** | Prof. Heike Flämig |
| **Admission Requirements** | None |
| **Recommended Previous Knowledge** | • Introduction to Logistics and Mobility<br>• Transport and cross-docking Technology<br>• Logistics Management |
| **Educational Objectives** | After taking part successfully, students have reached the following learning results |
| **Professional Competence** | |
| *Knowledge* | Students are able to...<br>• integrate LSPs into the concept of business logistics<br>• tell the specifics of business services and logistics Services and their derived characteristics<br>• describe logistics functions as LSP service packages<br>• explain, why companies outsource logistics Services and what are actual trends in Business<br>• describe basic outsorucing processes and tender management success factors<br>• describe and analyze intra- and intermodal transport institutions as well as tasks, challenges and opportunities for the Management of LSPs |
| *Skills* | Students can...<br>• support the sub-segment specific business functions and management Tasks (e.g. for Road Transport, Airlines, SeaPort Providers etc.)<br>• categorize LSPs regarding strategic product-market-positioning<br>• derive action plans regarding management tasks depending on contigencies |
| **Personal Competence** | |
| *Social Competence* | Students can...<br>• discuss case studies in Groups (within and outside of the classroom), reaching a common understanding and result<br>• prepare and deliver Business presentations<br>• give and discuss Feedbacks in the large group |
| *Autonomy* | Students can...<br>• produce written reports independently |
| **Workload in Hours** | Independent Study Time 138, Study Time in Lecture 42 |
| **Credit points** | 6 |
| **Course achievement** | None |
| **Examination** | Written elaboration |
| **Examination duration and scale** | 2 scientific written papers of approx. 20 pages each. Presentation (approx. 15 pages) with 20-minute closing lecture in groups of 3 to max. 5 persons. Grading of 4 partial grades of 25% each (2 seminar papers, 2 presentation documents) individually per group member. |
| **Assignment for the Following Curricula** | Logistics and Mobility: Specialisation Traffic Planning and Systems: Elective Compulsory<br>Logistics and Mobility: Specialisation Production Management and Processes: Elective Compulsory<br>Engineering and Management - Major in Logistics and Mobility: Specialisation Traffic Planning and Systems: Elective Compulsory<br>Engineering and Management - Major in Logistics and Mobility: Specialisation Information Technology: Elective Compulsory<br>Engineering and Management - Major in Logistics and Mobility: Specialisation Production Management and Processes: Elective Compulsory<br>Engineering and Management - Major in Logistics and Mobility: Specialisation Production Management and Processes: Elective Compulsory |

| Course L1240: Logistics Service Provider Management | |
|---|---|
| **Typ** | Seminar |
| **Hrs/wk** | 3 |
| **CP** | 6 |
| **Workload in Hours** | Independent Study Time 138, Study Time in Lecture 42 |
| **Lecturer** | Prof. Stephan Freichel |
| **Language** | DE |
| **Cycle** | SoSe |
| **Content** | **1 Concept and Functions**<br><br>Define the role of logistics services providers in the overall concept and functions of logistics services providers. Workshop on the role of logistics services providers in the economy, based on up-to-date topics in the field and in the news.<br><br>**2 Outsourcing and Cooperation**<br><br>Make or buy, forms and management of inter-organizational relations<br><br>**3 Institutions**<br><br>Special business management features of carriers, haulage contractors, CEP services<br><br>**4 Trends, Strategies and Management Functions**<br><br>Market trends, requirements, basic business management and management functions (operations, business development, HR, IT, finance/planning and control, organization, leadership)<br><br>**5 Strategic Developments and Case Studies**<br><br>Selected aspects (e.g. risk and innovation management, global and regional networking, greenwashing and sustainability)<br><br>Examples:<br><br>Case Study A) Types of company (such as haulage contractors, railway operators, road transport companies, heavy goods, textile and refrigerated goods specialists, CEPs, etc) will be introduced and discussed in the context of a presentation.<br><br>Case Study B) Individual companies will be analyzed on the basis of accessible material such as company reports, websites and possibly telephone interviews and case studies will be explained and discussed with regard to the functions of the logistics services provider and the management task of the corporate managements of the selected cases. |
| **Literature** | Pfohl, H.-Chr.: Logistiksysteme. Betriebswirtschaftliche Grundlagen.<br>8., neu bearbeite und aktualisierte Auflage, Berlin u.a. 2009<br><br>Eßig, M. / Hofmann, E. / Stölzle, W.: Supply Chain Management. München 2013.<br><br>Freichel, S.L.K.: Organisation von Logistikservice-Netzwerken. Reihe: Logistik und Unternehmensführung, hrsg. von Prof. Dr. H.-Chr. Pfohl, Bd. 4. Berlin 1993.<br><br>Aberle, G.: Transportwirtschaft. Einzelwirtschaftliche und gesamtwirtschaftliche Grundlagen, 4. überarbeitete und erweiterte Auflage, München/Wien 2006.<br><br>Buchholz, J./Clausen, U./Vastag, A. (Hrsg): Handbuch der Verkehrslogistik, Heidelberg 1998.<br><br>Corsten, H.: Dienstleistungsmanagement, 3. Auflage, München 1997.<br><br>Müller-Daupert, B. (Hrsg.): Logistik-Outsourcing, 2. Auflage, München, Vogel, 2009<br><br>Ihde, G. B.: Transport, Verkehr, Logistik. Gesamtwirtschaftliche Aspekte und einzelwirtschaftliche Handhabung, 3. völlig überarb. und erw. Auflage, München 2001.<br><br>van Suntum, U.: Verkehrspolitik, München 1986. |

## Module M0985: Introduction to Railways

**Courses**

| Title | Typ | Hrs/wk | CP |
|---|---|---|---|
| Introduction to Railways (L1184) | Lecture | 2 | 4 |
| Introduction to Railways (L1185) | Recitation Section (large) | 1 | 2 |

| | |
|---|---|
| **Module Responsible** | Prof. Carsten Gertz |
| **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...<br>• give definitions for basic terms related to railways<br>• explain specifics concerning the handling of goods on railways<br>• explain the required infrastructure<br>• describe the work at the track super structure |
| *Skills* | -- |
| **Personal Competence** | |
| *Social Competence* | Students can...<br>• work at tasks in groups and come to results together<br>• discuss contents in groups, summarize them and present them in front of others<br>• convey contents to other by processing them in writing |
| *Autonomy* | Students can work out and understand contents themselves during the lecture through literature research |
| **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** | Civil- and Environmental Engineering: Specialisation Traffic and Mobility: Compulsory<br>Civil- and Environmental Engineering: Specialisation Civil Engineering: Elective Compulsory<br>Civil- and Environmental Engineering: Specialisation Water and Environment: Elective Compulsory<br>Logistics and Mobility: Specialisation Traffic Planning and Systems: Elective Compulsory<br>Engineering and Management - Major in Logistics and Mobility: Specialisation Traffic Planning and Systems: Elective Compulsory |

### Course L1184: Introduction to Railways

| | |
|---|---|
| **Typ** | Lecture |
| **Hrs/wk** | 2 |
| **CP** | 4 |
| **Workload in Hours** | Independent Study Time 92, Study Time in Lecture 28 |
| **Lecturer** | André Schoppe |
| **Language** | DE |
| **Cycle** | SoSe |
| **Content** | Lecture:<br>The module provides a basic knowledge of the field of railroad engineering. An overview of railroad operations, control and safety technology, railroad superstructure, structural engineering, project management as well as maintenance and design of infrastructure facilities is given. The aim of this module is to give students as much insight as possible into railroad infrastructure. The module is examined by means of a written exam at the end of the semester.<br>Lecture Hall Exercise:<br>In order to give the students practical examples, full-day practical excursions are carried out. New handling techniques and currently available hardware will be presented by visiting the marshalling yard "die Zugbildungsanlage Maschen (ZBA)". Furthermore, the training center for track construction and civil engineering as well as the operations center in Hanover will be visited, where facilities and tasks will be presented. Questionnaires will also be provided for practice purposes. In addition, study papers can be handed out and supervised as required. |
| **Literature** | Die maßgebliche Literatur wird in StudIP veröffentlicht. Weitere Hinweise werden in der Veranstaltung gegeben. |

| Course L1185: Introduction to Railways | |
|---|---|
| **Typ** | Recitation Section (large) |
| **Hrs/wk** | 1 |
| **CP** | 2 |
| **Workload in Hours** | Independent Study Time 46, Study Time in Lecture 14 |
| **Lecturer** | André Schoppe |
| **Language** | DE |
| **Cycle** | SoSe |
| **Content** | See interlocking course |
| **Literature** | See interlocking course |

## Module M0980: Logistics, Transport and Environment

**Courses**

| Title | Typ | Hrs/wk | CP |
|---|---|---|---|
| Logistics, Transport and Environment (L0009) | Project-/problem-based Learning | 2 | 4 |
| Environmental Management and Corporate Responsibilty (L1160) | Seminar | 2 | 2 |

| | |
|---|---|
| **Module Responsible** | Prof. Heike Flämig |
| **Admission Requirements** | None |
| **Recommended Previous Knowledge** | • Introduction to logistics and mobility<br>• Foundations of Management |
| **Educational Objectives** | After taking part successfully, students have reached the following learning results |
| **Professional Competence** | |
| *Knowledge* | Students are able to...<br>• explain basic terms of transport logistics, commercial traffic, transport policy and sustainability<br>• describe actors and system boundaries, challenges and goals of transport logistics<br>• reflect standards of sustainability management |
| *Skills* | Students are able to...<br>• design logistics systems independently<br>• differentiate sustainability, CR, CSR and environmental management<br>• critically evaluate measures for sustainable logistics and develop them |
| **Personal Competence** | |
| *Social Competence* | Students can...<br>• creatively develop solutions in teams and work out presentations<br>• present their knowledge and skills to other students |
| *Autonomy* | Students can...<br>• carry out small research studies independently<br>• apply theoretical knowledge in practical projects<br>• apply presentation techniques such as free speech, designing charts (i.e. in Power-Point), use of media (Flip-Charts, Whiteboard, Metaplan) |
| **Workload in Hours** | Independent Study Time 124, Study Time in Lecture 56 |
| **Credit points** | 6 |
| **Course achievement** | None |
| **Examination** | Written elaboration |
| **Examination duration and scale** | Written assignment with short presentation |
| **Assignment for the Following Curricula** | Logistics and Mobility: Specialisation Traffic Planning and Systems: Elective Compulsory<br>Logistics and Mobility: Specialisation Production Management and Processes: Elective Compulsory<br>Logistics and Mobility: Specialisation Information Technology: Elective Compulsory<br>Engineering and Management - Major in Logistics and Mobility: Specialisation Traffic Planning and Systems: Elective Compulsory<br>Engineering and Management - Major in Logistics and Mobility: Specialisation Production Management and Processes: Elective Compulsory<br>Engineering and Management - Major in Logistics and Mobility: Specialisation Information Technology: Elective Compulsory |

| Course L0009: Logistics, Transport and Environment | |
|---|---|
| **Typ** | Project-/problem-based Learning |
| **Hrs/wk** | 2 |
| **CP** | 4 |
| **Workload in Hours** | Independent Study Time 92, Study Time in Lecture 28 |
| **Lecturer** | Prof. Heike Flämig |
| **Language** | DE |
| **Cycle** | SoSe |
| **Content** | Application and creative development of professional knowledge within the framework of the case study "Environmental impacts of supply chains" using a specific company as example.<br><br>Depending on the chosen focus of the academic year:<br><br>• characteristics of different transport systems<br>• technologies, structures and processes of transport logistics systems (nodes, network, interactions)<br>• location and route planning<br>• connections of information flow and material flows in transport chains<br>• interrelation between private and private (contract logistics) and private and public (business policy, transport policy) and their (diverging)<br>• design approaches for sustainable logistics |
| **Literature** | Ihde, Gösta B.: Transport, Verkehr, Logistik. Gesamtwirtschaftliche Aspekte und einzelwirtschaftliche Handhabung. 3. überarbeitete Auflage. Vahlen, München 2001 |

| Course L1160: Environmental Management and Corporate Responsibilty | |
|---|---|
| **Typ** | Seminar |
| **Hrs/wk** | 2 |
| **CP** | 2 |
| **Workload in Hours** | Independent Study Time 32, Study Time in Lecture 28 |
| **Lecturer** | Prof. Heike Flämig |
| **Language** | DE |
| **Cycle** | SoSe |
| **Content** | • Imparting knowledge about standards (e.g. EMAS and ISO 14.001) as important methodological approaches for the integration of environmental and sustainability management in business companies<br>• Explaination of theoretical concepts of corporate sustainability management<br>• Imparting pracitical knowledge from different stakeholder views: consulting company, trading enterprise, NGO, financial market |
| **Literature** | -- |

## Module M0671: Technical Thermodynamics I

**Courses**

| Title | Typ | Hrs/wk | CP |
|---|---|---|---|
| Technical Thermodynamics I (L0437) | Lecture | 2 | 4 |
| Technical Thermodynamics I (L0439) | Recitation Section (large) | 1 | 1 |
| Technical Thermodynamics I (L0441) | Recitation Section (small) | 1 | 1 |

| | |
|---|---|
| **Module Responsible** | Prof. Arne Speerforck |
| **Admission Requirements** | None |
| **Recommended Previous Knowledge** | Elementary knowledge in Mathematics and Mechanics |
| **Educational Objectives** | After taking part successfully, students have reached the following learning results |
| **Professional Competence** | |
| *Knowledge* | Students are familiar with the laws of Thermodynamics. They know the relation of the kinds of energy according to 1 $^{st}$ law of Thermodynamics and are aware about the limits of energy conversions according to 2$^{nd}$ law of Thermodynamics. They are able to distinguish between state variables and process variables and know the meaning of different state variables like temperature, enthalpy, entropy and also the meaning of exergy and anergy. They are able to draw the Carnot cycle in a Thermodynamics related diagram. They know the physical difference between an ideal and a real gas and are able to use the related equations of state. They know the meaning of a fundamental state of equation and know the basics of two phase Thermodynamics. |
| *Skills* | Students are able to calculate the internal energy, the enthalpy, the kinetic and the potential energy as well as work and heat for simple change of states and to use this calculations for the Carnot cycle. They are able to calculate state variables for an ideal and for a real gas from measured thermal state variables. |
| **Personal Competence** | |
| *Social Competence* | The students can discuss in small groups and work out a solution. 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 understand the problems posed in tasks physically. They are able to select the methods taught in the lecture and exercise to solve 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>Digital Mechanical Engineering: Core Qualification: Compulsory<br>Engineering Science: Specialisation Mechanical Engineering: Compulsory<br>Engineering Science: Specialisation Mechatronics: Elective Compulsory<br>Engineering Science: Specialisation Biomedical Engineering: Compulsory<br>Engineering Science: Specialisation Advanced Materials: Elective Compulsory<br>Green Technologies: Energy, Water, Climate: Core Qualification: Compulsory<br>Integrated Building Technology: Core Qualification: Compulsory<br>Logistics and Mobility: Specialisation Traffic Planning and Systems: Elective Compulsory<br>Mechanical Engineering: Core Qualification: Compulsory<br>Mechatronics: Core Qualification: Compulsory<br>Mechatronics: Core Qualification: Elective Compulsory<br>Orientation Studies: Core Qualification: Elective Compulsory<br>Naval Architecture: Core Qualification: Compulsory<br>Technomathematics: Specialisation III. Engineering Science: Elective Compulsory<br>Process Engineering: Core Qualification: Compulsory<br>Engineering and Management - Major in Logistics and Mobility: Specialisation Traffic Planning and Systems: Elective Compulsory |

| Course L0437: Technical Thermodynamics I | |
|---|---|
| **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** | SoSe |
| **Content** | 1. Introduction<br>2. Fundamental terms<br>3. Thermal Equilibrium and temperature<br>3.1 Thermal equation of state<br>4. First law<br>4.1 Heat and work<br>4.2 First law for closed systems<br>4.3 First law for open systems<br>4.4 Examples<br>5. Equations of state and changes of state<br>5.1 Changes of state<br>5.2 Cycle processes<br>6. Second law<br>6.1 Carnot process<br>6.2 Entropy<br>6.3 Examples<br>6.4 Exergy<br>7. Thermodynamic properties of pure fluids<br>7.1 Fundamental equations of Thermodynamics<br>7.2 Thermodynamic potentials<br>7.3 Calorific state variables for arbritary fluids<br>7.4 state equations (van der Waals u.a.) |
| **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 L0439: Technical Thermodynamics I | |
|---|---|
| **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** | SoSe |
| **Content** | See interlocking course |
| **Literature** | See interlocking course |

| Course L0441: Technical Thermodynamics I | |
|---|---|
| **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** | SoSe |
| **Content** | See interlocking course |
| **Literature** | See interlocking course |

# 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 |